Long-Term Pavement Performance Data Analysis Program

Strategic Plan Objectives, Analysis Outcomes, and Supporting Project

Objective 1
Traffic characterization and prediction

Guidelines for data collection (hardware, software, placement, calibration, data collection frequency). *Some elements require work beyond LTPP data analysis, but analysis is needed to provide some components.* — A Critical 1

- **NCHRP** LTPP-PROJ-0000283 — NCHRP 1-39: Traffic Data Collection, Analysis, and Forecasting for Mechanistic Pavement Design — $500,000 — Completed — 8/30/2000 to 7/30/2004 — **1A1**
- **FHWA** LTPP-PROJ-0000002 — Long-Term Pavement Performance Weigh-in-Motion Approach Smoothness Specifications — $0 — Completed — 1/1/1900 to 11/1/2005 — **1A2**
- **FHWA** LTPP-PROJ-0000204 — Refinement of Pavement Smoothness Requirements for WIM Systems — $0 — Completed — 10/1/2009 to 8/1/2012 — **1A3**
- **FHWA** FHWA-PROJ-09-0046 — Verification, Refinement, and Applicability of Long-Term Pavement Performance (LTPP) Classification Scheme — $249,977 — Completed — 9/30/2009 to 12/31/2012 — **1A4**
- **FHWA** LTPP-PROJ-0000004 — NCHRP 20-50(20): LTPP Data Analysis: Develop Practical Tools and Procedures to Improve WIM Data Quality — $350,000 — Active — 10/3/2018 to 7/30/2019 — **1A5**
- **Problem Statement Number** LTPP-PROJ-0000005 — Validate Vehicle Simulation Model and Provide Recommendations for Improved Weigh-in-Motion Site Selection and Calibration — $750,000 — Proposed — 1/1/1900 to 1/1/1900 — **1A6**
- **Problem Statement Number** LTPP-PROJ-0000006 — Truck Tire Wander, Pressure, and Width Data Collection — $150,000 — Proposed — 1/1/1900 to 1/1/1900 — **1A7**
- **Problem Statement Number** LTPP-PROJ-0000007 — Adding Axle Groupings Beyond Quad Tire Groups to Long-Term Pavement Performance Database — $30,000 — Proposed — 1/1/1900 to 1/1/1900 — **1A8**
- **Problem Statement Number** LTPP-PROJ-0000008 — Collecting Data From Static Scales — $75,000 — Proposed — 1/1/1900 to 1/1/1900 — **1A9**
- **Problem Statement Number** LTPP-PROJ-0000009 — Innovative Cost-Effective Alternatives to Traditional Weigh-in-Motion Calibration — $200,000 — Proposed — 1/1/1900 to 1/1/1900 — **1A10**

Guidelines for using traffic data in pavement applications. — B Critical 2

- **FHWA** LTPP-PROJ-0000010 — Optimization of Traffic Data Collection for Specific Pavement Applications — $266,058 — Completed — 1/23/2003 to 8/15/2005 — **1B1**
- **FHWA** FHWA-PROJ-09-0045 — Development of New Default Traffic Datasets for the Mechanistic-Empirical Pavement Design Guide Using the Data from Long-Term Pavement Performance Specific Pavement Study Traffic Data Collection Pooled Fund Study, TPF-5(004) — $258,409 — Completed — 9/30/2009 to 5/30/2012 — **1B2**
- **FHWA** LTPP-PROJ-0000011 — Effect of Traffic Data Input Levels on Mechanistic-Empirical Pavement Design Guide Outputs — $500,000 — Active — 9/17/2010 to 12/16/2011 — **1B3**
- **Problem Statement Number** LTPP-PROJ-0000012 — Evaluation of Lane and Directional Changes of Traffic Loading Over Time — $150,000 — Proposed — 1/1/1900 to 1/1/1900 — **1B4**
- **FHWA** LTPP-PROJ-0000013 — Guidance to Facilitate the Analysts' Use of the LTPP Traffic Data, Including Estimating Traffic Loads — $412,210.35 — Completed — 7/21/2014 to 12/31/2017 — **1B5**

Procedures for forecasting and backcasting traffic loading data. — C Very High 3

- **FHWA** LTPP-PROJ-0000014 — Estimating Cumulative Traffic Loads, Phase 1 — $250,000 — Completed — 10/15/1998 to 9/30/2001 — **1C1**
- **FHWA** LTPP-PROJ-0000015 — Estimating Cumulative Traffic Loads, Phase 2 — $293,000 — Completed — 10/31/1999 to 12/20/2002 — **1C2**
- **FHWA** LTPP-PROJ-0000016 — Predicting Truck and Axle Loading Patterns — $193,919 — Completed — 7/21/2014 to 9/1/2017 — **1C3**

Objective 2
Materials characterization

Relate material properties to pavement performance. — A Critical 1

- **NCHRP** LTPP-PROJ-0000017 — NCHRP 20-50(14): Significance of As-Constructed Asphalt Concrete Air Voids to Pavement Performance — $487,234 — Completed — 6/5/2000 to 6/28/2002 — **2A1**
- **NCHRP** LTPP-PROJ-0000018 — NCHRP 9-49A: Performance of Warm-Mix Asphalt Technologies: Stage II — Long-Term Field Performance — $349,969 — Completed — 4/29/2011 to 9/30/2016 — **2A2**
- **FHWA** LTPP-PROJ-0000019 — Assessment of Selected Long-Term Pavement Performance Material Data Tables and Development of Representative Test Tables – Volume I — $243,000 — Completed — 9/1/1999 to 3/1/2001 — **2A3**
- **FHWA** LTPP-PROJ-0000020 — Study of Long-Term Pavement Performance Laboratory Resilient Modulus Test Data and Response Characteristics — $103,056 — Completed — 6/1/2000 to 4/30/2001 — **2A4**
- **FHWA** LTPP-PROJ-0000021 — Long-Term Pavement Performance Computed Parameter: Dynamic Modulus (E*) — $265,477 — Completed — 8/17/2007 to 9/30/2009 — **2A5**
- **Problem Statement Number** LTPP-PROJ-0000022 — Effect of Reclaimed Asphalt Pavement and Polymer Modified Asphalt on Pavement Performance — $316,751 — Completed — 1/1/1900 to 1/1/1900 — **2A6**
- **Problem Statement Number** LTPP-PROJ-0000023 — Performance of Treated Versus Untreated Sections of Unbound Materials — $150,000 — Proposed — 1/1/1900 to 1/1/1900 — **2A7**
- **FHWA** LTPP-PROJ-0000024 — NCHRP 20-50(18): LTPP Data Analysis: Significance of As-Constructed Asphalt Pavement Air Voids to Pavement Performance — $650,000 — Completed — 4/1/2018 to 6/30/2020 — **2A8**
- **Problem Statement Number** LTPP-PROJ-0000025 — Aggregates and the Performance of Portland Cement Concrete — $450,000 — Active — 1/1/1900 to 1/1/1900 — **2A9**
- **Problem Statement Number** LTPP-PROJ-0000026 — Change in Performance Grade Grading Over Time and Effect on Mixture Stiffness and Pavement Distress — $650,000 — Proposed — 1/1/1900 to 1/1/1900 — **2A10**
- **Problem Statement Number** LTPP-PROJ-0000027 — Impact of Mix and Materials Properties on Individual Distress Type for Concrete Pavements — $200,000 — Proposed — 1/1/1900 to 1/1/1900 — **2A11**
- **Problem Statement Number** LTPP-PROJ-0000028 — Effect of Warm Mix on Pavement Performance — $100,000 — Proposed — 1/1/1900 to 1/1/1900 — **2A12**

Relationships among material properties determined in the laboratory and field. — B Very High 1

- **NCHRP** LTPP-PROJ-0000029 — NCHRP 9-48: Field Versus Laboratory Volumetrics and Mechanical Properties — $500,000 — Proposed — 8/1/2009 to 12/31/2015 — **2B1**
- **FHWA** LTPP-PROJ-0000030 — Temperature Predictions and Adjustment Factors for Asphalt Pavements — $231,930 — Completed — 10/1/1994 to 6/1/1999 — **2B2**
- **FHWA** LTPP-PROJ-0000031 — Analyses Relating to Pavement Material Characterizations and Their Effects on Pavement Performance — $270,000 — Completed — 4/1/1995 to 9/1/1997 — **2B3**
- **FHWA** LTPP-PROJ-0000032 — Backcalculation of Layer Parameters for Long-Term Pavement Performance Test Sections, Volume I — $125,000 — Completed — 8/7/1997 to 7/31/1998 — **2B4**
- **FHWA** LTPP-PROJ-0000033 — Backcalculation of Layer Parameters for Long-Term Pavement Performance Test Sections, Volume II — $171,000 — Completed — 5/1/1997 to 8/31/2001 — **2B5**
- **FHWA** LTPP-PROJ-0000034 — Review of the Long-Term Pavement Performance Backcalculation Results — $228,530 — Completed — 1/23/2003 to 8/31/2005 — **2B6**
- **FHWA** FHWA-PROJ-11-0066 — Backcalculation of the Long-Term Pavement Performance Program Deflection Data — $585,144 — Completed — 9/30/2011 to 12/29/2015 — **2B7**
- **FHWA** LTPP-PROJ-0000035 — NCHRP 20-50(19): LTPP Data Analysis: Feasibility of Using LTPP Data to Develop Relationships Between Laboratory- and Field-Derived Properties of Unbound Materials — $69,762 — Completed — 6/11/2018 to 4/10/2019 — **2B8**
- **Problem Statement Number** LTPP-PROJ-0000036 — Relationships Among Material Properties Determined in the Laboratory and Field for Hot-Mix Asphalt — $375,000 — Proposed — 1/1/1900 to 1/1/1900 — **2B9**
- **Problem Statement Number** LTPP-PROJ-0000037 — Relationships Among Material Properties Determined in the Laboratory and Field for Portland Cement Concrete — $250,000 — Proposed — 1/1/1900 to 1/1/1900 — **2B10**

Estimate material design properties from conventional material parameters. — C Very High 1

- **Problem Statement Number** LTPP-PROJ-0000038 — Estimating Subgrade Resilient Modulus From Conventional Soils Test Parameters (To Be Combined With 2D2 and 2F1a) — $300,000 — Proposed — 1/1/1900 to 1/1/1900 — **2C1**

Using deflection and DCP procedures to obtain material properties and their variability. — D Very High 1

- **Problem Statement Number** LTPP-PROJ-0000039 — Material Properties and Variability With Depth (To Be Combined With 2C2 and 2F1a) — $200,000 — Proposed — 1/1/1900 to 1/1/1900 — **2D1**

Guidelines for characterizing material properties. — E High 1

- **FHWA** LTPP-PROJ-0000040 — Estimation of Key Portland Cement Concrete, Base, Subbase, and Component Engineering Properties From Routine Tests and Physical Characteristics — $368,386 — Completed — 8/13/2007 to 4/13/2010 — **2E1**
- **Problem Statement Number** LTPP-PROJ-0000041 — Estimation of Key Hot-Mix Asphalt, Base, Subgrade, and Component Engineering Properties from Routine Tests and Physical Characteristics — $500,000 — Proposed — 1/1/1900 to 1/1/1900 — **2E2**

Time and load dependent material properties. — F High 1

- **NCHRP** LTPP-PROJ-0000198 — NCHRP 1-50: Quantifying the Influence of Geosynthetics on Pavement Performance — $600,000 — Completed — 9/1/2011 to 8/31/2016 — **2F1**
- **Problem Statement Number** LTPP-PROJ-0000199 — Short- and Long-Term Variability of the Subgrade, Subbase, and Base Layer Properties (to be combined with 2C2 and 2D2) — $275,000 — Proposed — 1/1/1900 to 1/1/1900 — **2F2**
- **Problem Statement Number** LTPP-PROJ-0000200 — Time- and Load-Dependent Portland Cement Concrete Material Properties — $400,000 — Proposed — 1/1/1900 to 1/1/1900 — **2F3**
- **Problem Statement Number** LTPP-PROJ-0000201 — Short- and Long-Term Variability of the Asphalt Concrete Layer Properties — $250,000 — Proposed — 1/1/1900 to 1/1/1900 — **2F4**
- **Problem Statement Number** LTPP-PROJ-0000202 — Assessment of Changes in Pavement Friction Levels With Time and Loading — $400,000 — Proposed — 1/1/1900 to 1/1/1900 — **2F5**

Objective 3
Determination of environmental effects in pavement design and performance prediction

Characterization of temporal variations in pavements. — A Critical 2

- **NCHRP** LTPP-PROJ-0000042 — NCHRP 9-23: Environmental Effects in Pavement Mix and Structural Design Systems — $200,000 — Completed — 2/27/2001 to 12/31/2007 — **3A1**
- **NCHRP** LTPP-PROJ-0000043 — NCHRP 20-50(7/12): Daily and Seasonal Variations in In Situ Material Properties — $349,969 — Completed — 2/7/2000 to 8/31/2003 — **3A2**
- **FHWA** LTPP-PROJ-0000044 — Study of Long-Term Pavement Performance Pavement Temperatures — $94,000 — Completed — 10/1/1998 to 11/1/1999 — **3A3**
- **FHWA** LTPP-PROJ-0000045 — Analysis of Time Domain Reflectometry Data — $100,000 — Completed — 8/1/1997 to 7/1/1998 — **3A4**
- **FHWA** LTPP-PROJ-0000046 — Long-Term Pavement Performance Computed Parameter: Moisture Content — $141,000 — Completed — 7/1/2005 to 12/31/2007 — **3A5**
- **FHWA** LTPP-PROJ-0000047 — Seasonal Variations in the Moduli of Unbound Pavement Layers — $265,477 — Completed — 5/1/1997 to 3/31/2000 — **3A6**
- **FHWA** FHWA-PROJ-11-0118 — Evaluation of Long-Term Pavement Performance Program Climatic Data for Use in Mechanistic-Empirical Pavement Design Guide Calibration and Other Pavement Analyses — $360,538 — Completed — 5/18/2011 to 12/30/2015 — **3A7**
- **NCHRP** LTPP-PROJ-0000048 — NCHRP 1-40: Facilitating the Implementation of the Guide for the Design of New and Rehabilitated Pavement Structures — $650,000 — Completed — 7/1/2004 to 12/31/2006 — **3A8**
- **FHWA** LTPP-PROJ-0000049 — NCHRP 20-50(21): Enhancements of Climatic Inputs and Related Models for Pavement ME Using LTPP Climate Tool (MERRA-2) — $350,000 — Active — 8/24/2018 to 2/23/2021 — **3A9**
- **Problem Statement Number** LTPP-PROJ-0000050 — Seasonal Variations in Moduli of Unbound Pavement Layers — $650,000 — Proposed — 1/1/1900 to 1/1/1900 — **3A10**
- **Problem Statement Number** LTPP-PROJ-0000051 — Seasonal Variations in Backcalculated Moduli of Asphalt-Bound Pavement Layers — $225,000 — Proposed — 1/1/1900 to 1/1/1900 — **3A11**
- **Problem Statement Number** LTPP-PROJ-0000052 — Determination of Frost Penetration in Long-Term Pavement Performance Test Sections and Other Instrumented Sites — $100,000 — Proposed — 1/1/1900 to 1/1/1900 — **3A12**
- **Problem Statement Number** LTPP-PROJ-0000053 — Impact of Maintenance and Rehabilitation Treatments on Temporal Variations in Pavement Materials — $1,200,000 — Proposed — 1/1/1900 to 1/1/1900 — **3A13**
- **Problem Statement Number** LTPP-PROJ-0000054 — Assess the Adequacy of the Available Long-Term Pavement Performance Data to Support Conclusions Concerning the Implications of Construction Variability for Pavement Susceptibility to Environmentally Induced Variations — $175,000 — Proposed — 1/1/1900 to 1/1/1900 — **3A14**
- **Problem Statement Number** LTPP-PROJ-0000055 — Quantify the Impact of Construction Variability on Pavement Susceptibility to Environmentally Induced Variations — $350,000 — Proposed — 1/1/1900 to 1/1/1900 — **3A15**

Impact of long-term environmental effects on pavement layer characteristics and performance. — B Very High 1

- **NCHRP** LTPP-PROJ-0000056 — Predicting Inservice Performance of Flexible Pavements from Accelerated Pavement Testing — $100,000 — Completed — 3/4/2004 to 10/31/2005 — **3B1**
- **FHWA** LTPP-PROJ-0000057 — Determination of Frost Penetration in Long-Term Pavement Performance Sections — $98,922 — Completed — 8/1/1997 to 7/1/1998 — **3B2**
- **FHWA** LTPP-PROJ-0000058 — Long-Term Pavement Performance Computed Parameter: Frost Penetration — $199,819 — Completed — 7/1/2005 to 6/30/2008 — **3B3**
- **FHWA** LTPP-PROJ-0000059 — Effect of Multiple Freeze Cycles and Deep Frost Penetration on Pavement Performance and Cost — $369,683 — Completed — 3/4/2003 to 6/4/2006 — **3B4**
- **Problem Statement Number** LTPP-PROJ-0000060 — Conduct an Objective Assessment of the Applicability and Utility of Existing Models for Prediction of Long-Term Changes in Pavement Materials — $200,000 — Proposed — 1/1/1900 to 1/1/1900 — **3B5**
- **Problem Statement Number** LTPP-PROJ-0000061 — Environmentally Induced Changes and Degradation — $200,000 — Proposed — 1/1/1900 to 1/1/1900 — **3B6**

Recommendations for data collection to adequately consider temporal variations in predicting pavement performance. — C Critical 1

- **FHWA** LTPP-PROJ-0000062 — Evaluation of the Integrated Climatic Model Using Long-Term Pavement Performance Seasonal Monitoring Program Data — $0 — Completed — 2/27/2001 to 12/31/2007 — **3C1**
- **FHWA** FHWA-PROJ-14-0129 — Increase in Roughness Due to Environmental Factors in Flexible Pavements — $208,583 — Completed — 7/23/2014 to 7/23/2017 — **3C2**
- **FHWA** FHWA-PROJ-14-0131 — Incorporating a Curling Factor in Layer Moduli Backcalculation Using Long-Term Pavement Performance's Seasonal Monitoring Program Falling Weight Deflectometer Data for Jointed Pavement Test Sections — $138,092 — Completed — 5/1/2014 to 5/31/2016 — **3C3**
- **FHWA** LTPP-PROJ-0000063 — NCHRP 20-50(22): LTPP Data Analysis: Feasibility of Using LTPP Data to Improve Use of FWD and Longitudinal Profile Measurements — $100,000 — Active — 9/3/2019 to 6/2/2020 — **3C4**
- **Problem Statement Number** LTPP-PROJ-0000064 — Identification of the True Critical Variables for Understanding Temporal Variations in Pavements — $350,000 — Proposed — 1/1/1900 to 1/1/1900 — **3C5**

Quantify the relative impacts of environmental factors and traffic loading on pavement performance. — D Very High 2

- **FHWA** LTPP-PROJ-0000065 — Verification of Long-Term Pavement Performance Virtual Weather Stations Phase I Report: Accuracy and Reliability of Virtual Weather Stations — $135,000 — Completed — 1/1/2000 to 10/1/2000 — **3D1**
- **Problem Statement Number** LTPP-PROJ-0000066 — Assess and Quantify the Effects of Traffic Loading, Environment, and Their Interaction on Pavement Life — $500,000 — Proposed — 1/1/1900 to 1/1/1900 — **3D2**
- **Problem Statement Number** LTPP-PROJ-0000067 — Application of the Long-Term Pavement Performance Data to Validate Theoretical Analysis of the Relative Impacts of the Environment and Traffic on Pavement Response and Subsequent Performance — $200,000 — Proposed — 1/1/1900 to 1/1/1900 — **3D3**

Objective 4
Evaluation and use of pavement condition data in pavement management

Data collection cost effectiveness. — A Very High 1

- **NCHRP** LTPP-PROJ-0000068 — NCHRP 1-35A: Guide for Pavement Management: American Association of State Highway and Transportation Officials Pavement Management Guide — $6,579,080 — Completed — 12/1/1997 to 6/30/2000 — **4A1**
- **FHWA** LTPP-PROJ-0000069 — Assessment of Long-Term Pavement Performance Friction Data — $55,838 — Completed — 8/1/1997 to 7/1/1998 — **4A2**
- **FHWA** LTPP-PROJ-0000070 — Study of Long-Term Pavement Performance Distress Data Variability — $100,000 — Completed — 1/1/1997 to 12/1/1998 — **4A3**
- **FHWA** LTPP-PROJ-0000071 — Distress Data Consolidation — $141,000 — Completed — 8/15/1998 to 12/31/2000 — **4A4**
- **FHWA** LTPP-PROJ-0000072 — Long-Term Pavement Performance Profile Variability — $397,000 — Completed — 7/28/1997 to 3/1/2000 — **4A5**
- **FHWA** LTPP-PROJ-0000073 — Preliminary Evaluation and Analysis of Long-Term Pavement Performance Faulting Data — $58,000 — Completed — 5/1/1998 to 12/31/1998 — **4A6**
- **FHWA** LTPP-PROJ-0000074 — Characterization of Transverse Profiles — $196,000 — Completed — 7/28/1997 to 9/1/2000 — **4A7**
- **FHWA** LTPP-PROJ-0000075 — Pavement Smoothness Index Relationships — $60,000 — Completed — 2/1/2001 to 11/1/2001 — **4A8**
- **FHWA** LTPP-PROJ-0000076 — Smoothness Index Differences Related to Long-Term Pavement Performance Equipment Type — $78,437 — Completed — 1/6/2004 to 4/30/2005 — **4A9**
- **Problem Statement Number** LTPP-PROJ-0000077 — Develop Hierarchical Data Collection for Accurate Network- and Project-Level Pavement Management Considering Types and Frequency of Measurements — $400,000 — Proposed — 1/1/1900 to 1/1/1900 — **4A10**

Quality of data. — B Very High 2

- **NCHRP** LTPP-PROJ-0000078 — NCHRP 20-05/Topic 39-01: Quality Management of Pavement Distress Data Collection — $30,000 — Completed — 10/1/2007 to 9/30/2008 — **4B1**
- **FHWA** LTPP-PROJ-0000079 — Study of Long-Term Pavement Performance Pavement Deflections — $100,000 — Completed — 4/1/2001 to 9/1/2001 — **4B2**
- **FHWA** FHWA-PROJ-09-0024 — Simplified Techniques for Evaluation and Interpretation of Pavement Deflections for Network-Level Analysis — $299,951 — Completed — 8/1/2009 to 10/31/2011 — **4B3**
- **Problem Statement Number** LTPP-PROJ-0000080 — Analysis of Long-Term Pavement Performance Friction Data — $100,000 — Proposed — 1/1/1900 to 1/1/1900 — **4B4**
- **Problem Statement Number** LTPP-PROJ-0000081 — Quantitative Information of Environmental Variables on Pavement Performance Measures — $500,000 — Proposed — 1/1/1900 to 1/1/1900 — **4B5**
- **FHWA** LTPP-PROJ-0000082 — Quality Management Procedures for Network Level Pavement Condition Data — $149,193 — Completed — 10/1/2011 to 2/28/2013 — **4B6**

History of advances in measures. — C Very High 3

- **FHWA** FHWA-PROJ-10-0069 — Relating Ride Quality and Structural Adequacy for Pavement Rehabilitation/Design Decisions — $227,465 — Completed — 12/1/2010 to 12/1/2012 — **4C1**
- **Problem Statement Number** LTPP-PROJ-0000082 — Update of Pavement Smoothness Index Relationship — $150,000 — Proposed — 1/1/1900 to 1/1/1900 — **4C2**
- **FHWA** LTPP-PROJ-0000084 — Estimate Long-Term Pavement Performance Faulting Data Using Profile Measurements — $0 — Completed — 11/1/2012 to 11/1/2014 — **4C3**
- **Problem Statement Number** LTPP-PROJ-0000085 — Synthesis of Current Pavement Condition Data Collection Practice — $75,000 — Proposed — 1/1/1900 to 1/1/1900 — **4C4**
- **Problem Statement Number** LTPP-PROJ-0000086 — Guidelines for Transitioning From One Technology to Another — $500,000 — Proposed — 1/1/1900 to 1/1/1900 — **4C5**

Data management. — D High 1

- **NCHRP** LTPP-PROJ-0000087 — NCHRP 20-05/Topic10-05: Collection and Use of Pavement Condition Data — $0 — Completed — 1/1/1900 to 1/1/1900 — **4D1**
- **NCHRP** LTPP-PROJ-0000088 — NCHRP 20-50(9): Feasibility of Using Falling Weight Deflectometer Deflection Data to Characterize Pavement Construction Quality — $174,996 — Completed — 5/2/2000 to 6/3/2002 — **4D2**
- **Problem Statement Number** LTPP-PROJ-0000089 — Lessons Learned From Long-Term Pavement Performance Condition Data Development — $100,000 — Proposed — 1/1/1900 to 1/1/1900 — **4D3**
- **Problem Statement Number** LTPP-PROJ-0000090 — Identify the Best Format for Use of Pavement Condition Data in an Integrated Delivery System — $150,000 — Proposed — 1/1/1900 to 1/1/1900 — **4D4**

Objective 5
Development of pavement response and performance models applicable to pavement design and performance prediction

Guidelines for selection of appropriate load-response models for use in pavement design as a function of the acceptable level of risk and model complexity. — A Very High 1

- **NCHRP** LTPP-PROJ-0000091 — NCHRP 1-37A: Development of the 2002 Guide for the Design of New and Rehabilitated Pavement Structures (Phase II) — $6,579,080 — Completed — 2/1/1998 to 2/28/2004 — **5A1**
- **NCHRP** LTPP-PROJ-0000092 — NCHRP 1-46: Handbook for Pavement Design, Construction, and Management — $400,000 — Completed — 10/1/2009 to 12/31/2011 — **5A2**
- **NCHRP** LTPP-PROJ-0000093 — NCHRP 1-47: Sensitivity Evaluation of Mechanistic-Empirical Pavement Design Guide Performance Prediction — $0 — Completed — 9/2/2009 to 12/31/2011 — **5A3**
- **FHWA** LTPP-PROJ-0000094 — Comparison and Quality Evaluation of Long-Term Pavement Performance Dynamic Load Response Data From Ohio and North Carolina — $50,000 — Completed — 12/1/1999 to 12/1/2000 — **5A4**
- **FHWA** LTPP-PROJ-0000095 — LTPP Ohio SPS-1 and 2 Dynamic Load Response Data Processing — $0 — Completed — 8/1/2011 to 10/1/2012 — **5A5**
- **Problem Statement Number** LTPP-PROJ-0000095 — Evaluation of Load-Response Models (Axle Load and Environment) — $200,000 — Proposed — 1/1/1900 to 1/1/1900 — **5A6**
- **Problem Statement Number** LTPP-PROJ-0000096 — Effect of Multiple Axle Group Loading on Pavement Performance — $1,500,000 — Proposed — 1/1/1900 to 1/1/1900 — **5A7**
- **Problem Statement Number** LTPP-PROJ-0000097 — Development of Alternative Computational Tools to Enhance Model Response (After NCHRP 1-47) — $450,000 — Proposed — 1/1/1900 to 1/1/1900 — **5A8**
- **Problem Statement Number** LTPP-PROJ-0000098 — Use of Energy Density Methods to Predict Pavement Response — $700,000 — Proposed — 1/1/1900 to 1/1/1900 — **5A9**

Mechanistic-empirical procedures for using commonly collected pavement data to predict specific distresses. — B Very High 2

- **NCHRP** LTPP-PROJ-0000099 — NCHRP 20-50(5): Variations in Pavement Design Inputs — $249,991 — Completed — 10/13/1999 to 10/12/2001 — **5B1**
- **Problem Statement Number** LTPP-PROJ-0000100 — Evaluation of the Performance Prediction Models in the Mechanistic-Empirical Pavement Design Guide — $400,000 — Proposed — 1/1/1900 to 1/1/1900 — **5B2**
- **FHWA** LTPP-PROJ-0000208 — Using Multiobjective Optimization to Enhance Calibration of Performance Models in the Mechanistic-Empirical Pavement Design Guide — $115,404 — Completed — 7/28/2014 to 10/31/2017 — **5B3**

Calibrated relationships (transfer functions) between pavement response and individual distress types. — C High 3

- **FHWA** LTPP-PROJ-0000101 — Validation of Guidelines for k-Value Selection and Concrete Pavement Performance Prediction — $84,000 — Completed — 10/1/1994 to 7/1/1996 — **5C1**
- **FHWA** LTPP-PROJ-0000102 — Design and Construction of Portland Cement Concrete Pavements, Volume I — $84,000 — Completed — 10/1/1994 to 8/1/1998 — **5C2**
- **FHWA** LTPP-PROJ-0000103 — Design and Construction of Portland Cement Concrete Pavements, Volume II — $84,000 — Completed — 10/1/1994 to 8/1/1998 — **5C3**
- **FHWA** LTPP-PROJ-0000104 — Design and Construction of Portland Cement Concrete Pavements, Volume III — $84,000 — Completed — 10/1/1994 to 8/1/1998 — **5C4**
- **NCHRP** LTPP-PROJ-0000105 — NCHRP 1-41: Models for Predicting Reflection Cracking of Hot-Mix Asphalt Overlays — $500,000 — Completed — 2/3/2005 to 2/26/2010 — **5C5**
- **NCHRP** LTPP-PROJ-0000106 — NCHRP 1-42: Top-Down Fatigue Cracking of Hot-Mix Asphalt Layers - Phase I — $39,556 — Completed — 8/22/2003 to 2/28/2005 — **5C6**
- **NCHRP** LTPP-PROJ-0000107 — NCHRP 1-52: A Mechanistic-Empirical Model for Top-Down Cracking of Asphalt Pavement Layers — $500,000 — Completed — 3/4/2013 to 3/30/2018 — **5C7**
- **NCHRP** LTPP-PROJ-0000108 — NCHRP 9-30A: Calibration of Rutting Models for Hot-Mix Asphalt Structural and Mix Design — $1,000,000 — Completed — 8/29/2005 to 3/31/2012 — **5C8**
- **Problem Statement Number** LTPP-PROJ-0000109 — Evaluation of Pavement Performance Models - Filling in the Gap with National Cooperative Highway Research Program 1-41 (after NCHRP 1-41) — $200,000 — Proposed — 1/1/1900 to 1/1/1900 — **5C9**
- **Problem Statement Number** LTPP-PROJ-0000110 — Development of Longitudinal Cracking Models for Portland Cement Concrete Pavements (after NCHRP 1-42) — $200,000 — Proposed — 1/1/1900 to 1/1/1900 — **5C10**
- **Problem Statement Number** LTPP-PROJ-0000111 — Revise Modeling of Fatigue Cracking to be a Fracture and Healing Process — $900,000 — Proposed — 1/1/1900 to 1/1/1900 — **5C11**
- **Problem Statement Number** LTPP-PROJ-0000112 — Implementation of National Cooperative Highway Research Program 1-41, Reflection Cracking Design Program — $760,000 — Proposed — 1/1/1900 to 1/1/1900 — **5C12**
- **Problem Statement Number** LTPP-PROJ-0000113 — Incorporating Top-Down Longitudinal Cracking Into Mechanistic-Empirical Pavement Design Guide — $750,000 — Proposed — 1/1/1900 to 1/1/1900 — **5C13**
- **Problem Statement Number** LTPP-PROJ-0000114 — Development of Transfer Functions for Spalling, Faulting, Raveling, and Thermal Cracking Along With Calibration and Validation — $0 — Proposed — 1/1/1900 to 1/1/1900 — **5C14**
- **FHWA** LTPP-PROJ-0000207 — LTPP Computed Parameter: Top-Down Cracking — $239,099 — Completed — 7/21/2014 to 9/20/2018 — **5C15**

Impact of pavement roughness on the dynamic loads applied to pavements. — D High 3

- **Problem Statement Number** LTPP-PROJ-0000115 — Coupling Vehicle Dynamics and Pavement Performance Prediction Models (Coordinate with 4C2) — $375,000 — Proposed — 1/1/1900 to 1/1/1900 — **5D1**

Validation of pavement response and performance prediction models. — E High 1

- **FHWA** FHWA-PROJ-10-0006 — National Forensic Workshop and Forensic Guidelines — $125,000 — Completed — 2/1/2010 to 3/1/2013 — **5E1**
- **NCHRP** LTPP-PROJ-0000116 — NCHRP 1-49: Guidelines for Conducting Forensic Investigation of Highway Pavements — $499,999 — Completed — 4/7/2010 to 12/30/2012 — **5E2**
- **Problem Statement Number** LTPP-PROJ-0000117 — Forensic Investigation of SPS-9 in Connecticut — $20,000 — Proposed — 1/1/1900 to 1/1/1900 — **5E3**

Response models for construction quality control. — F High 2

- **Problem Statement Number** LTPP-PROJ-0000118 — Asphalt Mixture Composition From Ground Penetrating Radar Signal Analysis — $0 — Proposed — 1/1/1900 to 1/1/1900 — **5F1**
- **Problem Statement Number** LTPP-PROJ-0000119 — Concrete Mixture Composition From Ground Penetrating Radar Signal Analysis — $0 — Proposed — 1/1/1900 to 1/1/1900 — **5F2**
- **Problem Statement Number** LTPP-PROJ-0000120 — Base Course Mixture Composition From Ground Penetrating Radar Signal Analysis — $0 — Proposed — 1/1/1900 to 1/1/1900 — **5F3**
- **Problem Statement Number** LTPP-PROJ-0000121 — Subgrade Mixture Composition from Ground Penetrating Radar Signal Analysis — $0 — Proposed — 1/1/1900 to 1/1/1900 — **5F4**
- **Problem Statement Number** LTPP-PROJ-0000122 — Constitutive Model of Complex Modulus of Asphalt From Ground Penetrating Radar Composition and Calibrated to Falling Weight Deflectometer Measurements — $0 — Proposed — 1/1/1900 to 1/1/1900 — **5F5**
- **Problem Statement Number** LTPP-PROJ-0000123 — Constitutive Model of Concrete From Ground Penetrating Radar Composition and Calibrated to Falling Weight Deflectometer Measurements — $0 — Proposed — 1/1/1900 to 1/1/1900 — **5F6**
- **Problem Statement Number** LTPP-PROJ-0000124 — Constitutive Model of Unbound, Modified, and Stabilized Base Course From Ground Penetrating Radar Composition and Calibrated to Falling Weight Deflectometer Measurements — $0 — Proposed — 1/1/1900 to 1/1/1900 — **5F7**
- **Problem Statement Number** LTPP-PROJ-0000125 — Expected Asphalt Fatigue Life, Risk, and Reliability Prediction From Ground Penetrating Radar/Falling Weight Deflectometer Inputs — $0 — Proposed — 1/1/1900 to 1/1/1900 — **5F8**
- **Problem Statement Number** LTPP-PROJ-0000126 — Expected Asphalt Rutting Life, Risk, and Reliability Prediction From Ground Penetrating Radar/Falling Weight Deflectometer Inputs — $0 — Proposed — 1/1/1900 to 1/1/1900 — **5F9**
- **Problem Statement Number** LTPP-PROJ-0000127 — Reconsideration of Asphalt Pay, Incentive, and Penalty Factors from Ground Penetrating Radar/Falling Weight Deflectometer Inputs — $0 — Proposed — 1/1/1900 to 1/1/1900 — **5F10**
- **Problem Statement Number** LTPP-PROJ-0000128 — Evaluation of Aggregate Absorptivity and Its Impact on Concrete Performance — $175,000 — Proposed — 1/1/1900 to 1/1/1900 — **5F11**
- **Problem Statement Number** LTPP-PROJ-0000129 — Use of Nondestructive Evaluation on Construction Risk Assessment — $675,000 — Proposed — 1/1/1900 to 1/1/1900 — **5F12**

Objective 6
Maintenance and rehabilitation strategy selection and performance prediction

Up-to-date LTPP maintenance and rehabilitation data validated for analysis use. — A Critical 1

- **NCHRP** LTPP-PROJ-0000130 — NCHRP 20-50(3/4): Effectiveness of Maintenance and Rehabilitation Options — $250,000 — Completed — 10/14/1999 to 1/31/2002 — **6A1**
- **FHWA** LTPP-PROJ-0000131 — Performance of Rehabilitated Asphalt Concrete Pavements in the Long-Term Pavement Performance Experiments — $54,000 — Completed — 10/1/1997 to 8/1/1999 — **6A2**
- **FHWA** LTPP-PROJ-0000132 — Assessment of the SPS-7 Bonded Concrete Overlays Experiment — $25,433 — Completed — 7/1/1999 to 12/1/2000 — **6A3**
- **FHWA** LTPP-PROJ-0000133 — Long-Term Pavement Performance Maintenance and Rehabilitation Data Review — $54,000 — Completed — 7/1/1999 to 4/1/2000 — **6A4**
- **Problem Statement Number** LTPP-PROJ-0000134 — Review and Validation of Long-Term Pavement Performance Maintenance and Rehabilitation Data — $100,000 — Proposed — 1/1/1900 to 1/1/1900 — **6A5**
- **Problem Statement Number** LTPP-PROJ-0000135 — Determination of Long-Term Pavement Performance Experiment Maturity for Analysis in Maintenance and Rehabilitation and Other Strategic Objective Analytical Projects — $180,000 — Proposed — 1/1/1900 to 1/1/1900 — **6A6**

Efficacy and performance prediction for pavement maintenance and rehabilitation options. — B Critical 2

- **NCHRP** LTPP-PROJ-0000136 — NCHRP 1-38: Guide on Pavement Rehabilitation Strategies — $100,000 — Completed — 3/1/1999 to 3/31/2001 — **6B1**
- **NCHRP** LTPP-PROJ-0000137 — NCHRP 14-14: Guide for Optimal Timing of Pavement Preventive Maintenance Treatment Applications — $312,397 — Completed — 4/10/2000 to 9/30/2003 — **6B2**
- **FHWA** FHWA-PROJ-13-0098 — Pavement Performance Measures and Forecasting, and the Effects of Maintenance and Rehabilitation Strategy on Treatment Effectiveness — $415,197 — Completed — 9/30/2013 to 12/31/2016 — **6B3**
- **FHWA** LTPP-PROJ-0000195 — NCHRP 20-50(17): LTPP Data Analysis: Consequences of Delayed Treatment of Pavement Preservation Treatments Placement on Asphalt Concrete, Portland Cement Concrete and Composite Pavement Structures — $425,000 — Cancelled — 1/1/1900 to 1/1/1900 — **6B4**

Guidelines for optimal timing of pavement maintenance and rehabilitation treatments. — C High