

Long-Term Pavement Performance Ancillary Information Management System (AIMS) Reference Guide

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FOREWORD

This document provides an overview of the contents of the Long-Term Pavement Performance (LTPP) program ancillary information. Ancillary information consists of data, images, reference materials, resource documents, and other information that support and extend the data stored in the Pavement Performance Database related to understanding the performance of pavement test sections included in the LTPP program. The primary purpose of this document is to explain the types and nature of the available information.

The LTPP program is an ongoing and active program. To obtain current information and access to other technical references, LTPP data users should visit the LTPP Web site at [http://www.fhwa.dot.gov/research/tfhrc/programs/infrastructure/pavements/ltpp/](http://www.fhwa.dot.gov/research/tfhrc/programs/infrastructure/pavements/ltp/). LTPP data requests, technical questions, and data user feedback can be submitted to LTPP customer service via e-mail at ltpinfo@dot.gov.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

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

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm ²	square millimeters	0.0016	square inches	in ²
m ²	square meters	10.764	square feet	ft ²
m ²	square meters	1.195	square yards	yd ²
ha	hectares	2.47	acres	ac
km ²	square kilometers	0.386	square miles	mi ²
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m ³	cubic meters	35.314	cubic feet	ft ³
m ³	cubic meters	1.307	cubic yards	yd ³
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
TEMPERATURE (exact degrees)				
°C	Celsius	1.8C+32	Fahrenheit	°F
ILLUMINATION				
lx	lux	0.0929	foot-candles	fc
cd/m ²	candela/m ²	0.2919	foot-Lamberts	fl
FORCE and PRESSURE or STRESS				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in ²

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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LIST OF ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ACSII	American Standard Code for Information Interchange
ADS	Automated photographic distress survey
AIMS	Ancillary Information Management System
AVC	Automated vehicle classification
AWS	Automated weather station
CSSC	Customer Support Service Center
DDV	Digitized drain inspection video
DEF	Deflection
DEFCAL	Deflection calibration
DIS	Pavement distress data
DiVA	Distress viewer and analyzer
DLR	Dynamic load response
DSV	Digitized distress data
DT	Data type
EDT	File name extension used for edited AWS and SMP data files
ERD	Engineering Research Division (standard electronic profile data file format)
ESAL	Equivalent single-axle load
FHWA	Federal Highway Administration
FRIC	Friction data module
FWD	Falling weight deflectometer
GPR	Ground-penetrating radar
IMS	Information Management System
INV	Inventory data module
IRD	International Road Dynamics Inc.
IRI	International Roughness Index
JPG	JPEG file interchange format
JPEG	Joint photographic expert group
LPF	Longitudinal profile
LTPP	Long-Term Pavement Performance
LTAS	LTPP Traffic Analysis Software

LTQC	LTPP traffic quality control
MAT	Materials testing data
MDD	Manual distress data
MDM	Manual distress map
MDS	Manual distress survey
MNT	Maintenance data module
MPEG	Moving pictures expert group
NARA	National Archives and Records Administration
PDF	Portable document format
PPDB	Pavement Performance Database
PRF	Profile
PROF	Profile data module
PVR	Per vehicle record
QC	Quality control
RHB	Rehabilitation data module
RSC	Regional support contractor
SAMP	Sampling (materials) data
SAS [®]	Statistical Analysis Software [®]
SDR	Standard data release
SMP	Seasonal Monitoring program
SPS	Specific Pavement Study
TFHRC	Turner-Fairbank Highway Research Center
TPF	Transverse profile
TMG	<i>Traffic Monitoring Guide</i>
TST	Testing (materials) data
WIM	Weigh-in-motion
WSP	Weigh-in-motion site profile

INTRODUCTION

Understanding why some pavements perform better than others is essential to building and maintaining a cost effective highway system. In 1987, the Long-Term Pavement Performance (LTPP) program—a comprehensive long-term study of in-service pavements—began a series of field experiments monitoring more than 2,400 asphalt and portland cement concrete pavement test sections across the United States and Canada. The primary purpose of the program is to establish a national long-term pavement database to support pavement research efforts that result in products to improve pavement performance. After more than 20 years of operation, the LTPP program has amassed a large volume of data. While much data are stored in an electronic relational database, an even larger amount of ancillary information exists and is available to those interested in the complex details of LTPP data. The purpose of this document is to describe the available LTPP ancillary information.

ANCILLARY INFORMATION

Ancillary information includes data, images, reference materials, resource documents, and other information that support and extend the data stored in the Pavement Performance Database (PPDB) related to understanding the performance of pavement test sections included in the LTPP program.⁽¹⁾ All of the electronic ancillary information is stored at the Federal Highway Administration (FHWA) Turner-Fairbank Highway Research Center (TFHRC) in McLean, VA, in what is called the Ancillary Information Management System (AIMS). AIMS comprises a set of internal tools used by LTPP staff to manage the vast amount of electronic data. While the majority of AIMS data are contained in PPDB in some form, some types of raw data that are summarized in the database are only available from AIMS.

Figure 1 illustrates the current terminology used by the LTPP program to describe the overall system to manage information intended for public dissemination for pavement performance research purposes. The total system is called the LTPP Information Management System (IMS), which includes products, PPDB, and AIMS as the major categories. Products are program results that can be used to improve pavement performance. PPDB is the formal database that contains the majority of research data on the performance of the LTPP test sections in an electronic relational database format. AIMS contains the larger electronic base of raw data files used to populate PPDB and other information not contained in PPDB.

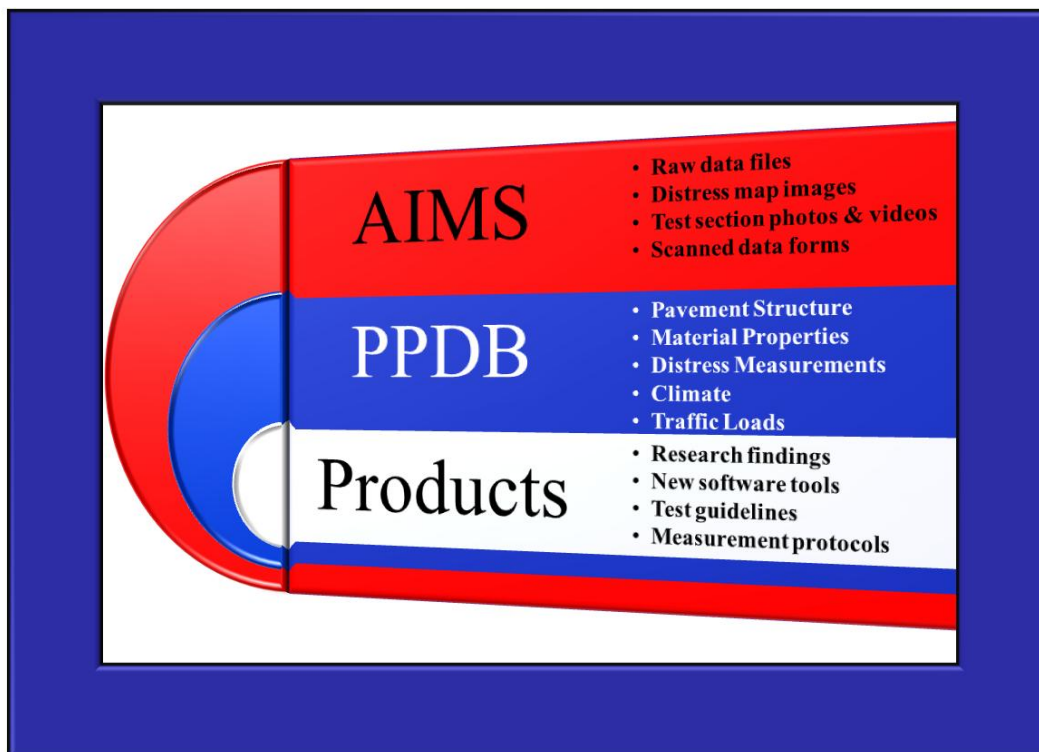


Figure 1. Illustration. Major categories of the LTPP IMS.

LTPP provides access to its ancillary information in the interest of linkage between the collected raw data and the summaries of processed data contained in the publicly disseminated database. Accessibility to the raw base line measurement data increases the potential for reinterpretation

using new future data concepts. A simple example of a data concept is the International Roughness Index (IRI). Providing access to the raw longitudinal profile (LPF) data allows other types of indices to be computed, such as an index based on dynamic truck loads. Note that IRI is based on passenger car suspension.

Ancillary information is provided without any indication of data quality. While some elements may have undergone quality reviews, some of the electronic files contained in AIMS are raw files that may not have been edited to correct errors discovered during database processing. AIMS also contains data that may not have been loaded into the database for quality concerns or other reasons (e.g., the data were collected after the out-of-study date). LTPP ancillary information users assume responsibility for performing their own checks on data quality and assessment of the appropriateness of the data or information for their intended purposes.

A brief summary of the ancillary data available from the LTPP program is presented in table 1. Not all of the data indicated in table 1 are available for all test sections, equipment evaluations, traffic measurements, etc.

Table 1. Summary of LTPP ancillary information.

Category	Ancillary Information	Comments
Automated weather station (AWS)	Raw files from data loggers	
	Edited upload files	
Drainage inspection	Inspection video	
	Scanned paper data forms	
Dynamic load response (DLR)	Raw time history sensor response files	More raw data are available than exists in PPDB
Falling weight deflectometer (FWD) measurements	Time history drop data	Not contained in PPDB
	Raw FWD measurement files	
	Scanned paper data forms	
	FWD electronic calibration files	Relative and reference calibration data
Friction	Scanned paper data forms	
Ground-penetrating radar (GPR)	Raw GPR data files	
	Interpreted measurement upload files	
	Raw data graphs	
	Images of interpretations	
Inventory	Scanned paper data forms	
Longitudinal Profile (LPF)	1-inch (25-mm) spacing raw profile data	Contained in converted Engineering Research Division (ERD) file format
	Raw profiler data files from weigh-in-motion (WIM) scale locations	

Category	Ancillary Information	Comments
	Scanned dipstick paper data collection forms	Paper data forms contain unfiltered pavement profile
	Profile preprocessing software internal computation database files	
	Equipment comparison reports and data	
Maintenance data module (MNT) and rehabilitation data module (RHB)	Scanned paper data forms	
Material tests	Scanned paper data forms	
Pavement distress	Digitized 1.4-inch (35-mm) black and white surface images	Not all 1.4-inch (35-mm) film digitized
	1.4-inch (35-mm) black and white film surface images	Not a formal part of AIMS
	Scanned images of photographic interpreted distress location map	
	Scanned images of manual survey distress location map	Shows location of surface distress features
	Scanned manual distress data (MDD) forms	
	Digitized photographs from manual distress surveys (MDSs)	Includes photos of interesting/unusual distresses
	Manual distress photograph metadata database	Contains a description of photos
	Scanned transverse profile (TPF) dipstick measurement data sheets	TPF dipstick measurements processed by LTPP preprocessing software
	Database used by the software to perform time series review of photographic and MDD	
Resilient modulus laboratory test	Time history load and deflection response	Data from all tests not available
Seasonal Monitoring program (SMP)	Raw files from data loggers	
	Edited upload files	
	Scanned paper data sheets	

Category	Ancillary Information	Comments
Specific Pavement Studies	Scanned paper data forms	
Test section coordinates	Scanned paper data forms	
Test section videos	Digitized walking inspection videos	
	Through profiler windshield videos	Shows general condition of test section
Traffic	Raw traffic data in “card” format	Annual estimates from the raw data are contained in PPDB
	LTPP Traffic Analysis Software (LTAS) preprocessing internal computation database files	Includes measurements in the non-LTPP study lane
	International Road Dynamics Inc. (IRD) raw data files and outputs from its iANALYZE software	From sites in the LTPP pooled fund study project

The 1.4-inch (35-mm) photographic images of test section surfaces used as the primary basis for distress interpretation at the start of the program have not been completely converted into electronic format. This is currently the most significant issue in digitization to complete the electronic AIMS. While not all of the available film has been converted to an electronic format, the physical photographic media still contains greater resolution than the pixilated digital images.

The following sections provide more information on the general nature of the available ancillary information following the categories listed in table 1. Appendix A provides additional details on general types of files and file naming conventions.

AUTOMATED WEATHER STATION

Automated weather stations (AWSs) were installed at selected Specific Pavement Study (SPS)-1, SPS-2, and SPS-8 experiment sites. AWS data available from AIMS include raw electronic data files downloaded from data loggers connected to the AWSs and data files produced by the pre-upload computer program used by the LTPP regional support contractors (RSCs) to review, edit, and create database upload files from the raw data for entry into PPDB.

DRAINAGE INSPECTION

Ancillary LTPP information includes the data from inspection of the subsurface drainage structures at SPS-1 and SPS-2 project sites. The inspection data includes measurements and information recorded on paper data collection forms and video images. The video images from a

remote camera inserted into the drainage system outflow exits and passed as far into the subsurface drains as possible are available in digital format.

DYNAMIC LOAD RESPONSE

Dynamic load response (DLR) data were collected at the North Carolina SPS-2 site and the Ohio SPS-1, SPS-2, SPS-8, and SPS-9 sites. The available DLR ancillary information not contained in PPDB are the raw time-history data files in American Standard Code for Information Interchange (ACSII) format produced by the strain, pressure, and linear variable differential transformer measurements under moving truck wheel loads.

AIMS contains more DLR measurement files than those uploaded into PPDB due to processing issues. Data users interested in LTPP DLR data must contact the LTPP Customer Support Service Center (CSSC) in order to obtain the most current data and information on problems discovered with past releases of DLR data.

FALLING WEIGHT DEFLECTOMETER

Falling weight deflectometer (FWD) measurements were performed on test sections to measure the deflection response of the pavement structure. In addition to the raw data produced by the automated FWD measurement device, associated data include manual pavement temperature gradient measurements and FWD calibration data.

The raw electronic data files from the FWD device are stored in AIMS. While the test time, test location, equipment calibration settings, equipment configuration factors, air and pavement temperature, and peak deflection basin measurements are stored in PPDB, the time-history deflection and load sensor measurements are only available from AIMS.

When FWD measurements are performed on LTPP test sections, measurement of the subsurface temperature of the bound surface pavement layers at various depths are performed using external instruments. The paper data sheets used to record these data in the field have been electronically scanned and are stored in AIMS.

LTPP FWD data undergo a variety of quality control (QC) checks. Calibrations are performed using a combination of relative and reference procedures. Measurement data are also subjected to automated data checks prior to uploading into PPDB. AIMS includes the raw electronic files generated during these calibrations and pre-upload data checks.

FRICITION

Friction measurements are performed by participating highway agencies on a voluntary basis using their equipment. The measurements are recorded on paper data forms that are submitted to LTPP for entry into PPDB. The scanned images of the paper data collection forms used to report data are saved in electronic format in AIMS.

GROUND-PENETRATING RADAR

Ground-penetrating radar (GPR) measurements were performed in 2003 on all SPS-1 projects that were still in-service at the time. Measurements were also performed on selected SPS-2, SPS-5, and SPS-6 project sites.

The ancillary information from these GPR measurements includes the raw data files containing readings every 6 inches (152 mm), a graph of the data contained in the raw data file, a graph of the interpreted dielectric constant versus position, a graph of the interpreted layer thicknesses versus position in the right wheel path and center of the lane, and the upload files used to populate the table in PPDB that contains the interpreted results.

INVENTORY DATA

Inventory data include pavement age, general location, pavement type, layer thicknesses and types, material properties, composition, previous construction improvements, and other background information obtained from agency files for pavement structures in-service prior to LTPP monitoring. The data are reported to LTPP by participating highway agencies on paper data collection forms. Images of the paper data collection forms used to collect this data are saved in electronic scanned format in AIMS.

LPF

LTPP LPF measurement ancillary information includes raw data files from high-speed inertial profile measurements on pavement test sites and weigh-in-motion (WIM) scales and manual measurements on remote test sites using the dipstick device.

The majority of LTPP LPF measurement data were collected using high-speed inertial profilers. The raw data files and database files generated by the LTPP pre-upload data processing software are stored in AIMS. LTPP LPF data include measurements performed on pavement test sections and at WIM scale measurement sites.

A small subset of LPF measurement data was collected using a manually operated dipstick device. Ancillary information from dipstick measurements includes an image scan of the paper data collection forms and electronic data files generated during the pre-upload processing of these data.

The 1-inch (25-mm) interval longitudinal pavement profile data available from the more modern profilers are not contained in PPDB and are only available by request to LTPP CSSC. All LPF measurements at WIM scale sites are stored only in AIMS.

MAINTENANCE AND REHABILITATION

Maintenance data modules (MNTs) and rehabilitation data modules (RHBs) include data for maintenance and rehabilitation construction events performed after LTPP monitoring of the test sections had begun. These data are reported on paper data collection forms. Images of the paper data collection forms used to collect this data are saved in electronic scanned format in AIMS.

MATERIAL TESTS

This data type contains field tests and laboratory test results on material samples obtained from the LTPP test sections. The majority of these data are reported on paper data collection forms. Images of the paper data collection forms used to collect these data are saved in electronic scanned format in AIMS.

PAVEMENT DISTRESS

The major categories of LTPP pavement distress ancillary information are manual distress, automated photographic distress, manual TPF measurements, and data from automated quality review records.

The manual distress ancillary information includes scanned images of the paper field data distress maps, paper data collection sheets, and digitized images from photographs taken during a manual distress survey (MDS). The electronic database that documents the basic information on the location of each manual distress photographic image file is also contained in AIMS.

A significant exception to the definition of AIMS data being electronic files are the pavement images recorded on 1.4-inch (35-mm) black and white film. Two sets of film are available. One set of film was used to record the image of the pavement surface. These images were used as the basis for surface distress interpretations from raters. The other film set was used to measure the distortion in the pavement TPF using an optical image analysis process. All original raw 1.4-inch (35-mm) film media is stored in a climate-controlled facility at the Materials Reference Library. Approximately 2,000 images collected between 2002 and 2004 have been electronically digitized and stored in AIMS. Users desiring access to view raw film format must make arrangements through the LTPP CSSC.¹

Manual TPF measurements performed using the dipstick measurement device are recorded in the field on paper forms. The data from these paper forms are entered into a pre-upload processing software that checks the data, performs quality checks, and generates PPDB upload files. AIMS contains electronically scanned images of the field paper data collection forms and files generated by the data processing program.

Other pavement distress information stored in AIMS that are not available in PPDB includes images of the hand-drawn distress maps that indicate the location of the various distresses from the manual surveys, computer-generated maps from interpretation of 1.4-inch (35-mm) film, digitized images from photographs taken during MDSs, and digitized images from the 1.4-inch (35-mm) photography.

RESILIENT MODULUS MATERIAL TESTS

Resilient modulus tests were performed on asphalt concrete cores and unbound aggregate/subgrade material samples following the LTPP P07 and LTPP P46 test protocols.^(2,3) The LTPP P07 test protocol is a test procedure that includes resilient modulus, creep compliance, and

¹The 1.4-inch (35-mm) film contains a continuous image requiring special equipment to view. One set of equipment for viewing this film exists at TFHRC.

tensile strength from asphalt concrete core samples tested in indirect tension. The LTPP P46 protocol is a resilient modulus test performed on unbound base and subbase materials in compression mode. The raw time history data files from the parts of these laboratory tests based on repeat cyclical load/response measurements are contained in AIMS.

Only a partial record of the raw LTPP P46 test protocol time-history data on unbound materials exists since the original laboratory contractors were not required to submit these data.

SEASONAL MONITORING PROGRAM

The data in the Seasonal Monitoring program (SMP) module contain processed raw and interpreted data from instrumentation and other measurements performed on these sites. The SMP ancillary information includes the raw electronic instrumentation data files, edit files from the software program that were used to perform primary quality checks on the raw data and produce the PPDB upload files, and scanned electronic paper data collection forms.

SPS

This module includes general and construction information collected from the test sections included in the SPS experiments. These data are entered on paper data collection forms. Images of the paper data collection forms used to collect the general and construction data contained in this module are saved in electronic scanned format in AIMS.

TEST SECTION COORDINATES

Test section coordinates are measurements or estimates of test section locations using Global Positioning System technology or other modern mapping techniques. These measurements are recorded on paper data collection forms. Images of the paper data collection forms used to collect this data are saved in electronic scanned format in AIMS.

TEST SECTION VIDEOS

The following types of test section videos have been electronically digitized and are available:

- **Walking inspections of test sections:** During the initial inspection of test sections at the start of the program, videos showing the test section surface and surrounding terrain were made on some sections. Walking inspection videos were also created during MDSs on some sections. The videos were taken by staff walking the length of each test section, and they contain an oral narrative of significant features.
- **Through-the-windshield video from the high-speed profiler:** Video cameras were mounted in some of the LTPP profilers, and videos of the test sections were recorded through the windshield during measurements. These videos were used to check on the general condition of each test section and to detect maintenance activities. These video recordings were performed by only some regional LTPP data collection contractors and are available for a subset of test sections.

TRAFFIC

LTPP traffic data ancillary information includes traffic measurement input files used by the LTPP Traffic Analysis Software (LTAS) files created by legacy LTPP traffic QC (LTQC) software and versions based on Statistical Analysis Software[®] (SAS[®]), files from the International Road Dynamics Inc. (IRD) iANALYZE[®] software, and scanned paper data forms. The SAS[®] binary file formats are no longer supported.

LTAS reads data files formatted in a FHWA *Traffic Monitoring Guide* (TMG) format for classification or weight data, performs traffic data QC checks, provides data graphs for semi-automated data checks by regional staff, creates a variety of quality assurance reports, and creates the annual traffic data statistics stored in PPDB.⁽⁴⁾ The internal database files created by LTAS are now part of the LTPP standard data release (SDR). The AIMS component of LTAS-related data contains output files in the TMG format.

The first contractor was selected to install WIM scales at select LTPP test section locations as part of the LTPP SPS Traffic Data Collection Pooled Fund Study. AIMS includes vendor proprietary binary raw data output and ASCII versions of the same data produced by the iANALYZE[®] software.

The traffic ancillary information also includes electronic images of the paper data forms used to report basic traffic information, traffic scale calibration, historical traffic, and traffic estimates produced by the agency when no onsite measurements were performed.

RESOURCE DOCUMENTS AND TOOLS

LTPP created a comprehensive set of documents that explain how the data were collected, processed, and stored. The most complete source of these documents is contained in the electronic reference library distributed as part of the LTPP SDR. Some of the resource documents in the reference library include the following:

- Data collection guides.
- Test protocols and procedures.
- Descriptions of field and laboratory test equipment.
- Test section construction reports.
- Monitoring equipment installation reports.
- Experiment design.
- Test section recruitment guidelines.
- Equipment comparison reports.
- Directives.
- Data user guides.

The reference library also contains the following user tools:

- **LTPP Table Navigator:** A computer program that presents metadata on the structure and contents of PPDB. This includes the table schema, data dictionary, and codes list.
- **LTAS Navigator:** A computer program that presents metadata on the structure and contents of LTAS. This includes the table schema, data dictionary, and codes list.
- **ESALCalc:** A computer program that allows the user to compute 18-kip (80-kN) equivalent single-axle loads (ESALs) based on the 1993 American Association of State Highway and Transportation Officials (AASHTO) *Guide for Design of Pavement Structures* methodology.⁽⁵⁾ An internal database contains computed ESALs from LTPP test sections with traffic monitoring data, or a user can change the input assumptions and perform their own computations.
- **FWD forward calculation spreadsheets:** These spreadsheets contain a forward calculation technique for estimating layer moduli from FWD deflection measurements developed under a LTPP data analysis contract.

- **Rigid pavement design spreadsheet:** This spreadsheet automated updates to the 1998 supplement to the AASHTO *Guide for Design of Pavement Structures* for rigid pavements.⁽⁶⁾

Some of the resource documents, analysis reports, and other tools developed by the LTPP program are available at [http://www.fhwa.dot.gov/research/tfhrc/programs/infrastructure/pavements/ltpp/](http://www.fhwa.dot.gov/research/tfhrc/programs/infrastructure/pavements/ltp/).

OBTAINING LTPP ANCILLARY INFORMATION

LTPP ancillary information can be obtained upon request by contacting the LTPP CSSC located at TFHRC in Mclean, VA, at lttinfo@dot.gov or via phone at (202) 493-3035.

Data requests should be for specific information since the more than 2.5 million electronic files require more than 3.1 terabytes of computer storage space. While access to this information is not currently available over the Internet, work is underway to make some of these data available on the Web.

TECHNICAL DETAILS

Some of the technical details of the electronic files containing LTPP ancillary information include the following:

- Electronic data formats follow U.S. National Archives and Records Administration (NARA) standards existing at the time the various versions of LTPP directives on the subject were written. In some cases, other popular formats were used if NARA did not have an existing standard at the time.
- Scanned paper data forms are saved in a black and white portable document format (PDF).
- Videos are digitized to moving pictures expert group (MPEG) formats.
- Still images are digitized to joint photographic expert group (JPEG) formats.
- File naming conventions are documented in appendix A. The file names are linked to a defined directory storage structure. Many file names contain only a survey date since they are stored in a directory storage structure that defines the type of data, the agency in which a test section is located, and the test section number. In other cases, a more complex naming scheme is used to store similar data in a common end folder location. Data users should request electronic ancillary information in the predefined folder structure shown in appendix A.
- While some of the file name extensions conform to modern electronic file name practice (e.g., “.pdf” is a PDF file), many file extensions conform to LTPP practice for its custom electronic file structures. These file name extension practices change over time.
- The schema that describes custom LTPP electronic data files is available upon request from LTPP CSSC.

APPENDIX A. AIMS TECHNICAL STORAGE DETAILS

INTRODUCTION

Details on the general formats and directory structure used to store electronic files in AIMS are presented in this appendix. Field names, such as STATE_CODE, from PPDB are used to specify directory folder storage structures. The definitions of these field names can be found in the *Long-Term Pavement Performance Information Management System Pavement Performance Database User Reference Guide* or the LTPP Table Navigator program distributed with the LTPP SDR and available from the LTPP FHWA Web site.⁽⁷⁾

While some file naming conventions are referenced here, there are cases where a reference is made to other LTPP literature on file naming conventions. Data users interested in using data from LTPP AIMS should contact the LTPP CSSC with questions concerning the contents and formats of these files.

ELECTRONIC AIMS FILE STANDARDS

The following file standards specify required and preferred standards for electronic data files converted from paper, video, and photographic images.

Specifications for Scanned Paper Data Forms

Scanned paper data forms conform to NARA's *Expanding Acceptable Transfer Requirements: Transfer Instructions for Permanent Electronic Records*.⁽⁸⁾ References to this standard are also available.⁽⁹⁾

For LTPP purposes, the following minimum specifications were specified:

- Data forms shall be scanned at a minimum resolution of 300 pixels per inch (12 pixels per mm).
- All data forms in a defined category are scanned into PDF files.
- Bitonal (Black and white) scanning is preferred, provided a relatively small electronic file is produced.
- Image compression in the PDF creation process shall use lossless compression methods (JBIG2 Lossless).

The preferred practice is to scan paper data forms formatted primarily in portrait orientation in an up-right orientation when they are opened for viewing.

Specifications for Digitized Video

At the time the original LTPP guidelines were prepared, NARA had not developed national standards for digitized video due to the rapidly evolving nature of digital video formats and the lack of any open, national or international consensus standards for the creation and preservation of

digital video. Due to business requirements for smaller file sizes, the following file types and minimum standards are used:

- **MPEG1:** This is appropriate for older video obtained from Super-VHS video recorders. Minimum frame size is 320 × 240 pixels.
- **MPEG2:** This is the preferred video compression standard since it is compatible with modern DVD players and is recommended for video collected using digital cameras. Minimum frame size is 320 × 240 pixels. Data rates should not exceed 7 megabits/s.

Other digitized video formats can be used if approved by FHWA.

Still Digital Images

Still digital images obtained from digital cameras or scanned color photographs are stored in JPEG or JPEG file interchange format (also known as JPG).

Minimum standards for JPG files include the following:

- 256 colors.
- Quality compression of 50 or greater.
- 300 pixels per inch (12 pixels per mm).

Images previously submitted to LTPP CSSC not meeting these minimums do not have to be re-imaged unless directed by FHWA.

DETAILS BY DATA/FORMAT TYPE

The following sections provide details on AIMS data, file directory storage structure, and some file naming conventions for some data types. Table 2 presents a summary of the overall file directory storage structure used to store AIMS files on the internal LTPP file servers.

Table 2. LTPP AIMS directory storage structure.

Primary Directory	2 nd Tier	3 rd Tier	4 th Tier	5 th Tier	6 th Tier	7 th Tier	8 th Tier
AWS	STATE_CODE	AWS_ID					
DEF	STATE_CODE	STATE_CODE+SHRP_ID	SURVEY_DATE				
DEFCAL	DEFL_UNIT_ID	YEAR	<i>Cal Type</i>				
DIS	<i>Dis Type</i>	STATE_CODE	STATE_CODE+SHRP_ID	SURVEY_DATE			
GPR	STATE_CODE+SPS_ID						
PRF	<i>Prof Type</i>	STATE_CODE	STATE_CODE+SHRP_ID	SURVEY_DATE			
SMP	STATE_CODE	STATE_CODE+SHRP_ID	SURVEY_DATE				
TRF	LTAS	STATE_CODE	STATE_CODE+SHRP_ID	YEAR	<i>LTAS Type</i>		
TRF	SAS	STATE_CODE	STATE_CODE+SHRP_ID	LEV4	YEAR		
TRF	LTQC	STATE_CODE	STATE_CODE+SHRP_ID	LEV4	DATA	YEAR	<i>LTQC Type</i>
TRF	SHEET	STATE_CODE	STATE_CODE+SHRP_ID				
TRF	PVR	STATE_CODE	STATE_CODE+SHRP_ID	YEAR	BINARY		
TRF	PVR	STATE_CODE	STATE_CODE+SHRP_ID	YEAR	ASCII	SOFTWARE VERSION	
<i>Data Type</i>	STATE_CODE	STATE_CODE+SHRP_ID					
MAT	TST	<i>Test Type</i>	STATE_CODE	STATE_CODE+SHRP_ID			
DSV	STATE_CODE	STATE_CODE+SHRP_ID	<i>Video Type</i>				
DDV	STATE_CODE	STATE_CODE+SHRP_ID					

Note: *Cal_Type*: {REF, REL}, *Dis_Type*: {MDS, ADS}, *Prof_Type*: {TPF, PRF, LPF, WSP}, *LTAS_Type*: {AVC, WIM, VOL}, *LTQC_Type*: {AVC4, WIM7, DATA}, *Data_Type*: {INV, MAT\TST, MAT\SAMP, RHB, MNT, FRIC, SPS}, *TST_Type*: {P07, P46}, and *Video_Type*: {GEN, DIS, PROF}.

Automatic Weather Station (AWS) Data

AWS data are stored using the following directory structure:

AWS\STATE_CODE\AWS_ID

This directory contains all raw electronic data files downloaded from the AWS instrumentation, EDT files created by the AWSCheck software, and PPDB upload files created by the AWSCheck software. In those cases where multiple EDT files were created by RSCs for an AWS site, a number is appended to the file name extension to make the file name unique. Preferred practice is to assign the appended number starting with 1 for the earliest file and increasing sequentially with time.

For other files, the file naming convention is assigned in accordance with directives existing at the time of data acquisition and/or file creation.

Deflection (DEF)—Falling Weight Deflectometer (FWD) Peak, Time History, and Pavement Temperature Data

The electronic version of the following FWD files is stored in AIMS. The file naming convention is assigned in accordance with directives existing at the time of data acquisition and/or file creation as follows:

- Version 10 “*.FWD” files contain both peak deflection data and time history data.
- Version 20 “*.FWD” files contain both peak deflection data and time history data.
- Version 25 “*.F25” files contain peak deflection data only.
- Version 25 “*.HXT” files are ASCII files containing converted binary encoded time history data.
- FWDWin “*.DDX” files are ASCII files converted from MS Access containing peak and time-history data.
- Highway agency FWD data collected on LTPP sections regardless of format.

In addition, the pavement temperature gradient measurements recorded on paper data forms and performed during FWD measurements are scanned following the guidelines in this document and stored in the AIMS. The following file naming convention is used for these files:

DEF+STATE_CODE+SHRP_ID+SURVEY_DATE (YYYYMMDD).pdf

The following directory/subdirectory structure is used to store both the FWD measurement data and scanned paper pavement temperature gradient data:

DEF\STATE_CODE\STATE_CODE+SHRP_ID\SURVEY_DATE (YYYYMMDD)

An example of a directory/subdirectory structure is \DEF\48\480102\20040905.

Deflection Calibration (DEFCAL)—Falling Weight Deflectometer Calibration Files

The following data files are included for DEFCAL FWD calibration files:

- Raw electronic data files generated during a relative calibration test on a FWD used to collect data for the LTPP program. The raw data files should be submitted in the native data collection format with file names in accordance with applicable directives existing at the time of the test.
- Electronic data files produced by the RelCal software containing the results of the relative calibration test results.
- Electronic data files produced by the WinFWDCal software in pavement deflection data exchange format used for calibrations following the *AASHTO Recommended Standard of Practice R32-09*.⁽¹⁰⁾ This includes FWDCalibrationRecord dd-mm-yyyy.DDX and FWDCalibrationOutput dd-mm-yyyy.DDX. Other electronic files used in this process, such as those produced by the FWD, should also be stored.
- Scanned output showing gain factors from results of a reference calibration test, (certificate of calibration), available Temperature Sensor Check (TSC) forms on a FWD used to collect data for the LTPP program. The files should be named REFCAL_TEST_DATE (YYYYMMDD). pdf.

The following directory structure is used:

- DEFCAL\DEFL_UNIT_ID\4-digit Year\REF – for files associated with reference (annual) calibration. This includes both reference and relative calibration tests.
- DEFCAL\DEFL_UNIT_ID\4-digit Year\REL – for files associated with relative (monthly) calibration.
- Where DEFL_UNIT_ID is the FWD measurement unit identifier used in the MON_DEFL_MASTER table.

Example

DEFCAL\8002-131\1994\REL\DATA Files (e.g., 13020394.RC1 and 13020394.CS1).

Note that this is an example of a file name used during relative calibration. Other file names were used because of the number of attempts made to pass calibration.

DEFCAL\8002-131\1994\REF\DATA Files (SDX1926.GO1, Load188.LO1, and Dyna131A.GO1).

Note that these are example of file names used during reference calibration. Other file name conventions were also used.

Ground Penetrating Radar (GPR)

GPR measurements include the raw data files containing readings every 6 inches (152 mm), a graph of the data contained in the raw data file, a graph of the interpreted dielectric constant versus position, a graph of the interpreted layer thicknesses versus position in the right wheel path and center of the lane, and the upload files used to populate the table in the PPDB that contains the interpreted results.

GPR data are stored using the following directory structure:

GPR\STATE_CODE+SPS_ID\filename.ext.

Pavement Distress Data (DIS)

This data type includes manual distress, transverse profile, automated distress, distress viewer and analyzer (DiVA), and manual distress photo database categories.

Manual Distress Surveys (MDS)

This category includes the manual distress maps (MDM files), manual distress survey photos/images (MDP files), and manual distress data (MDD files). The MDD files include all of the paper data collection forms for a linked manual distress survey data set, which may include the following types of data depending on the type of test section: Manual distress survey summary form (sheets 1, 2, 4, 5, 8, and 9), rut depth measurements (sheet 3), faulting measurements (sheet 6), lane shoulder drop-off separation (sheets 7 and 10), hand drawn distress maps, and transverse profile measurements with the dipstick (sheets DS-7 and DS-8). The file directory storage structure for these data is as follows:

DIS\MDS\STATE_CODE\STATE_CODE+SHRP_ID\SURVEY_DATE (YYYYMMDD).

The appropriate file naming convention for manual distress maps scanned before issuance of directive is assigned in accordance with the relevant LTPP distress directives (e.g., D-17, D-31, D-44, or their successors). File names for digitized manual distress photographs are assigned in accordance with the relevant LTPP distress directives (e.g. D-17, D-31, D-44 or their successors).

Manual distress survey data from sets digitized after issuance of LTPP Directive GO-48 “AIMS Electronic Data Format, Submission Standards, and Dates” contain all paper data forms, including manual distress maps, in a single PDF file named using the following convention:

MDD+STATE_CODE+SHRP_ID+SURVEY_DATE (YYYYMMDD).pdf

For distress data sets where linked distress measurements in a data set were conducted on different days, the first measurement day in the data set is used in the file name.

Manual distress surveys scanned following the old tagged image file format (TIFF) protocol have been replaced by a single PDF file following these guidelines. If changes are made to

previously scanned manual distress data causing re-scanning of the data packet, the new data packets are submitted in PDF format.

Examples

DIS\MDS\24\240504\20040609\MDP240504A200401.jpg—Manual distress photograph-1 on section 24_0504 taken on June 9, 2004.

DIS\MDS\24\240504\20040609\MDD24050420040609.pdf—File containing an image of all manual distress data forms from the manual distress survey performed on June 9, 2004 in PDF format.

Automated Photographic Distress Surveys (ADS)

This category includes distress maps interpreted from the automated distress survey images (ADS files) and digitized images from the 1.4-inch (35-mm) photographic distress film (ADP files).

The directory structure for each subcategory is as follows: the file names should be assigned in accordance with the relevant LTPP distress directives (e.g. D-17, D-31, D-44, or their successors).

DIS\ADS\STATE_CODE\STATE_CODE+SHRP_ID\SURVEY_DATE (YYYYMMDD).

An example of a directory structure file name is *DIS\ADS\24\241006\20010229.*

DiVA and Distress Photo Database

The Distress Review Microsoft Access[®] file from the DiVA output and the Distress Photo Survey Microsoft Access[®] metadata database table is stored in the DIS root directory.

ProQual Transverse Profile (TPF) Data Files

The transverse profile (TPF) archival data file produced by the ProQual software is stored using the following directory structure:

DIS\TPF\STATE_CODE\STATE_CODE+SHRP_ID\SURVEY_DATE (YYYYMMDD).

The file name convention produced by ProQual is used for these files.

An example file name is *DIS\TPF\01\012106\19921222.*

Note that scanned paper data forms containing transverse profile measurements using the dipstick are included in the MDD files defined under manual distress data.

Profile (PRF)—Longitudinal and Weigh-In-Motion (WIM) Sites

Separate folders exist for each profile subcategory—longitudinal profile (LPF) and WIM site profile (WSP). Where applicable, data files created during the archival process using the ProQual

software are placed in the corresponding directories in accordance with Directive P-37 or its successor. Specific directions and subdirectory structures for each subcategory follow.

Longitudinal Profile (LPF)

Longitudinal profile measurements that have been collected with both high-speed road profilers and dipsticks are included in AIMS. The following directory structures and subfolders are used:

- PRF\LPF\STATE_CODE\STATE_CODE+SHRP_ID\SURVEY_DATE (YYYYMMDD).
 - Example: \LPF\01\012106\19921222
- PRF\LPF\STATE_CODE\STATE_CODE+SHRP_ID\SURVEY_DATE (YYYYMMDD)\ERD.

When possible, RSCs have converted raw profiles to the Engineering Research Division (.ERD) format and placed these files in the ERD directory subfolder as follows:

- \LPF\01\012106\19921222\ERD

File names for data from road profilers are assigned in accordance with applicable directives at the time the data were collected.

The following directory structure and file name convention are used for longitudinal profile measurements with a dipstick scanned from the paper data collection forms:

- PRF\LPF\STATE_CODE\STATE_CODE+SHRP_ID\SURVEY_DATE (YYYYMMDD)*File_name*.

Where:

File_name = PRF+STATE_CODE+SHRP_ID+'_'SURVEY_DATE (YYYYMMDD).pdf.

PRF\LPF\10\101450\20030308\PRF101450_20000308.pdf – longitudinal Dipstick data for section 101450 from 03/08/2000.

WIM Site Profile (WSP)

For the WIM site profile (WSP) subcategory, the following directory structures and subfolders are used for raw data and data in ERD format:

- PRF\WSP\STATE_CODE\SSEELW\SURVEY_DATE (YYYYMMDD)*filename.ext* is used for raw profile data files produced by the field measurement device and named in accordance with the LTPP file naming convention in force at the time of data collection.
- PRF\WSP\STATE_CODE\SSEELW\SURVEY_DATE (YYYYMMDD)\ERD*filename.erd* is used for longitudinal profile data converted to ERD format.

Where:

SS = State code

EE = Experiment number.

L = Lane designation, "O" is outer and "I" is inner.

W = Wheel path, "L," "R," and "C" for left, right, and center, respectively.

For example, *PRF\WSP\36\3608OL\20020913\ERD*.

Resilient Modulus Material Tests

This includes electronic test from the P07 test protocol *Test Method for Determining the Creep Compliance, Resilient Modulus, and Strength of Asphalt Materials Using the Indirect Tensile Test Device* and P46 test protocol *Resilient Modulus of Unbound Materials*.^(2,3)

The LTPP P07 data is stored using the following directory structure:

MAT\TST\P07\STATE_CODE\STATE_CODE+SHRP_ID\LAYER_NO\filename.ext.

The LTPP P46 data is stored using the following directory structure:

MAT\TST\P46\STATE_CODE\STATE_CODE+SHRP_ID\LAYER_NO\filename.ext.

Seasonal Monitoring Program (SMP)

For each SMP site, the following directory structure was created:

SMP\STATE_CODE\STATE_CODE+SHRP_ID\SURVEY_DATE(YYYYMMDD).

This directory contains all raw data files downloaded from the SMP instrumentation and scanned paper data forms collected on the survey date. File names for the scanned paper data forms use the following convention:

File_name=SMP+STATE_CODE+SHRP_ID+"_"+SURVEY_DATE.pdf.

EDT files created by the SMPCheck software and PPDB upload files created by the SMPCheck software are stored in the following upper tier directory structure:

SMP\STATE_CODE\ STATE_CODE+SHRP_ID\.

In those cases where multiple EDT files were created by RSCs for a SMP site, a number is appended to the file name extension to make the file name unique following the practice for similar AWS EDT files. Uploaded file names are assigned in accordance with the file naming convention produced by the SMPCheck software.

Traffic Data

Traffic data includes electronic traffic data files and scanned paper data forms.

Electronic Traffic Data Files

This category includes all ASCII data files output by the LTQC software, SAS[®] software, LTAS, or IRD iANALYZE software. A site may require use of multiple subdirectory structures.

The largest repository of electronic traffic monitoring data contained in AIMS is associated with LTAS data since this software is used by the LTPP program to check and process all traffic monitoring data. Traffic monitoring data collected before implementation of the LTAS software have been processed by this program. The directory structure used to store LTAS data is as follows:

TRF\LTAS\STATE_CODE\STATE_CODE+SHRP_ID\YEAR\data folders by type {AVC, WIM, VOL}.

Examples include the following:

- TRF\LTAS\22\220100\2008\ASCII.
- TRF\LTAS\22\220100\2008\WIM.

The following file storage structures are used for data processed by the legacy LTPP SAS[®] and LTQC software. Note that the SAS[®] binary data files are being archived and will no longer be generally available since they can no longer be opened.

SAS[®] directory structure: TRF\SAS\STATE_CODE\STATE_CODE+SHRP_ID\data folders by type {LEV1\YEAR, LEV2\YEAR, LEV3\YEAR, LEV4\YEAR\WIM7\MONTH, LEV4\YEAR\AVC\MONTH, LEV4\YEAR\DATA, LEV5\INDEX}

For example, TRF\SAS\32\321021\LEV1\1990.

LTQC directory structure: TRF\LTQC\STATE_CODE\STATE_CODE+SHRP_ID\LEV4\DATA\YEAR\data folders by type {AVC4, WIM7, DATA}.

For example, TRF\LTQC\36\364018\LEV4\DATA\1998\AVC4.

IRD monitored traffic data files are stored in a separate directory data structure since they were collected as part of the LTPP SPS Traffic Data Collection pooled fund study and are inputs into the IRD proprietary software which provides additional data review capabilities. This data type is called “per vehicle record” (PVR) and is stored using the following directory structure:

TRF\PVR\STATE_CODE\STATE_CODE+SHRP_ID\data folders by type {BIN, ACSII}.

Scanned Paper Data Forms

For traffic data sheets 1–9, 14, and 15, one PDF file was created containing all of these data sheets with the following name:

File_name = TRF+STATE_CODE+SHRP_ID.pdf.

For traffic data sheets 10, 11, 12, 13, and 16, one PDF file is created containing all of these sheets by the year using the following name:

File_name = TRF+STATE_CODE+SHRP_ID+"_"YEAR (YYYY).pdf.

These files are stored in the following directory structure:

TRF\SHEET\STATE_CODE\STATE_CODE+SHRP_ID*File_name.pdf*.

Other Scanned Paper Data Forms

This data type includes images of digitally scanned paper data forms for non-rejected LTPP test sections. All scanned images of data forms for a particular data type (DT) for a section or project are combined into PDF files. Files with unique file names containing similar data types with other electronic data can be stored in the same low level directory. The following file directory and file naming conventions are used for inventory, material, rehabilitation, maintenance, friction, and SPS. The files are stored in the same structure as other corresponding electronic data with matching DT as specified below.

DT\STATE_CODE\STATE_CODE+SHRP_ID\File_name.pdf

Where DT equals the following:

- INV for inventory data (including global positioning measurements).
- MAT\TST for material test data (one MAT directory with two subdirectories).
- MAT\SAMP for material sampling data (one MAT directory with two subdirectories).
- RHB for rehabilitation data.
- MNT for maintenance data.
- FRIC for friction monitoring data.
- SPS for general SPS project data, SHRP_ID=PROJECT_ID.

For INV, RHB, and MNT data. the following file naming convention is used:

- *File_name* = DT+STATE_CODE+SHRP_ID.pdf

For SPS data, the following file naming conventions are used:

- *File_name* = SPS+ "#"+STATE_CODE+SHRP_ID.pdf – for test section specific data
- *File_name* = SPS+ "#"+STATE_CODE+PROJECT_ID.pdf – for general project data

Where "#" is the SPS experiment number assigned to the project site.

For MAT\TST, the following file naming conventions are used:

- *File_name* = TST+” ”+L05+” ”+STATE_CODE+SHRP_ID.pdf—For lab data sheets L05, L05A, and L05B. All data sheets for a test section are included in one file.
- *File_name* = TST+STATE_CODE+SHRP_ID+” ” + Field Set.pdf—For all other lab data sheets. All data sheets for the same field set are stored in the same file.

For MAT\SAMP data forms the following file naming convention is used:

- *File_name* = TST+STATE_CODE+SHRP_ID+” ” + Field Set.pdf—All data sheets for the same field set are stored in the same file.

For FRIC data, the following file naming convention is used:

- *File_name* = FRIC+STATE_CODE+SHRP_ID+” ”SURVEY_DATE (YYYYMMDD).pdf.

Examples include the following:

- *INV\10\101450\INV101450.pdf*—Inventory data for section 10_1450. One PDF file is made for each test section or SPS project.
- *SPS\10\100100\SPS100102.pdf*—SPS1 construction data for section 10_0102.
- *FRIC\48\483855\FRIC483855_19951207.pdf*—All friction data for section 48_3855 from 12/7/1995.
- *MAT\TST\10\101450\TST_L05_101450.pdf*—All lab data sheets L05, L05A, and L05B for section 101450.
- *MAT\TST\10\101450\TST101450_1.pdf*—Lab data sheets for section 101450, for field set No.1.
- *MAT\SAMP\34\340801\SAMP340801_1.pdf*—Sampling on section 340801, field set No. 1.

Digitized Test Section Videos (DSV)

This data type includes digitized video of test sections. The digitized videos are stored in the following directory structure:

- DSV\STATE_CODE\STATE_CODE+SHRP_ID\VT\VIDEO_DATE (YYYYMMDD)*file_name*.

Where VT equals the following:

- GEN for initial video of test section or other at other dates not included below.

- DIS for video taken during a manual distress survey.
- PROF for video taken through the windshield of a profiler.

For example, *DSV\48\481077\GEN\19891202*.

File_Name = VT+STATE_CODE_SHRP_ID+”_”+VIDEO_DATE.fe

Where:

VT = Video type defined above.

Fe = File extension type appropriate to the type of file (i.e., mpg).

For example, *DSV\48\481077\GEN\481077_19891202.mpg*.

Digitized Drain Inspection Video (DDV)

This data type contains digitized video from photographic inspections of the subsurface drainage features on SPS-1 and SPS-2 projects. These videos are from cameras inserted into the lateral drains and extended as far up the drain as possible. The digitized videos are stored in the following directory structure:

- *DDV\STATE_CODE\STATE_CODE + SHRP_ID\file_name*.

Where:

file_name = STATE_CODE +SHRP_ID+VideoID.avi.

VideoID = A sequential number assigned to video of each lateral drain.

APPENDIX B. STATE CODES

Code	State/Territory/Province	Code	State/Territory/Province
01	Alabama	35	New Mexico
02	Alaska	36	New York
04	Arizona	37	North Carolina
05	Arkansas	38	North Dakota
06	California	39	Ohio
08	Colorado	40	Oklahoma
09	Connecticut	41	Oregon
10	Delaware	42	Pennsylvania
11	District of Columbia	44	Rhode Island
12	Florida	45	South Carolina
13	Georgia	46	South Dakota
15	Hawaii	47	Tennessee
16	Idaho	48	Texas
17	Illinois	49	Utah
18	Indiana	50	Vermont
19	Iowa	51	Virginia
20	Kansas	53	Washington
21	Kentucky	54	West Virginia
22	Louisiana	55	Wisconsin
23	Maine	56	Wyoming
24	Maryland	72	Puerto Rico
25	Massachusetts	81	Alberta
26	Michigan	82	British Columbia
27	Minnesota	83	Manitoba
28	Mississippi	84	New Brunswick
29	Missouri	85	Newfoundland
30	Montana	86	Nova Scotia
31	Nebraska	87	Ontario
32	Nevada	88	Prince Edward Island
33	New Hampshire	89	Quebec
34	New Jersey	90	Saskatchewan

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