The Highway Performance Monitoring System (HPMS)

The Federal Highway Administration (FHWA) and the States, beginning in 1978, jointly developed and implemented a continuous data collection system called the Highway Performance Monitoring System (HPMS). Currently, the HPMS contains over 110,000 highway sample segments, the most comprehensive nationwide data system in use regarding the physical condition and usage of the Nationís infrastructure. The HPMS database is the primary source of information for the Federal government about the Nationís highway system.

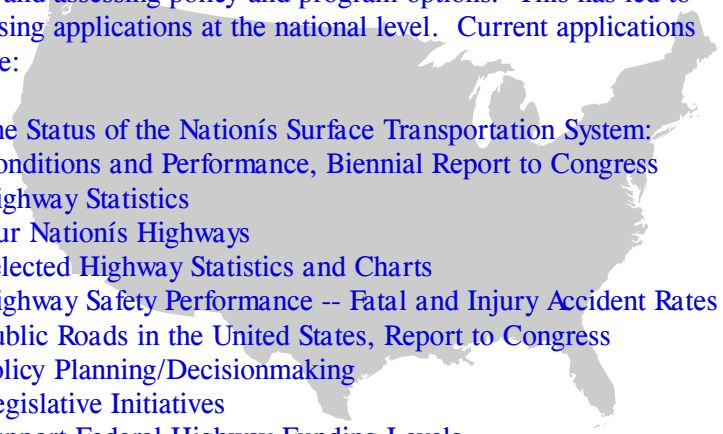
To make use of the HPMS database, FHWA developed an Analytical Process (AP). These models were originally developed and were subsequently enhanced over the years so that the U.S. Department of Transportation and the U.S. Congress can have available improved understanding of those factors which are of greatest importance in the development of highway programs and policy.

The HPMS AP is being used by FHWA, States, Metropolitan Planning Organizations (MPOs), and local government agencies to assess the physical condition, safety, service, and efficiency of operation of their respective highway systems. In addition to assessing the characteristics of the existing highway systems, the HPMS AP also is being used to predict the effect that proposed highway programs and policies are likely to have in the future. The capabilities of the HPMS AP may be summarized as:

- Assess Base Year Conditions and Performance
- Forecast Highway System Needs
- Simulate Highway System Conditions
- Analyze Investment Strategies
- Estimate User Costs

National Applications

Over the years, the HPMS has proven to be a useful tool for analyzing issues and assessing policy and program options. This has led to increasing applications at the national level. Current applications include:



- The Status of the Nationís Surface Transportation System: Conditions and Performance, Biennial Report to Congress
- Highway Statistics
- Our Nationís Highways
- Selected Highway Statistics and Charts
- Highway Safety Performance -- Fatal and Injury Accident Rates on Public Roads in the United States, Report to Congress
- Policy Planning/Decisionmaking
- Legislative Initiatives
- Support Federal Highway Funding Levels

Non-Federal Applications

Some years ago, the FHWA modified the HPMS AP models so that they could be used by State transportation agencies to assess the conditions and performance of their own highway systems. Increasingly, the States, as well as MPOs, have utilized the HPMS AP as they have addressed a wide variety of concerns about their highway systems. This reflects the advantages the HPMS has to offer to non-federal government agencies including:

- Since each State maintains its own HPMS database, no additional data collection effort is required under typical conditions;

- Use of the HPMS AP by non-federal government agencies does not involve model development costs;

- FHWA periodically provides HPMS AP software enhancements for both PC and mainframe computers;
- Operating costs for the HPMS AP are minimal (particularly in the case of the PC version);

- FHWA provides technical assistance to State and local agencies who request it; and

- Criteria used by the model can be adjusted to reflect State or local circumstance, practices, and funding constraints.

This brochure illustrates ways selected non-federal government agencies have utilized the HPMS to address a variety of their concerns. It illustrates the considerable flexibility and extensive analytical capabilities included in the design and operation of the HPMS AP.

Highway Adequacy Ratings

For States, local government agencies and MPOs, one of the most useful features of the HPMS AP is the ability to use it in development of Highway Adequacy Ratings. The AP includes routines for developing four types of indices, that is:

- Condition
- Safety
- Service
- Composite (combination of condition, safety, and service)

The AP includes provisions that allow the user to adjust the weights assigned to various elements included in the component and composite indices.

Example: Kentucky

Kentucky first used Adequacy Ratings for highway planning purposes in 1949 with occasional updates since that time. Because Kentuckyís Adequacy Rating approach addressed the same kinds of elements as the HPMS AP, an analysis was undertaken to determine whether the HPMS AP, with appropriate weights for various data elements, could be used as the standard model for the Adequacy Rating. An analysis was undertaken in which the composite indices for individual highway sections as developed by the HPMS and the Adequacy Rating program were compared. For sections where compatible data were used, it was found that there was ì good correlation.î The Kentucky Transportation Cabinet anticipates producing an Adequacy Rating Report once some data refinements have been completed.

Contact: Keith White, Division of Transportation Planning, Kentucky Transportation Cabinet (502-562-7183)

Highway Needs (Investment Requirements)

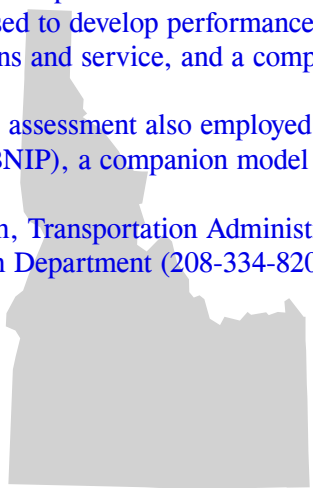
HPMS AP-generated estimates of investment requirements can serve as benchmarks for the development and evaluation of transportation policy and program options. For instance, in the 1995 Report to Congress concerning the Status of the Nationís Surface Transportation System: Condition and Performance, the AP was used to develop the investment scenario ì Cost to Maintain Current Conditions and Performance.î Previous reports to Congress also included an AP-generated scenario ì Cost to Improve Conditions and Performance.î

Example: Idaho

In 1995, Idaho completed its second comprehensive multi-jurisdiction highway needs and finance study. These analyses addressed State, county, highway district, and city road systems. The HPMS AP was used to determine deficiencies and estimate investment requirements for roadways. It was modified so that it could address needs on roads functionally classified as locals. Needs assessment criteria (minimum conditions standards, design standards, unit costs) were used which reflected Idaho conditions and practices. In addition to needs estimates, the HPMS AP also was used to develop performance ratings regarding condition, safety, operations and service, and a composite index.

This comprehensive needs assessment also employed the Bridge Needs and Investment Process (BNIP), a companion model to HPMS.

Contact: Ray Mickelson, Transportation Administrator, Idaho Transportation Department (208-334-8203)



Investment/Performance Relationships

The HPMS AP embodies an analysis which assesses the highway improvements and highway system conditions that can be expected under various funding scenarios. This is an important feature of the model because sufficient funds typically are not available to correct all highway system deficiencies. This feature enables an understanding of what kind of performance can be expected when funding is not adequate.

Example: North Carolina

The North Carolina Department of Transportation (NCDOT) utilized the HPMS AP to conduct an analysis of highway needs along with an assessment of the future performance and condition effects resulting from alternative policies and funding scenarios. This was accomplished by using the APís capabilities to simulate conditions and performance at seven funding levels (100, 80 , 70, 60, 40, 10 and 0 percent). For each funding level, HPMS outputs regarding safety, service, condition and composite indices were plotted. Investment/performance analyses were conducted for each functional classification to facilitate evaluations of the future impacts of different funding strategies and improvement programs.

North Carolina also employed the Bridge Needs and Investment Process (BNIP) to conduct a similar investment/performance analysis for bridges.

NCDOT concluded that the HPMS AP and BNIP ì… can provide an informational support basis to help management evaluate policy, analyze needs, develop improvement programs, and allocate money to maintain optimally the North Carolina highway and bridge systems.î

Contact: Marion R. Poole, Manager, Statewide Planning Branch,
North Carolina Department of Transportation
(919-733-4705)

Corridor Planning

While the HPMS AP was developed as a strategic planning tool, it embodies a number of technical procedures that can be used for other purposes. For instance, the AP includes analytical routines that assess the ìadequacyî of important highway features. In this context, ìadequacyî implies sufficiency to satisfy a specific requirement or standard (i.e., minimum conditions standards). This is consistent with processes often used to assess improvement needs by other means. Because the AP is automated, it can ease the computational effort required by such evaluations.

Example: Oregon

The HPMS AP is used by the Oregon Department of Transportation (ODOT) to assist in planning improvements to major corridors. Some 26 corridors have been designated to be of statewide significance. For each corridor, an HPMS dataset has been developed for 100 percent coverage. The HPMS AP is run with these datasets to review geometric and operational improvement needs. For each corridor, the HPMS AP is applied under two scenarios; i.e., the No Build and Total Build (full needs) scenarios. Results are analyzed in terms of congestion levels, travel speeds, geometric deficiencies, etc.

The results of these analyses are documented and transmitted to the appropriate regional office of ODOT for review and consideration as they develop corridor improvement plans. The information is an important part of the planning that leads to the development of the 6-year Statewide Transportation Improvement Program (STIP).

Oregon also used the HPMS AP in conjunction with a comprehensive multi-jurisdiction highway needs and finance study. The model was customized to permit assessment of a wider range of functional classifications than is covered by the FHWA version of HPMS AP.

Contact: Rich Arnold, Senior Highway Needs Analyst, Oregon Department of Transportation (503-986-4218)

State Transportation Plans

A principal focus of the HPMS AP is the development of information required for strategic and systems planning. That is, it has capabilities to:

- ï Define the current status and existing backlog of highway deficiencies;
- ï Identify, through simulation processes, the future conditions of the highway system;
- ï Estimate the investment requirements to address highway deficiencies; and
- ï Assess the condition and performance of the highway system under alternative funding scenarios.

These capabilities are valuable in the development of ISTEA-mandated Statewide Transportation Plans.

Example: South Carolina

The South Carolina Department of Transportation (and its predecessor organization) has been a user of the HPMS AP since 1988. Most recently, it was used in conjunction with the development of the Statewide Transportation Plan. This included identification of the existing backlog of deficiencies and the associated cost to address the deficiencies. Future needs also were identified. It was found that ì… future needs will grow at a faster rate than the Department will be able to fund improvements to solve these problems. Consequently, the condition of state highways will be expected to get much worse during the next twenty years.î A funding proposal to address this problem was included in the Plan.

Contact: James Campbell, Director of Planning, South Carolina Department of Transportation (803-737-1444)

Strategic Planning

As one of FHWAís major strategic planning tools, the HPMS is designed to measure and monitor the condition, performance, usage, and operating characteristics of the Nationís highways for use by policy decisionmakers and Congress in developing and evaluating Federal-aid highway programs and funding levels. Additionally, FHWA provides Congress with assessments of future highway investment needs and investment/performance relationships for budget and program development purposes.

These principal characteristics of the HPMS also are useful to State transportation agencies involved in strategic planning.

Example: Texas

Every two years, the Texas Department of Transportation (TxDOT) prepares its Strategic Plan in compliance with a Texas State Legislative mandate that applies to all state agencies. The most recent Strategic Plan covers the period 1995-1999. One of the elements of the Strategic Plan is an External/Internal Assessment which addresses a variety of topics. This includes fiscal aspects, funding requirements, and other topics. The HPMS AP was used by TxDOT to develop the highway component of the funding requirements analysis. The model also was employed in development of the current version of the Texas Transportation Plan.

TxDOT also used the HPMS AP to develop its Strategic Mobility Plan which linked the Departmentís mission and strategic goals and the investment required to fulfil those goals. This was followed by a review of the HPMS by the Office of the State Auditor which supported and validated the Departmentís use of the model and database. The Department concluded that ì In assessing the tailoring of HPMS for Texas as well as reviewing activities related to data gathering and computer modeling of needs, … use of the HPMS has been found to be quite satisfactory.î

Contact: Artie V. Elliott, Jr., Strategic Management Group, Texas Department of Transportation (512-463-6083)

Performance Monitoring

Because the HPMS database is updated periodically, it provides an excellent opportunity for benchmarking/performance monitoring. That is, a time series of system performance and condition indicators can be compiled from the database. Further, outputs of the AP also can be employed on a time series basis to ascertain trends in deficiencies, improvement requirements, and the four performance indices developed by the AP.

Example: California

Because of the value of transportation information to a wide range of public and private organizations, the California State Department of Transportation (Caltrans) annually produces a report containing HPMS data. In addition to substantial information regarding system mileage and vehicle miles of travel, the HPMS is used in the ìAssembly of Statistical Reportsî for system performance monitoring, including compilations such as mileage and travel by:

- ï Weighted design speed;
- ï Volume service flow ratio;
- ï Pavement condition;
- ï Lane width;
- ï Horizontal alignment adequacy; and
- ï Vertical alignment adequacy.

By comparing these annual HPMS-derived data, assessments can be made of the effectiveness of transportation programs in improving system performance over time.

Contact: Jane E. Wegge, Transportation System Information Program, California Department of Transportation (916-653-3272)

VMT Tracking

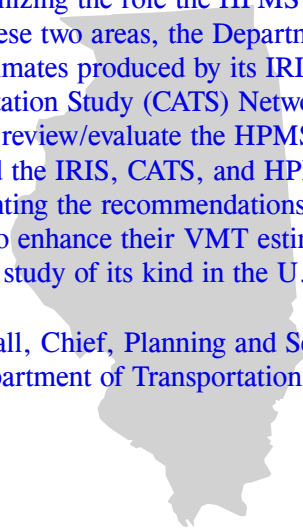
The HPMS provides a standard, recognized database that covers all regions of the U.S. In recognition of these features, the Environmental Protection Agency (EPA) now relies upon HPMS to estimate vehicle miles of travel (VMT) in connection with air quality conformity analyses undertaken pursuant to the 1990 Clean Air Act Amendments (CAAA). Consequently, in air quality nonattainment areas, improved VMT tracking is becoming more important.

Example: Illinois

The Illinois Department of Transportation (IDOT) is typical of large state DOTs from a data management viewpoint. The Department has invested a substantial amount of time and money to develop its own database to support planning efforts and contribute statistics and information for other purposes. IDOT produces/updates the HPMS from its Illinois Roadway Information System (IRIS) annually.

Illinois has two nonattainment areas: Chicago and the Illinois portion of St. Louis. While recognizing the role the HPMS will assume in monitoring VMT for these two areas, the Department is sensitive to differences in VMT estimates produced by its IRIS, the HPMS, and the Chicago Area Transportation Study (CATS) Network Model. IDOT has engaged a consultant to review/evaluate the HPMS sample in these two nonattainment areas and the IRIS, CATS, and HPMS VMT estimation processes. By implementing the recommendations from this study, IDOT and CATS hope to enhance their VMT estimation processes. This is the only current study of its kind in the U.S.

Contact: James P. Hall, Chief, Planning and Services Section, Illinois Department of Transportation (217-785-2752)



System Classification

One of the values of the HPMS AP in highway planning applications is its ability to estimate the investment requirement impacts of alternative needs assessment criteria. The AP readily accommodates changes in minimum conditions standards used to identify deficiencies. Likewise, the user can easily modify design standards which apply to improvements simulated by the model. The results of analyses regarding different criteria can help a transportation agency evaluate the effect of various policies that are associated with such matters, including system classification.

Example: Kansas

Like all states, Kansas has used the federal functional classification criteria in its highway planning processes. However, the Kansas Department of Transportation (KDOT) was concerned that application of the Stateís arterial standards to the large mileage in the arterial classification would result in substantial reconstruction and replacement costs. This was because, under the Stateís standards, geometric improvements made to low-volume arterials had to be made to full arterial standards. Therefore, the Department undertook a reclassification process in connection with preparation of the State Transportation Plan (STP). In this process, the federal designations were replaced with categories defined as Classes A through E. The Department then assessed the impact upon road user costs of program funding allocations and standards based upon the reclassified system. These analyses determined that ì… user costs more than double … for the conventional functional classification … with the same funding level, the road user costs increased only slightly when the funds were allocated according to the STP classification and standards.î

KDOT also has used the HPMS AP in other applications. This includes investigation of the effects of a ì maintenance onlyî funding scenario and the cost of deferring maintenance.

Contact: Dean Landman, consultant to and recently retired from the Kansas Department of Transportation (913-266-4467)

Highway User Cost Analysis

The HPMS AP includes several impact analyses such as travel speeds, accidents, emissions, fuel consumption, and operating costs. This analytical capability can be used to determine the effects on these performance characteristics of various policy scenarios, such as varying funding levels or emphasizing certain improvement types.

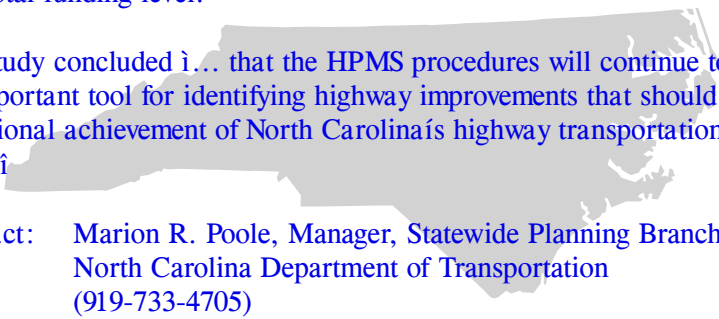
Example: North Carolina

In one of its applications of the HPMS AP, the North Carolina Department of Transportation (NCDOT) undertook a study with these objectives in mind, that is:

- Estimation of needs (investment requirements);
- Development of investment/system performance relationships; and
- Assessment of the effect on user costs associated with three different investment levels.

Methodologies developed by the FHWA were employed by NCDOT to compute user costs. The three investment levels examined were:

- Zero funding level;
- Maintain conditions level; and
- Total funding level.



The study concluded ì… that the HPMS procedures will continue to be an important tool for identifying highway improvements that should lead to optional achievement of North Carolinaís highway transportation goals.î

Contact: Marion R. Poole, Manager, Statewide Planning Branch, North Carolina Department of Transportation (919-733-4705)

Roadway Inventory Database

The HPMS database is the primary source of information for the Federal government about the Nationís highway infrastructure. The HPMS includes statistical information about pavement condition, roadway features, traffic characteristics and system performance.

The State-furnished HPMS data also is a valuable resource for State transportation agencies. Indeed, a number of States have elected to expand the database to serve better their own information needs.

Example: North Dakota

The North Dakota Department of Transportation (NDDOT) relies heavily on the HPMS as a highway database to support a variety of planning functions. NDDOT does not maintain other independent databases for highways; it uses the HPMS to develop mileage and traffic statistics used by DOT planners, MPOs, local governments, and private concerns with a transportation focus (e.g., trucking companies, railroads). The Planning Division is a primary user of the VMT output of HPMS in its work (plan development, capital program).

The agency has downloaded the HPMS to a PC database that can be managed within the Planning Division. The Planning Division is in the process of converting the HPMS database to the NDDOTís GIS. Once this is accomplished, the Division intends to use the HPMS even more extensively in the planning process.

Contact: Robert Olzweski, Transportation Project Manager, Planning Division, North Dakota Department of Transportation (701-328-3479) - for HPMS

Brad Wentz, GIS Coordinator, Planning Division, North Dakota Department of Transportation (701-328-3736) - for GIS

Budgeting Process

Some of the most useful functions of the HPMS AP are its capabilities to evaluate a wide range of scenarios regarding budget allocations. The AP can be executed with any specific budget allocation the user may wish to examine. This can include varying budget ceilings for specific subsets of the total highway system. Also, the AP can be executed with different total budget amounts to examine the effects of increased funding. Using these capabilities, the AP permits assessment of a variety of impacts and effects under each scenario (e.g., changes in backlog deficiencies, effects of deferred improvements, impacts on user costs, etc.). With this information, it is possible to make informed decisions about optimal budget allocations.

Example: Quebec

The Quebec Ministry of Transportation uses output from the HPMS Analytical Process to support two key components of its capital budgeting and program planning processes: developing annual capital budget requests and allocation of capital resources to its regional offices.

The Ministry has such a ì high level of confidence in its outputî that the Planning and Research Division uses direct AP output to determine annual transportation capital budget requests. The Ministry diligently supports the HPMS database and has developed a high degree of credibility with legislative interests in using the HPMS AP to support capital budget requests.

HPMS AP output is also used by the Ministry to allocate available capital resources to its regional offices. Using this technical, objective method of resource allocation instills a high level of confidence agency-wide in the Ministry's goal to provide quality transportation services in all geographic portions of the province.

Contact: Yvan Demers, Assistant Deputy Minister, Quebec Ministry of Transportation (418-528-0808)

Statewide Informational Booklet

At the minimum, the HPMS is a joint Federal and State undertaking. Whereas FHWA has responsibility for the maintenance and enhancement of the AP and analysis of national issues, the States supply the HPMS database upon which these analyses are based.

In some instances, the HPMS partnership extends to MPOs and local governments. In some States, local officials are asked to contribute data to the system. Given this extended partnership, there are occasions in which there has been a sharing of the information that is obtained from the database and analyses employing the AP.

Example: Washington State

As a means of providing local governments with improved explanations of the purposes for which HPMS can be used, the Washington State Department of Transportation (WSDOT) developed and distributed an informational booklet entitled ìWashington State Roadways: Selected Data and Analysis from the Highway Performance Monitoring System (HPMS).î This provided the Department an opportunity to highlight major concerns that emerged from the HPMS analyses.

The informational booklet addressed a number of topics such as (1) an overall description of the existing highway system; (2) travel characteristics; (3) pavement types and conditions; (4) urban congestion; (5) performance ratings; (6) backlog needs; (7) future roadway conditions; (8) future improvement needs; and (9) roadway conditions at various funding levels.

Contact: Loyd R. Fergestrom, Transportation System Engineer, Washington State Department of Transportation (360-705-7955)

In Conclusion

For almost two decades, HPMS has provided a sound basis for evaluating highway system deficiencies and improvement needs, for performing investment level/system performance analyses, and for conducting a variety of impact analyses for federal and other uses. No other model of this type has achieved the longevity that HPMS has. In addition to the basic soundness of the HPMS, use by non-federal organizations has increased as HPMS has been improved and enhanced a number of times over the years.

HPMS in the Future

As a dynamic, multipurpose information system, HPMS will continue to keep abreast of emerging essential data and analytical needs. Future enhancements will include technological and other advancements to maximize overall program utility, effectiveness, and efficiency at all levels of government. These include:

- Development of highly efficient, state-of-the-art software systems;
- Use of emerging electronic data access, delivery, and dissemination systems;
- Development of electronic publications, including CD ROM; and
- Data and analytical enhancements to keep abreast of essential needs of the HPMS partnership, including those of the Federal-aid highway program and the stewardship needs of the States and FHWA.

Contact: Beverly J. Harrison, Transportation Specialist, Office of Highway Information Management, Federal Highway Administration (202-366-4048)