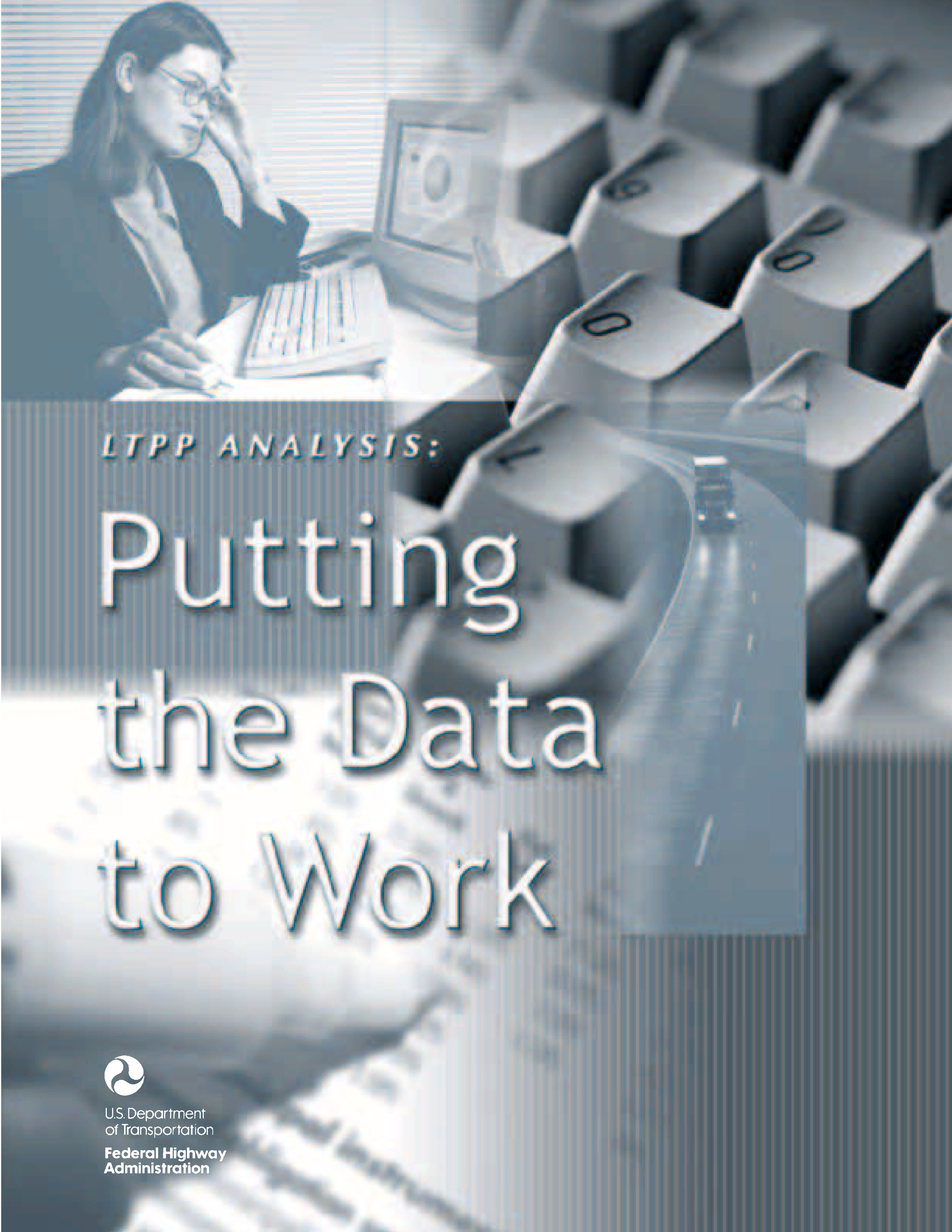

LTPP ANALYSIS:

Putting the Data to Work

U.S. Department of Transportation

Federal Highway Administration

INTRODUCTION

The Long Term Pavement Performance (LTPP) program gathers and processes data describing the structure, service conditions, and performance of in-service test sections in all 50 States, the District of Columbia, Puerto Rico, and 10 Canadian Provinces. To derive benefit from this data, engineers must analyze it, and LTPP s analysis program does just that. It takes the raw data that is collected from more than 2,400 pavement test sections throughout North America and converts it into useable information.

Indeed, LTPP s analysis program addresses a broad array of topics from field validation of pavement design procedures, to studies of variability in traffic and materials data, to investigating the development of pavement roughness. Findings from these analyses provide key information that helps highway engineers and managers in their day-to-day operations. (For more information see sidebar on the following page Highlights of Key Findings From LTPP s Data Analysis Program.)

Some analysis findings have also led to the development of products, such as Rigid Pavement Design software and LTPPBind. Although not all LTPP analyses immediately result in hands-on tools, all provide valuable insight and direction to guide future LTPP data collection and analysis efforts.

Thus, LTPP s data analysis program serves a dual function. It provides the technical basis for identifying and developing tools/products that pavement engineers and managers can use to design more cost-effective and better performing pavements. It also ensures that the data being collected is of the quality and completeness needed to find answers to how and why pavements perform as they do. In this function, LTPP s analysis program is the ultimate tool for ensuring the quality of the LTPP data.

HIGHLIGHTS OF KEY FINDINGS FROM LTPP'S DATA ANALYSIS PROGRAM

HIGHLIGHTS OF KEY FINDINGS FROM VARIOUS LTPP ANALYSIS PROJECTS INCLUDE:

- In 1997, LTPP analysis findings resulted in the adoption by AASHTO of new design procedures for jointed concrete pavements (<u>1998 Supplement to the AASHTO Guide for the Design of Pavement Structures, Part II Rigid Pavement Design & Rigid Pavement Joint Design</u>). These procedures help engineers tailor pavement design to site conditions to achieve the best balance between initial construction costs and long-term performance. The Rigid Pavement Design software assists in the use of the supplement.

- Engineers have long believed that the long-term performance of a pavement is related to the initial, as-constructed smoothness. In fact, a number of agencies pay a bonus for smooth pavement. Analysis of the LTPP data has provided quantitative evidence supporting this practice. Pavements that start out smooth deteriorate more slowly than those that are less smooth.

- Analysis of the LTPP traffic data has yielded previously unavailable information on the amount of traffic data needed to accurately estimate total design traffic loads at a particular site.

- Analysis of LTPP roughness data found that even thin overlays can yield substantial improvements in roughness. This finding supports the common practice of using overlays to correct rough pavements and suggests that structural rather than functional considerations should govern overlay thickness.

- Analysis of LTPP temperature data resulted in an improved temperature prediction tool for use in selecting Superpave binder grades. LTPPBind software assists in the selection of asphalt binders.

In 1998, the Federal Highway Administration s (FHWA s) ability to pursue analysis of the LTPP data was curtailed by the passage of the Transportation Equity Act for the 21st Century (TEA-21). TEA-21 effectively reduced LTPP s overall budget by one-third. In the face of this cutback, only $500,000 per year would be allocated to the national LTPP analysis effort. (Planning prior to the passage of TEA-21 called for annual analysis budgets in the range of $2 million to $2.5 million per year.)

Quick to recognize the danger of a budget cut of this magnitude, several American Association of State Highway and Transportation Officials (AASHTO) subcommittees drafted resolutions addressing the shortfall. As a result, the AASHTO Board of Directors approved $4.7 million in supplemental funding for LTPP as part of the National Cooperative Highway Research Program (NCHRP) for fiscal year (FY) 1999. Of this amount, $1.275 million is directed toward analysis. Similarly, AASHTO allocated $5.025 million of the NCHRP budget for FY 2000 to LTPP, with $950,000 to be used for analysis. The NCHRP LTPP analysis projects will be managed by NCHRP. Thus, the analysis of LTPP data on a national level, which has been the sole responsibility of FHWA since 1992, is now a shared responsibility between FHWA and NCHRP.

This report, LTPP Analysis: Putting the Data to Work, provides an overview of LTPP s analysis program. Specifically, it outlines the analysis projects that will be undertaken by FHWA in FYs 1999 and 2000 and those planned for pursuit through 2003. In addition, since analysis of LTPP data is now a shared responsibility with NCHRP, this report also outlines the project selection process and projects recommended for the FYs 1999 and 2000 NCHRP LTPP analysis projects.

FHWA-SPONSORED ANALYSIS

Planning

Prior to 1997, a needs-based approach was used in planning for the analysis of the LTPP data. The selection of specific projects to be undertaken was driven by two primary considerations: (1) needs, as defined and articulated by State and Provincial highway agency personnel, FHWA staff and contractors, and others; and (2) the extent to which the data then available in the LTPP database could support the analysis projects. This approach has been very fruitful, but results in uneven use of the data. Some data types have seen close scrutiny in several different analysis projects, whereas other data types have scarcely been examined at all.

The strategic approach to LTPP analysis adopted by FHWA in mid-1997 provides for a more systematic examination of the LTPP data, with work organized into four major stages. The first stage of analysis calls for systematic review, evaluation, and processing of individual data types to: (1) derive computed parameters (summary statistics or engineering parameters derived from the raw LTPP data) needed for use in subsequent analysis; (2) characterize the variability of the data; (3) assess the adequacy of available data in relation to analysis needs; and (4) identify, examine, and attempt to explain anomalous or counterintuitive data. The later stages focus on more advanced performance comparisons and analyses, as well as model evaluation, development, and refinement.

In light of the severe funding constraints imposed by TEA-21, FHWA s highest analysis priorities are those projects most closely linked with issues of data quality and completeness, i.e., the first-stage analyses. Plans to initiate more advanced analyses in the future depend on changes in the funding situation.

Identifying Analysis Projects

FHWA staff and the Transportation Research Board (TRB) LTPP Data Analysis Expert Task Group (ETG) work together to identify specific analysis projects. Lists of potential projects are drawn up and subsequently vetted through a series of ETG meetings. Criteria for identifying analysis projects currently underway and planned for pursuit by FHWA include data availability, findings of previous LTPP analyses, and the anticipated need for computed parameters to support more advanced analyses. For example:

- Several of the analysis projects initiated in 1995 identified the presence of counterintuitive trends in the profile indices. This work pointed to the need for a close examination of the profile data to: (1) determine whether these trends were in fact real, or merely an artifact of errors in the data collection process; and (2) quantify the variability present in the profile data. Thus, analysis to examine the longitudinal profile data was planned and undertaken.

- The use of backcalculated layer moduli in several analysis projects, and the expectation that they would be needed in future analyses, coupled with the nature of the backcalculation process, pointed to the need for applying uniform backcalculation processes to all of the LTPP deflection data and adding the results to the LTPP database.

- Anticipated applications of the data from the LTPP seasonal monitoring sites pointed to the need for interpreting the data from the moisture, temperature, and frost penetration instrumentation to derive estimates of in situ moisture contents and frost penetration for addition to the database.

- Knowledge of the differences between the two methods of distress data collection used in LTPP, and the need to be able to use the data from the two methods interchangeably, pointed to the need for analysis to reconcile the differences between the two data sets and to create a consolidated distress data set that might be used in future performance analyses.

Factors considered in scheduling the projects included the amount of data accumulated in the pertinent tables of the database, and the urgency of the need for the analysis results to: (1) provide a basis for decisions regarding future data collection, and (2) provide the foundation for future analyses.

Getting the Job Done

Since 1994, the vast majority of LTPP data analysis has been conducted through FHWA research contracts. A small component of the analysis program is accomplished through FHWA staff research. Advice and guidance on LTPP analysis, including planning and project selection, peer review of analysis reports, and assistance with oversight of ongoing work, are provided by the TRB LTPP Committee and its supporting ETGs. The ETG on LTPP Data Analysis carries the bulk of the responsibility for this function. The Traffic and Distress ETGs also provide valuable advice on analyses dealing with traffic and distress data. ETG members are appointed by the National Academy of Sciences and a portion of the ETG membership rotates each year.

Projects

FHWA s LTPP analysis efforts for FYs 1999 and 2000 are focused on the systematic review and processing of the LTPP data. FHWA has adopted this focus to ensure that all of the data in the LTPP database see the kind of scrutiny needed to identify problems while there is still time to fix them. These analyses will provide the technical basis for three types of products:

- Informational products to support sound pavement design and management decisions.

- Computed parameters to support future pavement performance analyses (whether sponsored by FHWA, NCHRP, individual States, or other entities).

- Improvements and enhancements to the LTPP database by way of the feedback provided to LTPP operational activities.

The specific projects selected for pursuit by FHWA in FYs 1999 and 2000 are summarized in Tables 1 and 2 (tables begin on page 12). Projects that have been identified for pursuit in FYs 2001 through 2003 are summarized in Table 3.

In these tables, the NEEDS column summarizes the primary motivation for pursuit of the project. In the EXPECTED OUTCOMES column, outcomes expected to be of immediate interest or benefit to the pavement engineering community at large are denoted by gray boxes. The benefits of the remaining outcomes will be immediately evident primarily to those making direct use of the LTPP data. Over time, broader benefits will accrue in the form of improved efficiency in future data analyses and more sound conclusions resulting from the expansion and improvement of the LTPP database.

NCHRP-SPONSORED ANALYSIS

Project Identification and Selection

The project identification and selection process for NCHRP-sponsored LTPP analyses began in September 1998 with a TRB LTPP Committee-sponsored workshop to develop a set of candidate LTPP analysis project statements. Workshop participants included the TRB Expert Task Groups on LTPP Data Analysis, and representatives of the Distress and Traffic ETGs. TRB and FHWA LTPP staff served as coordinators for the breakout groups. Background material provided to participants included a broad array of information on needs and expectations assembled in support of previous LTPP data analysis planning efforts.

At the conclusion of the workshop, more than 50 project statements had been developed. Each participant was provided with a set of the project statements and was asked to complete a ballot rating all of the projects. The ballot results were compiled and summarized by the FHWA and TRB staff. In addition, detailed assessments of data availability (in relation to analytical requirements) were prepared for the more highly rated projects.

The ballot results and the data availability assessments served as the starting point for November 1998 deliberations (by the workshop participants) as to the final selection of LTPP data analysis projects to be recommended for inclusion in the FY 1999 NCHRP program. The program of analysis recommended by the workshop participants was forwarded to, and subsequently approved by, the TRB LTPP Committee.

The process used to develop a recommended set of LTPP analysis projects for pursuit by NCHRP in FY 2000 was similar to the one outlined above, but it differed in a few key details. Specifically, additional project statements were solicited and added to the set remaining after the selection of the FY 1999 analysis projects. Workshop participants again completed a ballot rating the proposed projects, and detailed data availability assessments were prepared for all of the proposed projects. The compiled ballot results and data availability assessments were used in the deliberations at a January 1999 meeting in which the projects to be recommended were selected. The set of projects recommended by the Analysis ETG was subsequently forwarded to the TRB LTPP Committee. The TRB LTPP Committee approved the recommended projects and forwarded the problem statements to the AASHTO Standing Committee on Research (SCOR) for consideration in the balloting of the FY 2000 NCHRP program. Ultimately, all of the recommended LTPP analysis projects were selected for pursuit.

Getting the Job Done

The 1999 NCHRP-sponsored LTPP analysis is being conducted in accordance with NCHRP procedures. The NCHRP panels for these projects are drawn from State, highway, and academic experts, as well as members of LTPP expert task groups. Liaison representatives from the FHWA staff facilitate coordination.

Projects

The FYs 1999 and 2000 NCHRP LTPP analysis projects as recommended by the TRB LTPP Data Analysis ETG are summarized in Tables 4 and 5. In these tables, the NEEDS column summarizes the primary motivation for pursuit of the project. In the EXPECTED OUTCOMES column, outcomes expected to be of immediate interest or benefit to the pavement engineering community at large are denoted by gray boxes.

The projects identified in Tables 4 and 5 were subsequently grouped by NCHRP (or in one case, combined with another proposed NCHRP project). As with all NCHRP projects, refinements or adjustments to the project statement are the purview of the individual project panels.

The array of needs addressed by these projects is quite broad. Some address immediate needs, whereas others will contribute toward achievement of more long-range analytical goals. Both types of projects are essential to the long-term success of LTPP.

WHAT'S NEXT

Work is now underway to identify and select a set of LTPP data analysis projects to be recommended for inclusion in the FY 2001 NCHRP program. The process used for this effort will be similar to that used for prior fiscal years, though with broader participation. Key elements of this process are:

- Solicitation of project statements from the State and Provincial highway agencies and industry groups.

- A September 1999 workshop to identify, define, and evaluate the projects that might be recommended for AASHTO funding in FY 2001. The project statements received from the States and industry groups will be considered and evaluated in this process. Workshop participants will include the TRB Expert Task Group on LTPP Data Analysis; representatives of the TRB LTPP Committee; the other Expert Task Groups supporting LTPP, AASHTO, State departments of transportation (DOTs), and pavement industry groups; and FHWA and TRB staff members involved in LTPP.

- An October 1999 meeting of the TRB Expert Task Group on LTPP Data Analysis, at which the recommended set of analysis projects will be selected.

- A November 1999 meeting of the TRB LTPP Committee, at which they will consider the projects recommended by the Analysis ETG.

The expected outcome of this process will be a set of LTPP data analysis projects recommended for pursuit by NCHRP in FY 2001. These project statements will then be forwarded to SCOR for consideration in the selection of the FY 2001 NCHRP projects.

TABLE 1

PROJECT	NEEDS
Review of the LTPP Pavement Maintenance & Rehabilitation (M&R) Data	This study will help to ensure that the maintenance and rehabilitation data available in the LTPP database is as complete and reliable as possible.
Review of Structural Factors (SPS-1 and 2) and Rehabilitation Experiments (SPS-5 and 6)	A comprehensive review of the SPS experiments, as they were actually constructed, will provide much needed information to guide: (1) planning for future analyses involving these experiments, and (2) future monitoring of the test sites.
Review of Laboratory Materials Data	This study will identify and provide the basis for resolving any anomalous observations present in the LTPP laboratory materials data. Laboratory resilient modulus data for asphalt concrete (AC) materials will be addressed in a separate study.

FY 1999 FHWA LTPP Analysis Projects

OBJECTIVES	EXPECTED OUTCOMES
1. Examine the M&R data in the LTPP database to: (a) evaluate completeness and quality, and (b) identify anomalous data requiring closer examination and explanation. 2. Examine and explain anomalous data to discriminate between true errors and valid observations. 3. Identify remedial actions as appropriate.	Improved quality and completeness of the LTPP M&R data. Quantitative information as to the change in key performance measures that can be expected as a result of different M&R treatments.
1. Identify specific applications/analytical objectives that should be pursued. 2. Evaluate the data and test sections in each experiment. Identify areas of strength and weakness, and recommend corrective measures to strengthen each experiment. 3. Identify confounding factors in each SPS experiment that were not accounted for in the original experimental design. 4. Evaluate the quality and completeness (in relation to current data collection requirements) of the SPS construction data. 5. Evaluate the adequacy of existing data and current data collection requirements in relation to anticipated analytical needs.	Recommended program of analysis for the SPS-1, 2, 5, and 6 experiments. Information and observations with regard to the performance of the design features and treatments considered. Recommendations as to the resolution/correction of data that are anomalous or of inadequate quality. Recommendations as to adjustments in test section monitoring.
1. Examine the materials data in the LTPP database to: (a) evaluate completeness and quality, and (b) identify anomalous data requiring closer examination and explanation. 2. Examine and explain anomalous data to discriminate between true errors and valid observations. 3. Identify remedial actions as appropriate. 4. Depict differences between design and as-built properties. 5. Describe/characterize inconsistencies in the data or test procedures used to obtain them. 6. Establish procedures to account for data differences arising from multiple locations and sources.	Basis for identifying typical or representative material parameters as a function of material type or classification. Information on the magnitude of differences between designed/planned material parameters and as-built conditions. Information to guide future application and use of LTPP materials data in analysis. Recommendations with regard to the need for future improvements/enhancements of the LTPP materials data. Improved overall quality of LTPP materials data.

TABLE 2

PROJECT	NEEDS
Review of LTPP Layer Thickness Data	This review of the LTPP layer thickness data will serve to identify and resolve discrepancies in the pavement structure description based on laboratory and field measurements of pavement thickness.
Evaluation of LTPP Climatic Data	This review of the climatic data collected at LTPP seasonal monitoring and Specific Pavement Studies (SPS) test sites will serve to identify and resolve discrepancies in those data AND provide information on the accuracy of the climatic data obtained for the LTPP General Pavement Studies (GPS) test sections.
Review of Verification of Strategic Highway Research Program (SHRP) Asphalt Specification and Mix Design (SPS-9 Experiment)	A comprehensive review of the SPS-9 experiment as actually constructed will provide much needed information to guide: (1) planning for future analyses involving this experiment, and (2) future monitoring of the test sites.

FY 2000 FHWA LTPP Analysis Projects

OBJECTIVES	EXPECTED OUTCOMES
Examine LTPP pavement layer thickness data to: (1) evaluate quality and completeness, (2) identify and explain anomalous observations, and (3) characterize the extent of variation: (a) between measurements at different locations, and (b) between as-designed (inventory) and as-constructed (measured) thicknesses.	Information as to the extent of deviation between planned and as-constructed layer thickness. Information as to within-section thickness variation. Information to guide use of LTPP thickness data in future analyses. Improved quality of LTPP thickness data.
Examine LTPP climatic data to: (1) evaluate quality and completeness, (2) identify and explain anomalous observations, and (3) characterize the extent of variation between on-site measurements of climatic conditions and estimates derived from national weather data.	Guidelines for using National Climatic Data Center weather data to estimate site-specific weather conditions. Information to guide use of LTPP climatic data in future analyses. Improved quality of LTPP climatic data.
1. Identify specific applications/analytical objectives that should be pursued. 2. Evaluate the data and test sections in each experiment. Identify areas of strength and weakness, and recommend corrective measures to strengthen the experiment. 3. Identify confounding factors that were not accounted for in the original experimental design. 4. Evaluate data quality and completeness (in relation to current data collection requirements). 5. Evaluate the adequacy of existing data and current data collection requirements in relation to anticipated analytical needs.	Recommended program of analysis for the SPS-9 experiment. Information and observations with regard to the performance of the design features and treatments considered. Recommendations as to the resolution/correction of data that are anomalous or of inadequate quality. Recommendations for adjustments in test section monitoring.

TABLE 3

PROJECT	NEEDS
Review of the Study of Environmental Effects in the Absence of Heavy Loads (SPS-8 Experiment)	A comprehensive review of the SPS-8 experiment, as actually constructed, will provide much needed information to guide: (1) planning for future analyses involving this experiment, and (2) future monitoring of the test sites.
Review of Laboratory Resilient Modulus Data for AC Materials	This study will identify and provide the basis for resolving any anomalous observations present in the Mr data for AC materials.
Assessment of Field Materials Data	This study will identify and provide the basis for resolving any anomalous observations present in the LTPP materials data collected in the field (e.g., k-value, in situ density and moisture).
Review of Inventory Materials Data	This study will identify and explain any anomalous information present in the LTPP inventory materials data.
Evaluation and Characterization of Pavement Drainage	This study will examine the depth-to-water-table data collected at the LTPP seasonal monitoring sites in order to identify and resolve any anomalous observations. It will also develop a scheme to characterize pavement drainage conditions.

FHWA LTPP Analysis Projects Planned for FYs 2001-2003

PRELIMINARY OBJECTIVES

1. Identify specific applications/analytical objectives that should be pursued.
2. Evaluate the data and test sections in each experiment. Identify areas of strength and weakness, and recommend corrective measures to strengthen the experiment.
3. Identify confounding factors that were not accounted for in the original experimental design.
4. Evaluate data quality and completeness (in relation to current data collection requirements).
5. Evaluate the adequacy of existing data and current data collection requirements in relation to anticipated analytical needs.

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1. Examine the asphalt concrete resilient modulus data in the LTPP database to: (a) evaluate completeness and quality, and (b) identify anomalous data requiring closer examination and explanation.
2. Examine and explain anomalous data to discriminate between true errors and valid observations.
3. Identify remedial actions as appropriate.
4. Depict differences between design and as-built properties.
5. Describe/characterize inconsistencies in the data or test procedures used to obtain them.
6. Establish procedures to account for data differences arising from multiple locations and sources.

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1. Examine the field materials data in the LTPP database to: (a) evaluate completeness and quality, and (b) identify anomalous data requiring closer examination and explanation.
2. Examine and explain anomalous data to discriminate between true errors and valid observations.
3. Identify remedial actions as appropriate.
4. Describe/characterize inconsistencies in the data or test procedures used to obtain them.

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1. Examine the inventory materials data in the LTPP database to: (a) evaluate completeness, and (b) identify anomalous data requiring closer examination and explanation.
2. Examine and explain anomalous data to discriminate between true errors and valid information.
3. Identify remedial actions as appropriate.
4. Describe/characterize inconsistencies in the data or test procedures used to obtain them.

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1. Examine the depth-to-water-table data in the LTPP database to: (a) evaluate completeness, and (b) identify anomalous data requiring closer examination and explanation.
2. Examine and explain anomalous data to discriminate between true errors and valid information.
3. Identify remedial actions as appropriate.
4. Develop a scheme to characterize pavement drainage conditions.
5. Based on the scheme developed in (4), compute drainage parameters for each LTPP test site.

TABLE 4

PROJECT	NEEDS
Efficacy of Sealing Jointed Plain Concrete Pavement (JPCP) Joints	This work will apply data from the LTPP SPS-4 experiment to address the question of whether joint sealing is or is not cost-effective.
Determination of Service Life for Rehabilitation Options	This work will address the need for information on the service life that may be expected for different rehabilitation measures under various circumstances.
Timing and Effectiveness of Maintenance Treatments for Flexible Pavements	This investigation will provide expanded information as to the effectiveness of pavement maintenance treatments for flexible pavements.
Variability of Design Inputs for Mechanistic Design	This study will provide quantitative information as to the variability of key pavement design inputs.
Verification of Pavement Design Values Using Construction Test Data for SPS-1 and SPS-2 Sites	This study will provide information on the extent to which as-constructed values for key pavement design parameters are consistent with the values used in design.
Procedures for Estimating Seasonal Variations in Load-Carrying Capacity	This study is intended to fill a void with regard to consideration of seasonal variations in pavement design.
Factors Affecting Roughness	This study will build upon previous analyses of the LTPP pavement roughness data to develop more complete information as to the factors that affect pavement roughness.

Recommended FY 1999 NCHRP LTPP Analysis Projects

OBJECTIVES	EXPECTED OUTCOMES
1. Evaluate the performance of the LTPP SPS-4 test sections to quantify the impact of joint sealing on the subsequent performance of the pavements. 2. Identify the factors that influence that impact.	Factual information on the efficacy of joint sealing.
1. Analyze the data from rehabilitated LTPP test sections to determine the expected service life of different rehabilitation options. 2. Quantify the effect of pre-rehabilitation condition on performance.	Expanded information on the service life that may be expected for different rehabilitation measures.
1. Evaluate the effectiveness of each treatment considered in the LTPP SPS-3 experiment. 2. Identify the factors influencing maintenance treatment effectiveness. 3. Develop guidelines for application of maintenance treatments.	Guidelines for application and effective use of pavement maintenance treatments.
1. Develop a methodology to evaluate year-to-year changes in traffic loading estimates. 2. Analyze data collected at the LTPP seasonal monitoring test sections to provide quantitative information on the extent to which pavement material characteristics vary over time and space.	Information as to the magnitude of variation in key pavement design parameters.
1. Compare the design values for key pavement design and material parameters with as-constructed values obtained during or shortly after construction and quantify the differences. 2. Characterize the variability of the as-constructed values.	Quantitative information as to: (1) the magnitude of differences between design and as-constructed values for key pavement design parameters, and (2) the variability in the as-constructed values.
Develop practical procedures for estimating the in situ structural characteristics of the pavement layers.	Guidelines for estimating the seasonal variations in the structural characteristics of pavement layers.
1. Evaluate and quantify short-term variations in roughness, the relationship between roughness and the presence of other forms of distress, and the development of roughness over time as a function of pavement type and key pavement design factors. 2. Develop guidelines for collection, interpretation, and application of pavement roughness data and predictive models.	Guidelines for the collection, interpretation, and application of pavement roughness data and predictive models.

TABLE 5

PROJECT	BENEFITS
Effects of Pre-Rehabilitation Roughness on Rate of Deterioration of Overlaid Pavements	This study will address the question of the impact of pre-overlay roughness on deterioration rates for overlaid pavements.
Variation of AC Air Voids as a Function of Specifications and Its Significance to Performance	The FY 2000 phase of this project will assess the feasibility of using the LTPP data to quantify the in-place variability in AC air voids.
Feasibility of Using Falling-Weight Deflectometer (FWD) Data for Rapid Field Characterization of Pavement Quality	The study will use the LTPP data to explore the feasibility of using FWD data as a tool for assessing pavement construction quality.
Significance of Traditional Material Pay Factors to Pavement Performance	The FY 2000 phase of this study will assess the feasibility of using the LTPP data to develop information to guide selection of more appropriate pay factors for pavement construction.
Moisture and Temperature Effects on Material Properties	This work will contribute to improved methods to account for seasonal variations in pavement design and evaluation.
Common Characteristics of Good- and Poor-Performing Pavements	This work will follow-up on a previous FHWA-sponsored study addressing the same basic question with regard to pavement design: What works and what doesn t?
Guidelines for Operating and Maintaining Reliable Pavement Traffic Loading Data Collection	This study addresses a fundamental need in pavement engineering the need for reliable traffic loading data.
Quantify the Benefits of Accurate Pavement Traffic Loading Data	This study will address the question: How accurate does traffic data need to be?

Recommended FY 2000 NCHRP LTPP Analysis Projects

OBJECTIVES		EXPECTED OUTCOMES
Assess and quantify the effects of pre-overlay roughness on the rate of deterioration of overlaid rigid and flexible pavements.		Information to guide decisions on the use and timing of overlays.
Phase I: 1. Evaluate the feasibility of applying the LTPP data to address the objective identified for Phase II.	Phase II (FY 2001): 1. Quantify variability in AC air voids as constructed. 2. Compare as constructed values for AC air voids to design values.	Improved guidelines for selecting design AC air void contents. (Phase II, assuming conclusion of Phase I is positive.)
1. Analyze LTPP FWD data to evaluate the feasibility of using FWD data to characterize pavement quality.	2. Identify and evaluate methods of data interpretation suitable for use in this application of FWD data.	Prototype procedures for interpreting FWD data for quality control applications.
Phase I: 1. Assess the feasibility of using the LTPP data to address the Phase II objectives. Phase II: 1. Develop recommendations as to the specific test or measurements that can be used for quality assurance and	which have the greatest influence on AC and portland cement concrete (PCC) pavement performance. 2. Identify key material properties for use in performance-related specifications.	Basis for improved pavement specifications. (Phase II, assuming Phase I conclusion is positive.)
Develop relationships or procedures to enable examination of in situ pavement material properties based on temperature and moisture conditions within the pavement structure.		Procedures for estimating seasonal variations in pavement material properties.
1. Develop guidelines for the design and construction of long-lived AC and PCC pavements. 2. Quantify information on the benefits of selected design features 3. Compare and assess design/perform-	ance characteristics for new and rehabilitated pavements. 4. Develop qualitative and quantitative information on the effects of specific design features on performance.	Guidelines for the design and construction of long-lived pavements.
1. Develop guidelines for pavement traffic loading data collection. 2. Identify sampling protocols for both equipment location and quantity of data to be collected. 3. Identify site characteristics that significantly affect location, sampling	schemes, and reliability. 4. Develop methods for processing large volumes of continuous weigh-in-motion (WIM) or automatic vehicle classifier (AVC) data in preparation for detailed analysis.	Comprehensive guidelines for the collection of reliable traffic loading data.
Apply the LTPP traffic data, selected pavement design models, and probabilistic life-cycle cost concepts to establish	the costs and benefits associated with different levels of accuracy in traffic data collection.	Information to guide investment decisions (both how much and where) related to traffic data collection.