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Standard Guide for Prioritization of Data Needs for Pavement Management[1]

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1. Scope

1.1 This guide identifies data needs for pavement management systems. It also addresses the relative importance of various types of pavement data.

1.2 This guide was developed for use by federal, state, and local agencies, as well as consultants who provide services to those agencies.

1.3 This guide describes a process and provides a set of recommendations that any agency may use to develop a plan for acquiring pavement management data. Any individual agency may justifiably assign higher or lower priority to specified data items depending on their needs and policy.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 3319 Practice for Accelerated Polishing of Aggregates Using the British Wheel[2]
D 4123 Test Method for Indirect Tension Test for Resilient Modulus of Bituminous Mixtures[2]
D 4602 Guide for Nondestructive Testing of Pavements Using Cyclic Loading Dynamic Deflection Equipment[2]
D 4694 Test Method for Deflection With a Falling-Weight-Type Impulse Load Device[2]
D 4695 Guide for General Pavement Deflection Measurements[2]
D 4748 Test Method for Determining the Thickness of Bound Pavement Layers Using Short-Pulse Radar[2]
D 5340 Test Method for Airport Pavement Condition Index Surveys[2]
E 274 Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire[2]
E 303 Test Method of Measuring Surface Frictional Properties Using the British Pendulum Tester[2]
E 445 Test Method for Stopping Distance on Paved Surfaces Using a Passenger Automobile Equipped With Full-Scale Tires[2]
E 501 Specification for Standard Tire for Pavement Skid-Resistance Tests[2]
E 503 Test Methods for Measurement of Skid Resistance on Paved Surfaces Using a Passenger Vehicle Diagonal Braking Technique[2]
E 524 Specification for Standard Smooth Tire for Pavement Skid-Resistance Tests[2]
E 556 Test Method for Calibrating a Wheel Force or Torque Transducer Using a Calibration Platform (User Level)[2]
E 660 Practice for Accelerated Polishing of Aggregates or Pavement Surfaces Using a Small-Wheel, Circular Track Polishing Machine[2]
E 670 Test Method for Side Force Friction on Paved Surfaces Using the Mu-Meter[2]
E 770 Test Method for Classifying Pavement Surface Textures[2]
E 867 Terminology Relating to Vehicle-Pavement Systems[2]
E 950 Test Method for Measuring the Longitudinal Profile of Traveled Surfaces With an Accelerometer Established Inertial Profiling Reference[2]
E 965 Test Method for Measuring Pavement Macrotexture Depth Using a Volumetric Technique[2]
E 1082 Test Method for Measurement of Vehicular Response to Traveled Surface Roughness[2]
E 1166 Guide for Network-Level Pavement Management[2]
E 1170 Practice for Simulating Vehicular Response to Longitudinal Profiles of Traveled Surfaces[2]
E 1215 Specification for Trailers Used for Measuring Vehicle Response to Road Roughness[2]
E 1274 Test Method for Measuring Pavement Roughness Using a Profilograph[2]

2.2 *Other Publications:*

Guidelines on Pavement Management, AASHTO (1990)[3]
AASHTO Guide for Design of Pavement Structures, AASHTO (1986)[3]
FHWA Pavement Policy for Highways, Federal Register, Vol

[1] This guide is under the jurisdiction of ASTM Committee E17 on Vehicle-Pavement Systems and is the direct responsibility of Subcommittee E17.41 on Pavement Management.

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[2] *Annual Book of ASTM Standards*, Vol 04.03.

[3] Available from the American Association of State Highway and Transportation Officials, 444 N. Capitol St. NW, Washington, DC 20001.

54, No. 8 pp. 1353–58 (Jan. 13, 1989)[4]
Pavement Management Practices, NCHRP Synthesis 135 (1987)[5]
Guidelines and Procedures for Maintenance of Airport Pavements, FAA Circular 150-5320-6[6]

3. Significance and Use

3.1 A key objective of all pavement-management systems (PMS) is to provide a factual basis for improving the quality of decision making regarding the budgeting, design, programming, construction, maintenance and operation of a pavement network. Quality decision making requires a current inventory of the pavement system, evaluation of the present condition and use of the pavement system, estimation of future condition, and the implications of any changes in condition.

3.2 This guide may be used to identify data needs for pavement management by considering the use, generic type, and relative importance of the pavement. It can also assist in identifying methods for obtaining the data.

3.3 Any data element selected for collection should have a specific use and be of value in providing information from the PMS for the decision making process.

3.4 The specific type of data needed to make informed pavement management decisions will vary with such factors as the size, complexity and condition of the pavement network, the levels of service to be provided, the agency budget and budgeting process. Further, since pavement management is a dynamic process, responsive to changes in technology, the data needs for a particular agency may be expected to change over time. Accordingly, judgment invariably will be required in applying this guide to develop a hierarchy of data needs.

4. Data Types and Acquisition Methods

4.1 General types of pavement management data include the actual physical measurement of the pavement, information about usage, (that is, traffic and accident data) and administrative information. Both the types and acquisition methods of pavement management data can be generally classified.

4.2 The most appropriate classifications for the various types of pavement data are those related to the following groups.

4.2.1 *Performance*, the ability of a pavement to fulfill its purpose over time as reflected in the measurable change in condition over time,

4.2.2 *History*, past occurrences that influence pavement performance,

4.2.3 *Costs*, investment necessary for performance improvement or the liability as a result of declining performance,

4.2.4 *Policies and Regulations*, decisions that are made as constraints to pavement systems,

4.2.5 *Geometry*, alignment, dimensions and shape of the pavement and its apertenances, and

4.2.6 *Environment*, external factors affecting pavement performance.

4.3 This classification scheme has been used to incorporate all the component generic data items in Table 1. Table 1 also presents the corresponding methods to acquire those data items, again on a generic basis.

5. Sample Size and Frequency

5.1 The collection of pavement management data may be continuous or may involve a sampling process based on time, location, or other suitable parameters. The general type of sample (stratified or continuous), its size, and the time interval between repeat sampling, may vary considerably from agency to agency and from one type of analysis to another. The appropriate type and rate of sampling is dictated primarily by the nature of the analysis to be performed (that is, network versus project, trend analysis versus project design), the relative importance of the end use (that is, policy setting versus routine analysis), the budget of the managing agency, as well as conventional statistical considerations required to ensure that the data will be sufficiently accurate and precise to permit valid interferences to be drawn.

6. Uses of Data

6.1 Pavement management data is used for network and project level purposes. Network level management requires information for planning, budgeting, and forecasting trends. Project level management requires information for design and engineering of specific pavement sections or projects. The various data are used in network and project level analysis as shown in Table 2.

[4] Available from the U.S. Department of Transportation, Federal Highway Administration, Washington, DC 20590.
[5] Available from the Transportation Research Board, Box 289, Washington, DC 20055.
[6] Available from the Federal Aviation Administration, 800 Independence Ave., S.W., Washington, DC 20591.

TABLE 1 Pavement Management Data Items and Acquisition Methods

Data Category	Typical Acquisition Method(s)	Available Related ASTM Standards
Performance-Related		
Roughness	subjective rating	
	response type equipment	E 1082, E 1215
	profile measurement and response simulation	E 950, E 1170
	profilograph measurements	E 1274
Surface distress	pavement distress surveys (manual or automated)	D 5340
Friction	side force equipment	E 670
	locked wheel equipment	E 274, E 445, E 501, E 503, E 524, E 556
	slip friction (incipient) equipment	
	pendulum equipment	E 303
	texture measurement methods	D 3319, E 660, E 770, E 965
Deflection	impulse equipment	D 4694, D 4695
	static equipment	D 4695
	cyclic force equipment	D 4602, D4695
Layer material properties	in-situ and laboratory material testing	Many ASTM standards (Vol 04.03)
	back-calculation of material properties from field tests	None exist. Several useful methods available
	nondestructive pavement tests	D 4694, D 4695
	layer thickness	D 4748
History-Related		
Maintenance history	records, estimates, surveys, in-situ testing	
Construction history (includes new construction, reconstruction, rehabilitation and repair)	as-built records, estimates, surveys, in-situ testing	
Traffic	records, estimates and surveys	
Accidents	records, estimates and surveys	
Cost-Related		
Construction costs (includes new construction, reconstruction, rehabilitation and repair)	records, estimates and surveys	
Maintenance costs	records, estimates and surveys	
User costs	records, estimates and surveys	
Policy-Related		
Budget	records, public officials and other agencies	
Available alternatives	records, organizations, suppliers and other agencies	
Levels of service	public officials and policy statements	
Geometry-Related		
Section dimensions	records, estimates, direct measure and in-situ testing	
Curvature	records, estimates and direct measure	
Cross slope	records, estimates and direct measure	
Vertical curvature	records, estimates and direct measure	
Shoulder/curbs	records, estimates and direct measure	
Environment-Related		
Drainage	analysis from records or field observation/measurement	
Climate	analysis from records or field observation/measurement	

TABLE 2 Typical Uses of Pavement Management Data

Data Category	Network Level	Project Level
Performance-Related		
Roughness	a) Describe present status and estimate impacts on users	a) Quality assurance (as-built quality of new surface)
	b) Predict future status (deterioration curves) and impact on condition and users	b) Create deterioration curves
	c) Identify current and future needs	c) Estimate milling/leveling/overlay quantities
	d) Basics for priority analysis and programming	d) Determine effectiveness and benefit of alternative treatments
Surface distress	a) Describe present status and estimate impacts on users	a) Selection of maintenance treatment
	b) Predict future status (deterioration curves) and impact on condition and users	b) Predict future status
	c) Identify current and future needs	c) Identify needed spot improvements
	d) Maintenance priority programming	d) Develop maintenance and construction quantity estimates
	e) Determine effectiveness and benefits of alternative treatments	e) Determine effectiveness and benefit of alternative treatments
Surface friction	a) Describe present status and estimate impacts on users	a) Identify spot or section rehabilitation requirements
	b) Predict future status and impact on condition and users	b) Determine effectiveness and benefit of alternative treatments
	c) Priority programming	
	d) Determine effectiveness and benefit of alternative treatments	
Deflection	a) Describe present status	a) Input rehabilitation design
	b) Predict future status and impact on condition	b) Determine as-built structural adequacy
	c) Identify structural inadequacies	c) Estimate remaining service life
	d) Determine seasonal load restrictions	d) Determine seasonal load restrictions

TABLE 1 *Continued*

Data Category	Network Level	Project Level
	Performance-Related	
	e) Priority programming of rehabilitation	e) Determine effectiveness and benefit of alternative treatments
	f) Determine effectiveness and benefit of alternative treatments	
Layer material properties	a) Estimate section-to-section variability	a) Input rehabilitation design
	b) Develop basis for improved design standards	b) Determine as-built structural adequacy
	c) Describe present status	c) Estimate remaining service life
	d) Predict future status and impact on condition	d) Determine seasonal load restrictions
	e) Identify structural inadequacies	e) Determine effectiveness and benefit of alternative treatments
	f) Determine seasonal load restrictions	f) Provide as-built records
	g) Priority programming of rehabilitation	
	h) Determine effectiveness and benefit of alternative treatments	
	History-Related	
Maintenance history	a) Maintenance programming	a) Identify and diagnose problem sections
	b) Evaluate maintenance effectiveness	b) Evaluate maintenance effectiveness
	c) Determine effectiveness and benefit of alternative treatments	c) Determine effectiveness and benefit of alternative treatments
Construction history	a) Evaluate construction effectiveness	a) Provide as-built records
	b) Evaluate effectiveness of alternative designs and construction practices	b) Provide feedback to design
	c) Determine need for improved quality assurance procedures	
Traffic history	a) Priority programming	a) Input for pavement design
	b) Input to estimate general performance/distress trends	b) Identify traffic handling methods
	c) Estimate structural capacity	c) Estimate remaining service life
		d) Estimate structural capacity
Accident history	a) Develop countermeasures	a) Identify high-risk sites
	b) Priority programming	b) Develop countermeasures
	Cost-Related	
Construction costs	a) Priority programming	a) Economic evaluation
	b) Selection of network investment strategies	b) Selection of strategies
	c) Budget estimates	c) Bid evaluation
Maintenance costs	a) Priority programming	a) Evaluation of maintenance effectiveness
	b) Selection of network maintenance strategies	b) Selection of maintenance sections
	c) Budget estimates	c) Bid evaluation
Rehabilitation costs	a) Priority programming	a) Economic evaluation
	b) Selection of network rehabilitation strategies	b) Selection of rehabilitation strategies
	c) Budget estimates	c) Bid evaluation
User Costs	a) Priority programming	a) Economic evaluation
	b) Selection of management strategies	b) Selection of project strategies
	Policy-Related	
Budget	a) Priority programming	a) Economic evaluation
	b) Selection of management strategies	
	c) Life cycle cost comparisons	
Service level standards	a) Service performance assessment	a) Maintenance intervention limits with respect to service
	Geometry-Related	
Section dimensions	a) Apply general policy or standards	a) Assess section constraints
	b) Quantity estimation	b) Quantity estimation
Curvature	a) Apply general policy or standards	a) Assess section constraints
	b) Assess traffic operation	b) Assess safety
Cross slope	a) Apply general policy or standards	a) Assess safety
		b) Assess drainage
Grade	a) Apply general policy or standards	a) Assess safety
	b) Assess traffic operation	b) Assess drainage
Shoulder/curbs	a) Apply general policy or standards	a) Assess safety
		b) Assess drainage
	Environment-Related	
Drainage	a) Evaluate general network performance	a) Evaluate section
Climate	a) Evaluate general network performance	a) Evaluate section

7. Factors in Establishing Priorities

7.1 The following factors are important and should be considered in establishing data priorities, although not necessarily in the order listed.

7.1.1 *Type and class of facility*, highway (urban versus rural); airfield (commercial versus general),

7.1.2 *Functional classification*, highway (freeway, arterial, collector, local); airfield (runway, taxiway, apron),

7.1.3 *Levels-of-service*, that is, limiting values of roughness, severity and extent of various types of surface distress, etc.,

7.1.4 *Size of pavement network*,

7.1.5 *Type of agency*, that is, federal, state, local, 7.1.6 *Characteristics of agency*, that is, size, technical expertise, budget, data acquisition and data processing capabilities, policy, etc.,

7.1.7 *Traffic*, for highways: traffic volumes, vehicle classes and weights; for airfields: maximum wheel loads, number of repetitions of various loads,

7.1.8 *Intended use(s) and users of data*, that is, develop status reports, planning and programming documents, design or maintenance requirements, assess current analysis techniques, develop legislation and public information,

7.1.9 *Type and cost of data acquisition*, that is, manual, semiautomated, automated,

7.1.10 *Required precision and bias of various elements*,

7.1.11 *Prevalent distress types*,

7.1.12 *Frequency of data collection*, that is, time and space may vary with type of facility, agency budget, current network condition, etc., and

7.1.13 *Requirements for output to other agencies*, for example, legislative/administrative mandates.

8. Priority of Data Needs Guidelines

8.1 Many of the factors listed in Section 7 have been considered in developing guidelines that indicate the relative importance of the various data items in network and project level applications. These guidelines are shown in Table 3, Table 4, and Table 5 respectively, for roads, airfields, and other paved areas.

8.2 In the tables, the relative importance of a data to the item to the decision made at a given level is classified as either high, medium, or low (H, M, or L).

8.2.1 The level of importance of a data item does not necessarily indicate the required precision or preferred acquisition method for that data. Users should select a data acquisition method that is appropriate to their operational resources, to the reliability of their decision support model, and to their overall information management system. For example, although roughness may be of high importance for even low volume, major roads, this does not imply that a certain type of equipment be used for data acquisition.

8.3 The definition of major and minor highways in Table 3 is intended to cover most agency practices. Major highways would normally include freeways and arterials. Minor highways would normally include collectors and local streets. Some agencies use the terminology of primary, secondary, and tertiary highways. In such cases, a decision would be required as to whether the secondary classification best suits the major or minor classification of Table 3.

8.3.1 Likewise, the classification of traffic volumes into high and low categories is intended to represent but not be restricted to an annual average daily traffic volume (AADT) in excess of 10 000 for high and less than 10 000 for low; however, this is open to interpretation. Table 3 is intended to be applicable to all functional classifications, ranging from the

TABLE 3 Priority Guidelines (Level of Importance) of Data Needs: Roads and Highways

Data Categories	Network Level				Project Level			
	Major		Minor		Major		Minor	
	High Traffic	Low Traffic	High Traffic	Low Traffic	High Traffic	Low Traffic	High Traffic	Low Traffic
Performance-Related								
Roughness	H	H	M	M	H	H	H	H
Surface distress	H	H	H	H	H	H	H	H
Surface friction[A]	M	M	M	L	H	L	M	L
Deflection	M	L	M	L	H	H	H	M
Layer material properties	L	L	L	L	H	M	M	L
History-Related								
Construction	H	H	M	L	H	H	M	L
Maintenance	H	M	M	L	H	M	M	L
Traffic	H	M	M	L	H	M	M	L
Accident	H	M	H	M	H	H	H	M
Cost-Related								
Construction	H	H	H	H	H	H	H	H
Maintenance	H	H	H	M	H	H	H	M
User	H	M	M	L	H	M	M	L
Policy-Related								
Budget	H	H	H	H	H	H	H	H
Available alternatives	H	H	H	M	H	H	H	M
Service level standard	H	M	M	L	H	M	M	L
Geometry-Related								
Section dimensions	H	H	H	H	H	H	H	H
Curvature	H	M	M	L	H	M	M	L
Cross slope	M	L	M	L	H	M	M	M
Vertical curvature	M	L	L	L	M	L	L	L
Shoulder/curb	H	M	H	M	H	H	H	M
Environment-Related								
Drainage	H	M	H	M	H	M	H	M
Climate	H	M	M	L	H	M	M	L

[A] See 1.4.

TABLE 4 Priority Guidelines (Level of Importance) of Data Needs: Airfields

Data Categories	General Aviation		Commercial Aviation	
	High Traffic	Low Traffic	High Traffic	Low Traffic
Performance-Related				
Roughness	M	L	H	L
Surface distress	H	H	H	H
Surface friction[A]	M	L	H	M
Deflection	M	L	H	M
Layer material properties	M	L	M	L
History-Related				
Construction	H	H	H	H
Maintenance	H	M	H	M
Traffic	H	M	H	M
Accident	L	L	L	L
Cost-Related				
Construction	H	H	H	H
Maintenance	H	M	H	M
User	M	L	M	L
Policy-Related				
Budget	H	H	H	H
Available alternatives	H	M	H	M
Service level standard	H	H	H	H
Geometry-Related				
Section dimensions	H	H	H	H
Curvature	L	L	L	L
Cross slope	M	L	H	L
Vertical curvature	L	L	L	L
Shoulder	L	L	L	L
Environment-Related				
Drainage	H	M	H	M
Climate	M	L	H	M

[A]See 1.4.

highest volume roads of large agencies (major, high) to the lowest volume roads of small agencies (minor, low). Users may choose to interpret the range differently to suit the specific characteristics of their network.

8.4 Only two basic types of airfields are considered in Table 4: general and commercial aviation. The high traffic level would normally represent, but not be restricted to, facilities with more than 200 aircraft takeoffs and landings per day. The low traffic level normally would be less.

8.5 Only two basic types of other paved areas are considered in Table 5: heavy and light traffic areas. The former normally would include industrial yards and the like with a high percentage of loaded trucks. The latter would normally include areas used mainly by cars (for example, shopping center parking lots).

TABLE 5 Priority Guidelines (Level of Importance) of Data Needs Other Paved Areas (Commercial Areas, Industrial Yards, etc.)

Data Category	High Traffic	Low Traffic
Performance-Related		
Roughness	L	L
Surface distress	H	H
Surface friction	L	L
Deflection	H	L
Layer material properties	M	L
History-Related		
Construction	H	H
Maintenance	M	L
Traffic	H	L
Accident	N/A	N/A
Cost-Related		
Construction	H	H
Maintenance	H	M
User	N/A	N/A
Policy-Related		
Budget	H	H
Available alternatives	H	M
Service level standard	H	M
Geometry-Related		
Section dimensions	H	H
Curvature	N/A	N/A
Cross slope	H	M
Vertical curvature	M	L
Shoulder/curbs	N/A	N/A
Environment-Related		
Drainage	H	M
Climate	M	L

9. Data Storage

9.1 Data storage can range from manual to highly automated. There are different information processing systems. Full awareness of their capabilities should exist before selecting the most appropriate one. For example, a local agency well may have their data storage on a microcomputer as part of a self-contained pavement management system. In contrast, because of the volume of data and distribution and type of users, large agencies may want large, centralized data base systems.

10. Examples

10.1 Appendix X1 presents a simplified example of pavement management data acquisitions that might be used by a small city street department. Appendix X2 presents a similar example for a large agency. Appendix X3 presents a similar airport example. These appendixes are predicated on providing a basis for a network level analysis. Project level analysis would require a more detailed data analysis.

APPENDIXES

(Nonmandatory Information)

X1. SMALL AGENCY EXAMPLE

X1.1 In case of a small agency, the street department may want to establish a data base for their street network. This data base can be managed by manual or automated methods and may contain many data items, beginning with an inventory and condition survey of each street. Pavement historical data (for example, pavement type, thickness, age) is also very desirable.

X1.2 *Performance Related:*

X1.2.1 *Surface Distress*—The surface condition surveys may be conducted manually using appropriately trained personnel available in-house. The survey often is based on city blocks; that is, each city block is defined as a unique, data collection section and surveyed individually. The block-by-block approach may result in a substantial number of sections; therefore, a computerized data base would be beneficial.

X1.2.1.1 Sections can be segregated into two functional classes: major and local roadways. Major roadways include arterial and the collector streets, whereas, local roadways include all of the residential streets. Subcategories within each class also may be established.

X1.2.1.2 The survey procedure may be very basic if the agency is planning to use in-house personnel and manual data collection techniques. One rating form is prepared for each section. Distresses can be rated according to their severity and extent by either walking over each section or by driving at a suitably slow speed and occasionally getting out of the vehicle for detailed inspection. The raters either can work individually or in teams for cross-checking and safety purposes. A monitor should check their rating from time-to-time by independently rating a sampling of sections. Prior to inspection, a training class should be conducted to develop consistency among raters. The major streets often are rated every year. Local streets may be rated at less frequent intervals, depending on the resources available. The manual ratings may be checked in the office for inconsistencies and anomalies. After this review, the data are entered into the computer or the filing system. The raw sectional distress data may be filed separately or as part of a large data base. Preliminary analysis programs can check the raw data further and convert it into a more meaningful format to be stored in the data base. An index of the overall distress on each section can be calculated from the observed frequency, severity, and relative importance of the individual types of distress.

X1.2.2 *Other Performance Related Information*:

X1.2.2.1 The gathering of information will depend on the agency's resources. A small agency may not have the resources to purchase or contract for equipment to directly measure surface friction, roughness, or deflection. In a few cases, a subjective assessment can be made of the parameter of interest (for example, roughness).

X1.3 *Historically Related*:

X1.3.1 *Maintenance History*—A small agency may not be able to develop a data base for maintenance activities on individual sections. If not, consideration should be given to obtaining detailed maintenance records on selected sample sections or the development of average costs for maintenance activities.

X1.3.2 *Construction History*—Basic pavement design information (pavement structure type, thicknesses, and age) should be gathered from as-built plans and verified in the field as resources allow through coring, etc.

X1.3.3 *Traffic History*—Traffic data should be measured or estimated including a breakdown by traffic volume and type of vehicle. It would be beneficial to determine historical traffic information to evaluate performance.

X1.3.4 *Accident History*—Accident records and locations can be gathered from various sources including local law enforcement agencies. These could be used to assist in identifying abnormally high accident locations for investigation and for prioritizing pavement performance evaluation activities and rehabilitation programs.

X1.4 *Policy Related*:

X1.4.1 The city personnel can use the data base to determine the present status of the street network as well as individual sections in need of improvement. This pavement condition data together with using the data base, and information regarding traffic, pavement age, and historical pavement performance trends, permit the establishment of maintenance programs, rehabilitation programs and priorities based on the level of service required for various segments of the roadway network. Over time, the need for revised design procedures can be identified.

X2. LARGE AGENCY EXAMPLE

X2.1 In the case of a larger agency, it is more likely that computerized pavement management data files and analysis programs will be used. Also, a large network necessitates that the agency prioritize the collection of its performance-related and historically-related pavement management information. Data acquisition will depend heavily on the agency's resources to create the data file and to develop collection systems and procedures.

X2.2 *Performance Related*:

X2.2.1 *Surface Distress*—There are two approaches that can be considered to conduct manual surveys of large networks. One approach is to conduct a reasonably detailed condition survey on a sample of the network. The other approach is to conduct a condition survey over the entire network or entire length of each section. The type of condition survey can vary considerably with respect to the type of distress evaluated and the degree of detail (for example, number of measures of distress, severity and extent). It can also be different for different functional classes.

X2.2.1.1 In performing pavement distress surveys, the observation and recording of data may be on either a continuous or discrete basis. In the latter case, a driver and rater drive over a section at a suitable speed and then stop at a fixed sampling interval to record the observed distress. The stopping point may be at the end of the section or at some other predetermined length (for example, every quarter mile). In the continuous approach, the severity and extent of the various types of distress are recorded on a continuing basis. A lap-top/notebook type of computer or other suitable electronic recording device can be used for data collection. Automated equipment may be available, so that distress information can be gathered by driving a vehicle over the entire section. A sampling approach can also be used whereby detailed distress surveys can be conducted on a portion of the network, say 10 to 50 %, for network level analysis. In any case, the data can be collected and prioritized by functional class either annually or every other year based on the resources available.

X2.2.1.2 Training of the raters and stringent quality control are essential for consistency purposes. The supervisor of the raters is required to check a sampling of both field and office calculations.

X2.2.2 *Surface Friction, Roughness, Deflection, and Layer Properties*—These performance-related parameters may require the use of equipment. The degree to which these are measured will depend on the agency's use of the information and the state-of-the-art of the measurement process. The measurements should be prioritized based on the agency's resources, the characteristics of the network, and the agency's use of the data. For example, friction tests could be given high priority at locations with high incidence of wet pavement accidents.

X2.3 *Historically Related*:

X2.3.1 *Maintenance History*—The history of maintenance activities on a section is invaluable in prioritizing and selecting rehabilitation activities and in evaluating pavement designs. Due to the magnitude of the network involved, it may be appropriate to gather this information on a stratified sampling basis on functional class, type of pavement, etc.

X2.3.2 *Construction History*—The determination of the actual pavement structure present will probably involve gathering information from as-built plans with verification by field inspection. Due to the magnitude of the effort required, especially with older highway systems, this endeavor also should be prioritized by functional class and availability of records. Basic structural design information (pavement type, thickness, and age), however, should be gathered for the entire system. Geometrically related information also should be gathered on a priority basis.

X2.3.3 *Traffic History*—Traffic information should be gathered for the entire network and should include the characteristics of the traffic including car and truck type and volumes. Historical traffic information also should be assembled into a data base. The data then can be processed to evaluate performance of the road network, as well as to establish maintenance or rehabilitation programs, or both.

X2.3.4 *Accident History*—Accident history is invaluable in that it presents a key measure of the pavement's performance to the user. Accident history should be gathered over the entire network and used to prioritize testing and programming activities.

X2.4 *Environmental Related*:

X2.4.1 *Drainage*—Drainage information for particular pavement management sections may be difficult to quantify. Some analysis should be made on the quality of subgrades and the utilization and performance of under-drains or other drainage systems. Direct drainage measurements may be made on a sampling basis to evaluate performance.

X2.4.2 *Climate*—A large agency may encompass many differing climatic zones which affect pavement performance. Key climatic factors include freeze/thaw cycles, precipitation, and temperature ranges. Information can be obtained from weather services, and the network can be classified by different climatic zones.

X2.5 *Policy Related*:

X2.5.1 A large agency may have various components of the pavement management process housed in different areas of the organization. The development of pavement management outputs for performance prediction and prioritization of roadway programming to select network investment strategies requires an integration of activities across the agency to provide the required analysis output. Agencies will probably select different levels of service for various segments of networks. An agency-wide steering committee should be established to organize and prioritize activities for the pavement management process and to ensure that the pavement management system evolves to meet the agency's needs.

X3. AIRPORT EXAMPLE

X3.1 In the case of an airport, the airport authority may want to establish a data base for their pavement network. This data base can be managed by manual or automated methods and may contain many data items beginning with an inventory and condition survey of the pavement. Pavement historical data (for example, pavement type, thickness, age and maintenance) and traffic data also are desirable.

X3.2 *Performance Related*:

X3.2.1 *Surface Distress*—There are two basic approaches that can be considered to conduct manual surveys of large pavement networks. One is to conduct a reasonably detailed condition survey on a sample of the network, as in Test Method D 5340, or the entire length of each section. The other basic approach is to conduct a condition survey over the entire network or entire length of each section. The type of condition survey can vary considerably with respect to the types of distress evaluated and the degree of detail (that is, number of measures of distress, severity and extent. Also, it can be different for different functional classes.

X3.2.1.1 In performing pavement distress surveys, the observation and recording of data is normally done on a continuous basis using established procedures described in Test Method D 5340. The severity and extent of the various types of distress are recorded on a continuing basis. Automated equipment may be available, so that distress information can be gathered by driving a vehicle over the entire section. A sampling approach also can be used whereby detailed distress surveys can be conducted on a portion of each section in the network (say 10 to 15 %) for network level analysis. In any case, the data can be collected and prioritized by functional class either annually or every other year based on the resources available.

X3.2.1.2 Training of the pavement raters and stringent quality control are essential for consistency purposes. The supervisor of the raters is required to check a sampling of both field and office calculations.

X3.2.2 *Surface Friction, Roughness, Deflection and Layer Properties*—These performance related parameters may require the use of equipment. The degree to which these are measured will depend on the agency's use of the information and the state-of-the-art of the measurement process. The measurements should be prioritized based on the agency's resources, the characteristics of the network, and the agency's use of the data. For example, friction tests could be given high priority in rubber build up areas. Deflection measurements are critical to assessing the load carrying capacity (pavement classification number (PCN)) and projecting rehabilitation requirements at the project level.

X3.3 *Historically Related*:

X3.3.1 *Maintenance History*—The history of maintenance activities on a section is invaluable in prioritizing and selecting rehabilitation activities and in evaluating pavement designs. Depending on the size of the airport, it may be appropriate to gather this information on a stratified sampling basis on functional class, type of pavement, etc.

X3.3.2 *Construction History*—The determination of the actual pavement structure present probably will involve gathering information from as-built plans with verification by field inspection. Basic structural design information (pavement type, thickness, and age) should be gathered for the entire system.

X3.3.3 *Traffic History*—Traffic information should be gathered for the entire network and should include the characteristics of the traffic including aircraft type by landing and take-off. Historical traffic information also should be assembled into a data base. The data then can be processed to evaluate performance of the pavement network, as well as to establish maintenance or rehabilitation programs, or both.

X3.4 *Environmental Related*:

X3.4.1 *Drainage*—Drainage information for particular pavement management sections may be difficult to quantify. Some analysis should be made on the quality of subgrades and the utilization and performance of under-drains or other drainage systems. Direct drainage measurements may be made on a sampling basis to evaluate performance.