March 2006
Technical Memorandum: UCPRC-TM-2006-06

Moisture Sensitivity Study Database Documentation

Author:
L. Popescu

Work Conducted as part of Partnered Pavement Research Center Strategic Plan Element No. 2.2, which includes the "capture of all data from PPRC/PPRP activities into relational databases for future use."

PREPARED FOR:

California Department of Transportation
(Caltrans)

PREPARED BY:

University of California
Pavement Research Center
UC Davis and Berkeley

DOCUMENT RETRIEVAL PAGE	**Technical Memorandum Number:** **UCPRC-TM-2006-06**

Title: Moisture Sensitivity Study Database Documentation

Author: L. Popescu

Prepared for: Caltrans Division of Research and Innovation	**FHWA No.:** CA109999C	**Date Work Submitted:** October 15, 2008	**Date**: March 2006

Strategic Plan Element No: 2.2	**Status:** Stage 6, final	**Version No:** 1

Abstract:

This technical memorandum provides guidelines for accessing the data stored in the University of California Pavement Research Center's Moisture Sensitivity database. The memo also documents the structure of the database developed during the Partnered Pavement Research Center study, "Investigation of Conditions for Moisture Damage in Asphalt Concrete and Appropriate Laboratory Test Methods." The database presented does not allow addition of new data, although it can be upgraded to include this function if Caltrans considers collecting similar information in the future.

Keywords: moisture sensitivity, moisture sensitivity database, moisture sensitivity study

Proposals for implementation:

Related documents:

- Lu, Q. and Harvey, J. T. "Investigation of Conditions for Moisture Damage in Asphalt Concrete and Appropriate Laboratory Test Methods." (UCPRC-RR-2005-15)
- Q. Lu, J.T. Harvey, and C. L. Monismith. "Investigation of Conditions for Moisture Damage in Asphalt Concrete and Appropriate Laboratory Test Methods: Summary Version." (UCPRC-SR-2005-01)

Signatures:

L. Popescu **First Author**	C. L. Monismith **Technical Review**	D. Spinner **Editor**	J. T. Harvey **Principal Investigator**	T. J. Holland **Caltrans Contract Manager**

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

PROJECT OBJECTIVES

Creation of the Moisture Sensitivity database and this technical memorandum derives from work performed by the University of California Pavement Research Center for the California Department of Transportation (Caltrans) as part of the Partnered Pavement Research Program (PPRP) Strategic Plan Elements (SPEs) 2.2 and 4.9.

The objective of SPE 2.2 is to capture all data from PPRP activities into relational databases for future use. To accomplish this, UCPRC has undertaken the following activities:

1. Develop structures for new data
2. Organize all data produced
3. Develop improved access and analysis procedures
4. Maintain library and database

This technical memo describes data generated from a study on moisture sensitivity undertaken to satisfy SPE 4.9 with the objectives to investigate the conditions for moisture damage in asphalt pavements in California and to recommend appropriate test and treatment methods. These objectives, identified by the Partnered Pavement Research Program (PPRP), are to:

1. Perform a statewide field investigation to estimate the effects of different variables on the occurrence and severity of moisture damage and to determine major factors associated with moisture damage in the field, other than aggregate source. To the extent possible with available data, analyze the extent of moisture damage in California.
2. Perform a laboratory investigation to determine the effects of some major factors (air-void content and binder content) on moisture damage. Recommend mitigation measures.
3. Evaluate the effectiveness of the Hamburg Wheel Tracking Device test to determine the moisture sensitivity of asphalt mixes and to predict field performance. To the extent possible with available data, analyze the correlation between lab test results and field performance.
4. Develop and evaluate dynamic loading–involved test procedures for determining moisture sensitivity of asphalt mixes. Recommend appropriate conditioning procedures for laboratory tests.
5. Evaluate the effectiveness, especially the long-term effectiveness, of hydrated lime and liquid anti-stripping agents in improving the moisture resistance of hot-mix asphalt using both the current and new test procedures.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Background

The Moisture Sensitivity Study began in 2003 to ascertain whether the mixes placed at certain sites were more prone to moisture damage than others. This technical memorandum documents the database developed to store data gathered from field measurements and laboratory tests performed on cores extracted from selected pavement sections. It has also been developed to help users browse the data compiled during the study and to make use of the information in it.

Cored sections were chosen based on a visual survey conducted by UCPRC staff. The survey criteria included pavement condition, the condition and type of pavement drainage, and the cross section profile.

The original pavement design information of a few sections included in the test plan was available from Caltrans District Offices and was added to the database.

In accordance with the study test plan, twelve six-inch cores were taken at each test site. Four cores were extracted using a dry-saw cutting process and eight others were extracted using a wet-cut method. Immediately after extraction, all cores were photographed and their thicknesses were measured. In addition, dry cores were wrapped in plastic bags immediately after removal from the pavement and stored in plastic cylinders to preserve their natural moisture for further laboratory testing.

Latitudinal and longitudinal coordinates for all core locations were measured using a hand-held Geographic Positioning System (GPS) device. These coordinates—along with information describing the sections in terms of post mile, route number, county, traffic direction, and surface type—were recorded on paper forms.

Permeability tests were performed in the field at the time of coring.

Subsequent laboratory work included:

- The Hamburg Wheel Tracking Device (HWTD) test, which tests the rutting resistance and the moisture susceptibility of the field mix;
- Air-void content and maximum specific gravity (Rice specific gravity) measurements;
- Core thickness measurement; and
- Visual observation of bare aggregates, broken aggregates, interlayer material, and type of layer material.

1.2 Definitions

This section provides definitions of the terms most commonly used when referring to Database Systems.

- Database: A shared collection of logically related data (and a description of these data) designed to meet the information needs of an organization.
- Database Management System (DBMS): a software system that enables users to define, create, and maintain the database and provides controlled access to this database.
- Primary Key: a key in a relational database that is unique for each record.
- Foreign Key: a field in one table that is indexed in another. Foreign keys provide the building blocks for relating tables.
- Relational Database Management System (RDBMS): a second generation DBMS, which has become the dominant data-processing software used today.
- Relation: a table with columns and rows.
- Relational Database: a collection of normalized (appropriately structured) relations (tables).
- Referential Integrity: a feature provided by an RDBMS that prevents users or applications from entering inconsistent data.

1.3 Advantages of Database Systems

There are various Relational Database Management System (RDBMS) applications available. Some of these applications are more suitable than others, depending on things such as their purchase cost and the cost of license renewal, the size of the database, the number of users, the type of data to be stored, the frequency with which data is updated, and how soon updates need to be available.

There are several advantages to using a database management system versus a file-based management system (e.g., *Excel* files) including:

- *Control of data redundancy.* The database approach attempts to eliminate redundancy by integrating the files so that several copies of the same data item are not stored. Although the database approach does not eliminate redundancy entirely, it does control the amount of redundancy inherent in the database (e.g., sometimes it is necessary to duplicate key data items to model relationships, while at other times it is desirable to duplicate data items to improve performance).

- *Data consistency*. By controlling redundancy, the risk of inconsistencies occurring is reduced. If a data item is stored in a database only once, an update of its value only has to be performed once. If a data item is stored more than once and the system is aware of this, it can ensure that all copies of the item are kept consistent (all are updated at the same time).

- *Improved data integrity*. Database integrity refers to the validity and consistency of stored data. Integrity is usually expressed in terms of *constraints,* which are rules the database is not permitted to violate. Constraints may apply to data items within a single record or they may apply to relationships between records. The role of the DBMS is to enforce integrity constraints in the database.

After taking into account the aforementioned considerations, the RDBMS Microsoft *Access 2002* was selected for the Moisture Sensitivity study. The software comes with *Microsoft Office Professional Edition*.

2 MOISTURE SENSITIVITY DATABASE DESCRIPTION

2.1 Installing the Database

The name of the Moisture Sensitivity study database is "MoistureSensitivity.mdb." As noted, it is a Microsoft *Access 2002* database. The database can be converted into the format of the 1997 version of *Access*, if necessary.

A detailed description of the database fields, primary keys, and relationships among database tables is presented in Appendix A.

The database is installed by copying and pasting the directory "Moisture Sensitivity Study" from the data CD onto the hard disk of a PC, preferably the computer's *C* drive to maintain the links between the photographs and the database "Photo" table (i.e., the default path for the database is set to drive *C:*). If the database is installed on a drive other than *C:*, clicking the "View Photos" function will leave the photo window blank. (See Section 3.1.2.1 for details.)

The content of the "Moisture Sensitivity Study" directory includes:

- The "MoistureSensitivity.mdb" database.

- The original data files, "Moisture_Sections_Database.xls" and "Moisture_Cores_database.xls." The data in these files is organized in the database structure described in this document.

- The "Photos" directory, which stores the pictures of cores extracted during the project. The directory is organized into subdirectories labeled according to the identification number of each coring site.

2.2 Table Descriptions

A detailed description of each of the tables listed in this chapter can be found in Appendix A, Table A.1 to Table A.7.

Figure A.1 in Appendix A shows the dependencies among the tables listed.

2.2.1 Site Description *Table*

The Site Description Table (Table A.1) contains information about the specifics of each fieldwork site, such as route, county, district, direction, lane number, post mile start and end, layer design thickness (for only a few of the sections selected for this study), and construction year.

2.2.2 Material Detail *Table*

The Material Detail Table (Table A.2) contains the following information:

- Material information such as material type and material source;
- Material-specific laboratory tests data such as gradation, Los Angeles Abrasion for aggregates, viscosity for binder, and optimum binder content for the pavement mix;
- Site-specific observations such as drain condition and pavement surface condition described in terms of types of distresses; and
- Traffic information such as annual average daily truck traffic (AADTT) and annual average daily traffic (AADT).

The data in this table was compiled from mix design sheets and/or construction records provided by District offices.

2.2.3 Core Record *Table*

The Core Record Table (Table A.3) contains information about core location, coring method, the GPS of each core location, air-void content, moisture content, visual observations regarding the bonding between core lifts, etc. This information is based on observations and tests on field-extracted cores.

2.2.4 Layer Thickness Data *Table*

The Layer Thickness Data Table (Table A.4) lists the layer thickness and material type of each layer for each of the cores listed in the Core Record Table.

2.2.5 Photo *Table*

Cores were brought from the field to the lab, and a three-image set of photos was taken of each core: one of its top, one of its side, and one of its front. The image files are in JPG format and are stored in the database as Linked Objects.

2.2.6 Hamburg Wheel Track Data Table

The Hamburg Wheel Tracking Device Test is used to determine the premature failure susceptibility of hot-mix asphalt (HMA) due to weakness in the aggregate structure, inadequate binder stiffness, or moisture damage. This test method measures rut depth and number of passes to failure.

Test samples came from cores cut from individual layers. Only cores obtained using the wet-coring process were used in this test. Two cores from the wheelpath and two cores from between the wheelpaths were tested, and the test results were averaged for each pair of samples. The test data obtained includes the inflection point, stripping slope, rut depths at 10,000 reps and 20,000 reps, and air-void content.

The test data is stored in the Hamburg Wheel Track Data Table (Table A.6). Each reported test result is described by work site identification number (Site ID) and sample location (i.e., "between the wheelpaths" or "in the wheelpath"). The layer number that was tested from the selected samples is also listed in the Hamburg Wheel Track Data Table.

2.2.7 Permeability Data *Table*

The Permeability Data Table (Table A.5) contains the results of permeability tests performed in the field. The unit for the permeability data is 10^{-5} cm/sec.

2.2.8 CA County List *Table*

This table lists the full and abbreviated names of California counties.

2.2.9 Air-Void Data *Table*

The Air-void Data Table (Table A.7) contains the air-void and laboratory measurement data used to calculate air-void content. The air voids for most of the samples were measured using the sealing method with Parafilm® (AASHTO T275-07, modified for Parafilm® T275-A). However in a few cases this method was not considered accurate and a vacuum sealing method using Corelok® (AASHTO T331-07) was used instead. These cases included specimens with a coarse gradation.

3 VIEWING AND EXTRACTING DATA

3.1 The User Interface

When opening the MoistureSensitivity.mdb database a window similar to Figure 3.1 will show.

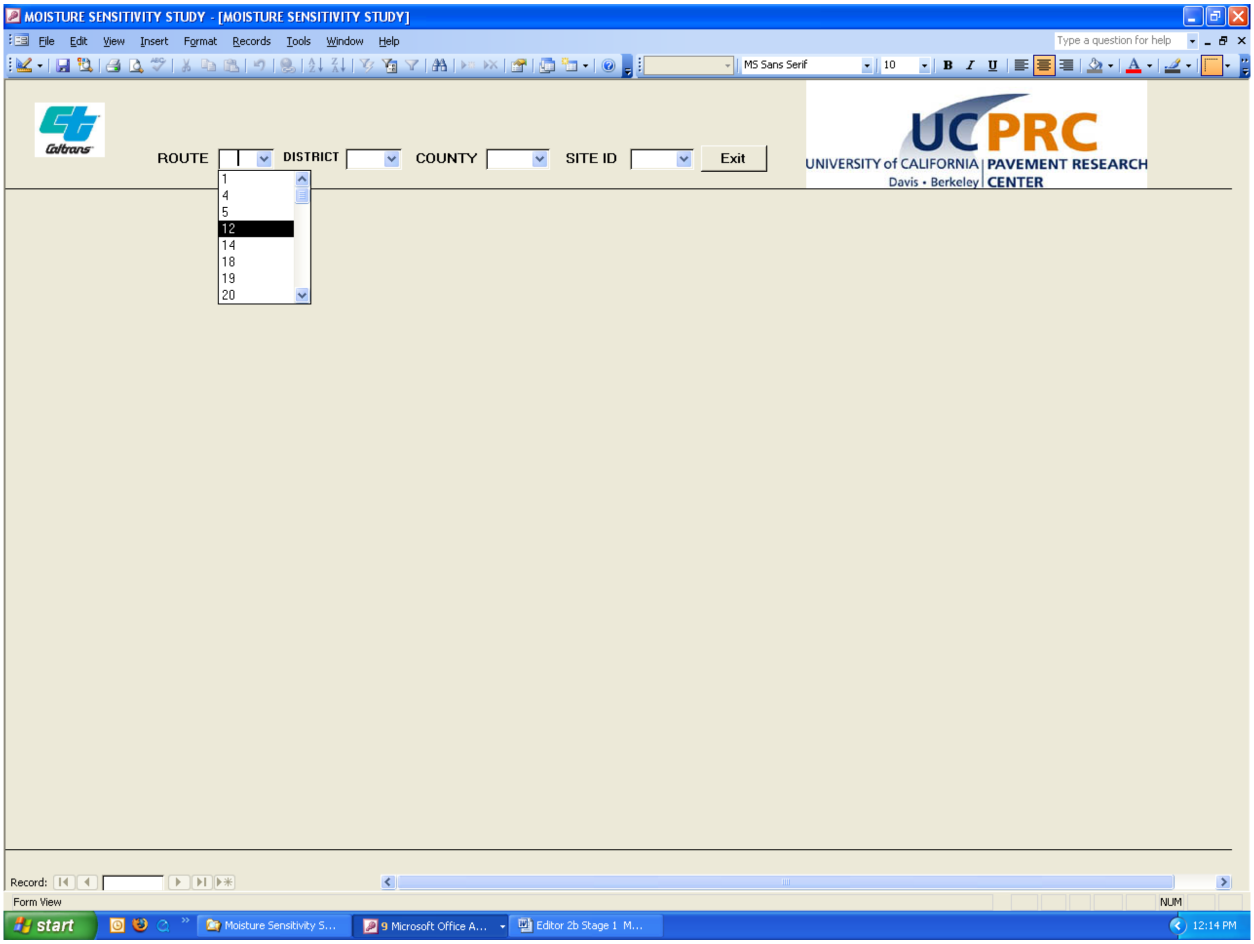

Figure 3.1: User interface – Start window.

Clicking on the list box next to the "Route" label will open a list of routes that have test data. Select a route then move to the next box, "District." This list box contains district numbers corresponding to the selected route. After selecting a district, move to the next list box, "County." This list box contains only those counties that correspond to the selected route and district. "Site ID," the last list box, contains the identification number assigned to each section by UCPRC. Once all parameters have been selected, the current window will update, as in Figure 3.2. The "Exit" button closes the database. The new window has four distinct sections as seen in figure below.

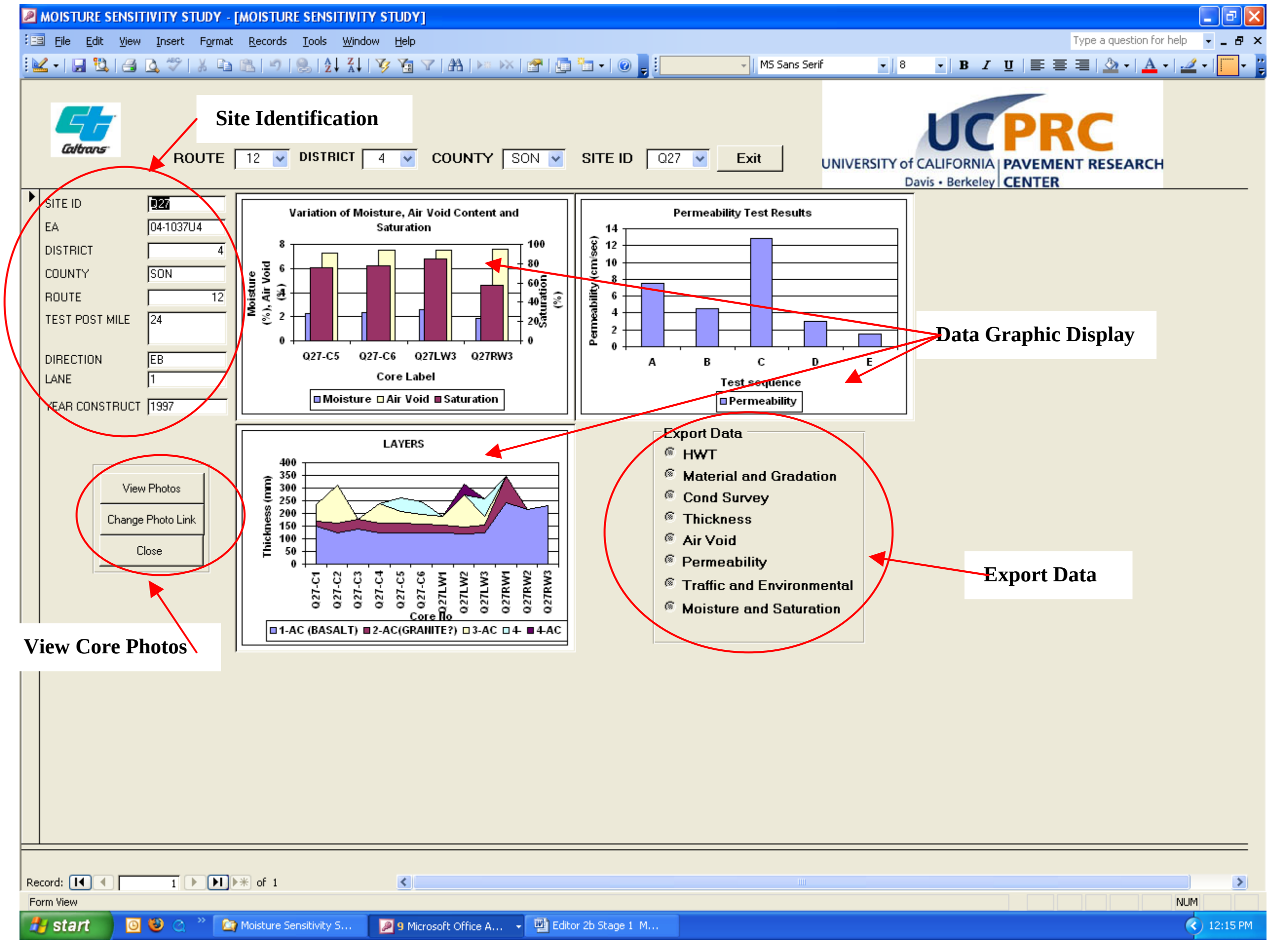

Figure 3.2: User Interface—Main Form.

3.1.1 Site Identification

The Site Identification, (Site ID) section is located on the upper left side of the interface and lists details of the selected site: Site ID, EA Number, District, County, Route Number, approximate Test Post Mile, Direction, Lane, and the year of the construction.

3.1.2 *View Photos* Button

Clicking the "View Photos" button activates a new window that displays the core pictures of the selected site (Figure 3.3).

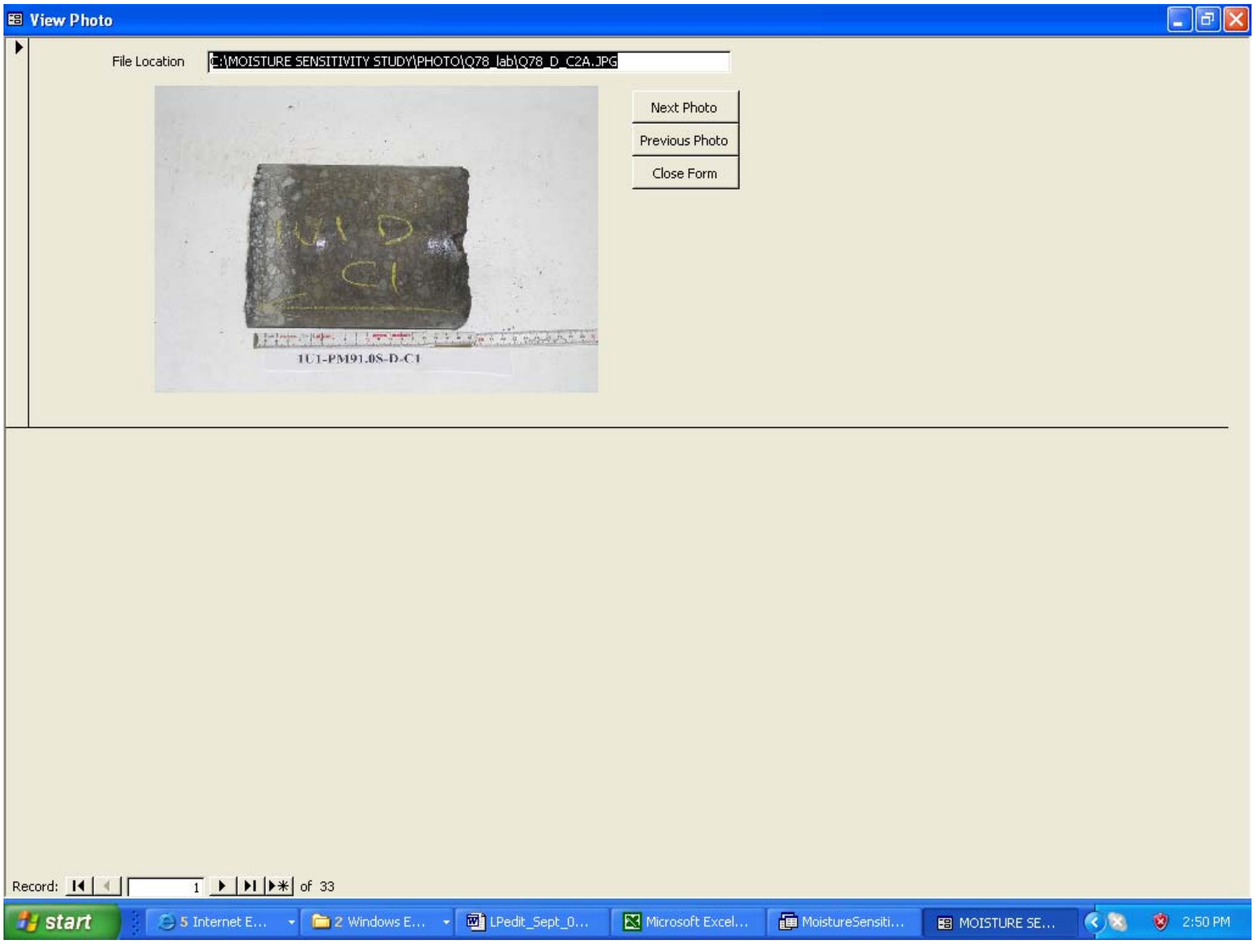

Figure 3.3: View Photos window.

This window displays one photo at a time. To move from one photo to another, use the "Next" or "Previous" button.

Click the "Close Form" button to return to the user interface.

3.1.2.1 Change Photo Link *Button*

If the database directory ("Moisture Sensitivity Study") has been installed on a drive other than *C:* (see Section 2.1), this button allows users to change the path to the linked photos in the database.

Clicking the "Change Photo Link" button brings up an input box ("Change Drive" [Figure 3.4]) where the user is asked to input the name of the drive where the "Moisture Sensitivity Study" data reside.

Note: The "Change Photo Links" function works only if the name of the directory "Moisture Sensitivity Study" has not changed.

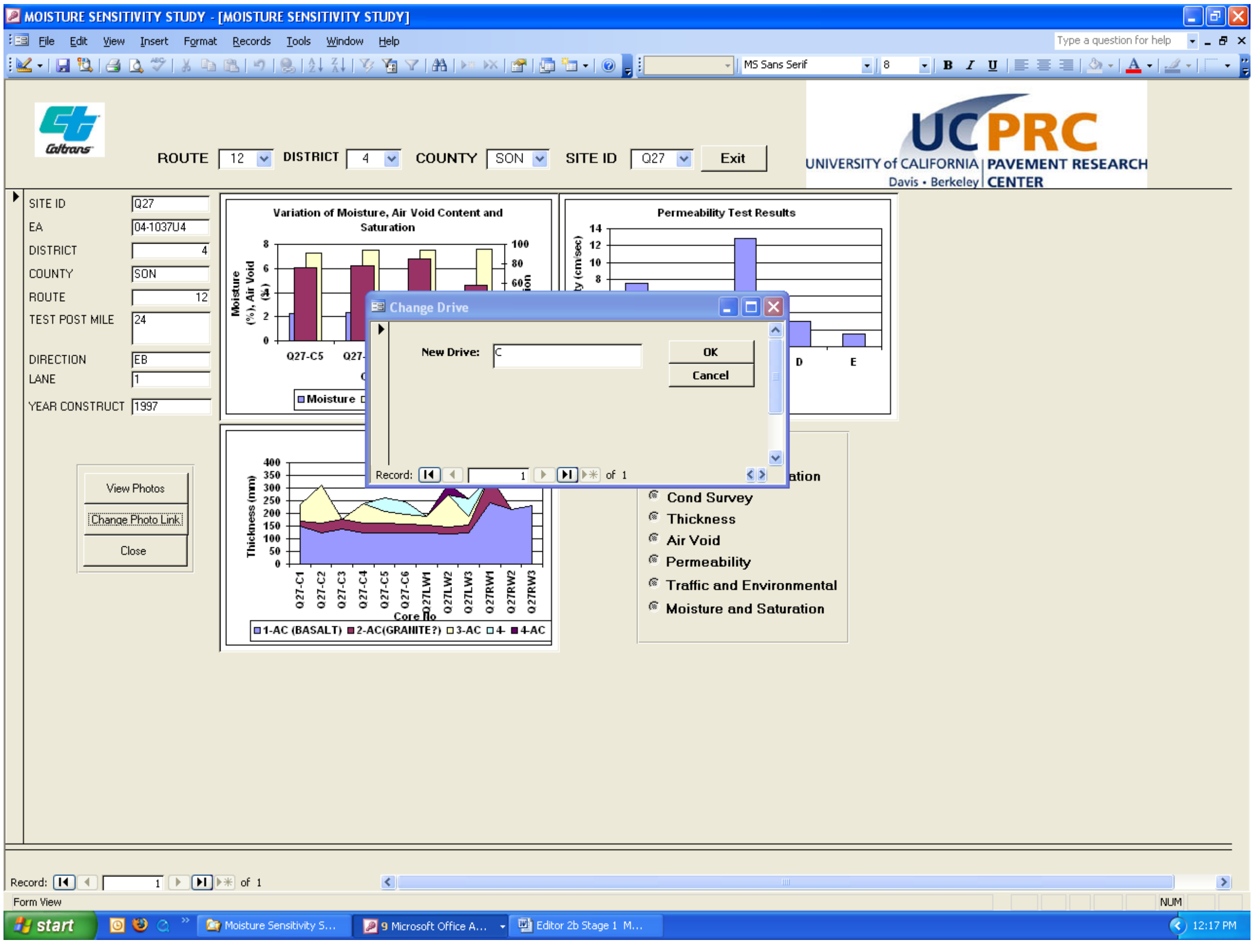

Figure 3.4: Change Photo Links window.

3.1.2.2 Close *Button*

The "Close" button has the same function as the "Exit" button: It closes the main "Moisture Sensitivity Study" window and exits the database.

3.1.3 Graphic Display of Data

This section includes three charts displayed on the main form (Figure 3.2).

3.1.3.1 Variation of Moisture, Air-Void, and Saturation *Chart*

This chart uses two Y-axes to plot the average moisture content, air-void, and saturation for the selected site. The chart reports weighted averages, using layer thickness as the weighting factor.

3.1.3.2 Permeability Test Results *Chart*

This includes all permeability tests performed in the field. Permeability readings were taken at different locations along each cored section, the number of tested points varying between three and five. The plotted data are the permeability values (cm/s) at each test point in the selected section.

3.1.4 *Export Data*

This section, located at the lower-right corner of the main window (Figure 3.2), provides access to the data. In some cases, moving the cursor over an item in the list brings up a "tip," a text message that defines the term (see Figure 3.5).

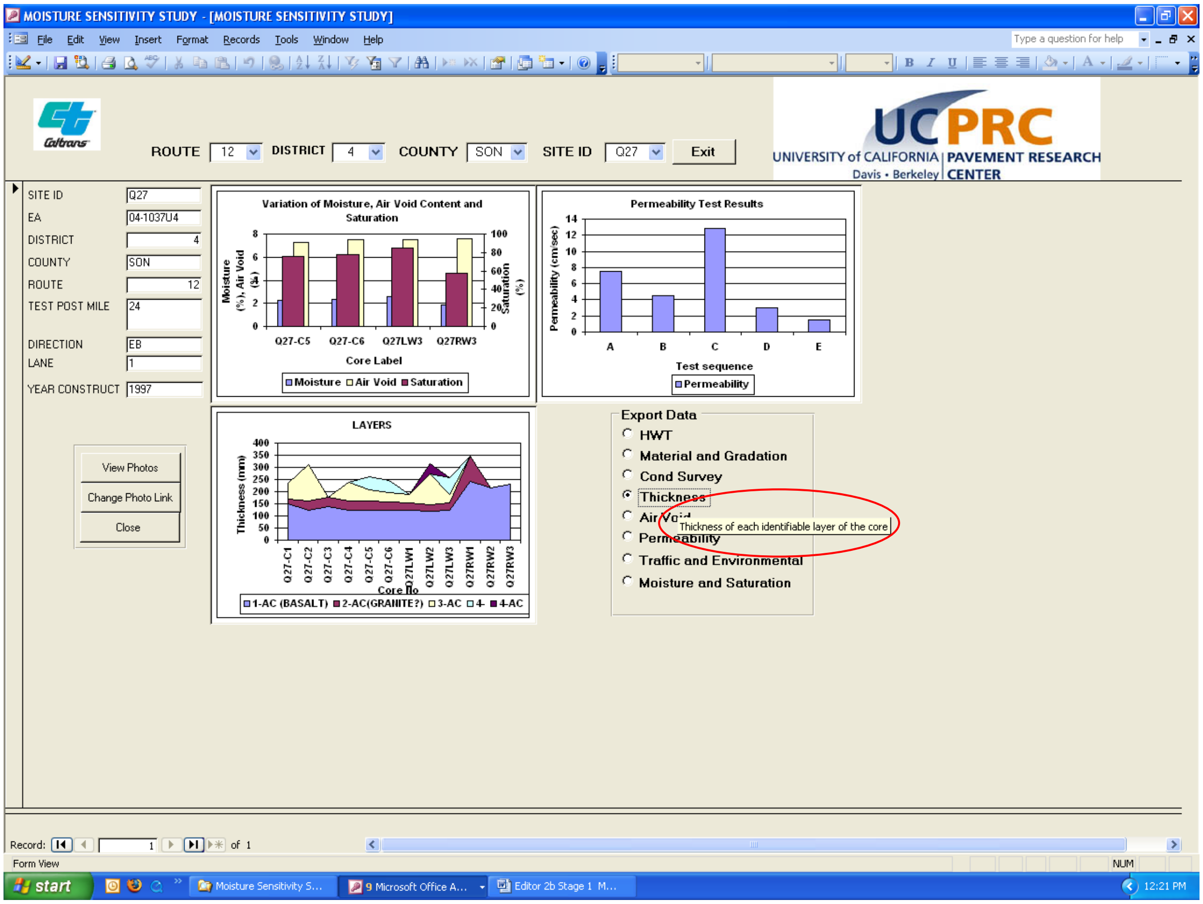

Figure 3.5: "Tip" example.

Clicking one of the listed items will export the data. The "Export Data" function allows users to export data to *Excel*. Each data set is exported to a separate *Excel* spreadsheet (for example, thickness data will be exported to "Thickness.xls"). When any of the eight report options are activated, a message box pops up showing the path to the exported data, which will be saved in a directory named "UCPRC_Moisture_Sensitivity." If the directory does not already exist on the *C:* drive (Figure 3.6), it will be created automatically.

Once the data has been exported, click "OK" to continue.

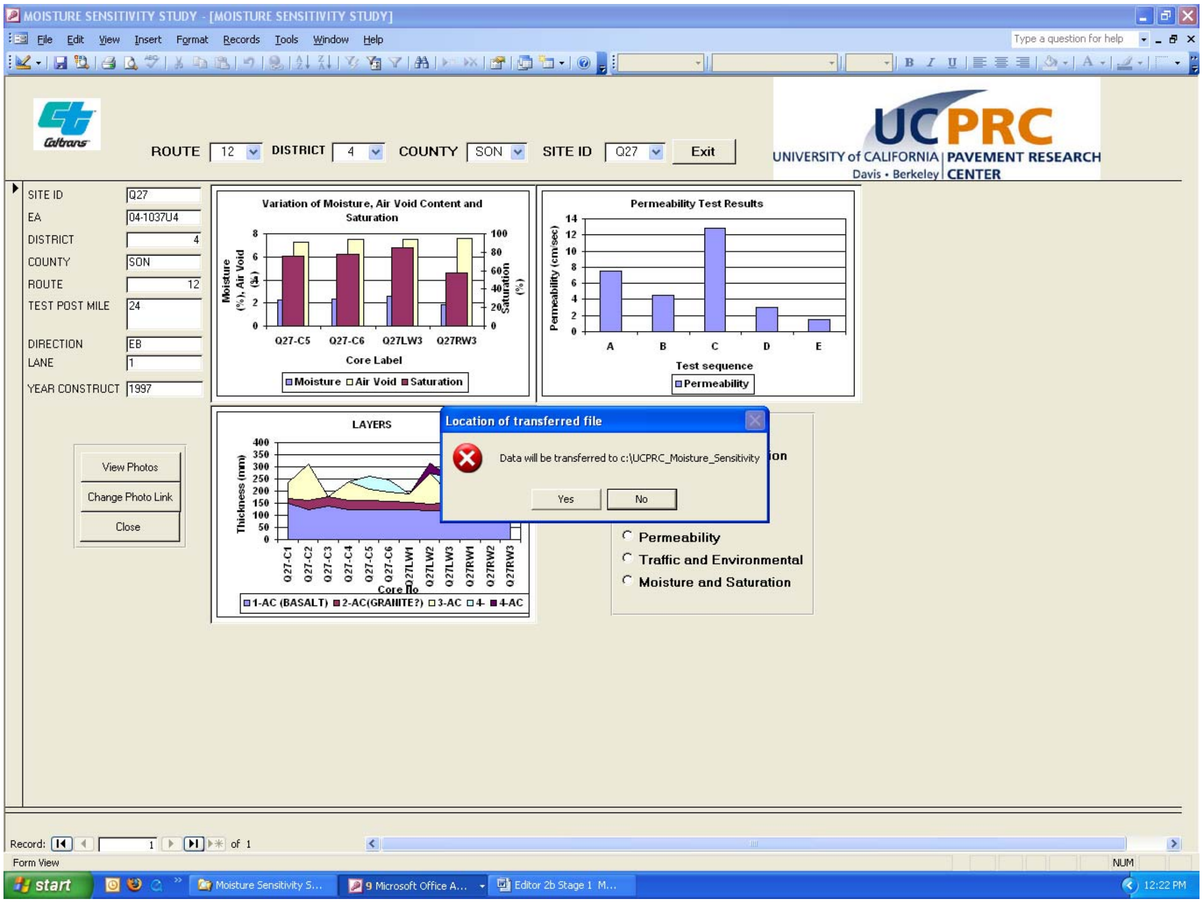

Figure 3.6: Message box when exporting data.

The exported data includes all the data in the database for the selected option.

The eight data export options include:

- *HWT*: Hamburg Wheel Track Test data.
- *Material and Gradation*: This includes items such as binder type and source, aggregate type and source, binder viscosity, aggregate gradation for the mix identified in the section selected for coring, etc.
- *Cond Survey*: The Condition Survey was done to obtain a general idea about the condition of the site and was less rigorous than described by the Caltrans Condition Survey Manual.
- *Thickness*: Includes the thickness of each layer of field-extracted cores measured in the lab.
- *Air-void*: Includes laboratory-measured weights needed to calculate air-void content. For cores with higher air-voids content the Corelok method was used to measure the air-voids.
- *Permeability*: Exports all permeability data.
- *Traffic and Environmental*: Exports ADTT, AADTT, speed, annual average rainfall, freeze/thaw, and snow.
- *Moisture and Saturation*: Exports the average (weighted by layer thickness) of air-void content, saturation and moisture for all cores in the database.

REFERENCE

Connolly T., Begg, C., and Strachan, A. (1999) Database Systems. *A Practical Approach to Design, Implementation, and Management*, second edition. Addison Wesley Longman, Ltd. Menlo Park, CA.

APPENDIX A: DETAILED DESCRIPTION OF DATABASE TABLES

Table A.1: Site Description

Field Name	Detail Description	Data Type
SITE ID	Unique site identifier	Text
EA CODE	Expenditure account number (Caltrans specific)	Text
DISTRICT CODE	Caltrans District Number 1 through 12	Byte
COUNTY CODE	California County abbreviation	Text
ROUTE NBR	Route number	Integer
BEGPFX CODE	Prefix of post mile at start	Text
BEGPM QNTY	Post mile at start	Single
ENDPFX CODE	Prefix of post mile at end	Text
ENDPM QNTY	Post mile at end	Single
DIRECTION CODE	Traffic direction (east, west, north or south).	Text
LANE NBR	Lane number from which cores were taken	Text
TEST PM DESC	The approximate post mile within the section closest to the coring location.	Text
CONSTR YR	Year the section was constructed	Text
SURVEY DATE	Date of survey to select coring sections	Date/Time
CRT LAYER NBR	Refers to the "layer of interest"—which is the top layer of the original construction—uses the number from original construction data.	Byte
TOP LAYER DESIGN THICKNESS QNTY	Thickness of top layer in original construction	Single
TOP LAYER CODE	Material type of the top layer of original construction	Text
MIX CODE	Type of mix	Text
UNDERLAYER1 CODE	Material type of the first layer below the layer of interest (according to original design data)	Text
UNDERLAYER1 QNTY	Thickness of the first layer below the layer of interest (mm)	Single
UNDERLAYER2 CODE	Material type of the second layer below the layer of interest (according to original design data)	Text
UNDERLAYER2 QNTY	Thickness of the second layer below the layer of interest (mm)	Single
UNDERLAYER3 CODE	Material type of the third layer below the layer of interest (according to original design data)	Text
UNDERLAYER3 QNTY	Thickness of the third layer below the layer of interest (mm)	Single
COMMENT TEXT	Relevant comments or notes	Text

Table A.2: Material Details

Field Name	Detail Description	Data Type
SITE ID	Unique site identifier	Text
BINDER CODE	Binder type	Text
BINDER REFINERY TEXT	Name of refinery supplying the binder	Text
VISCOSITY	Absolute viscosity of unaged binder at 60 C (in Pa·s)	Single
VISCOSITY AGED	Absolute viscosity of aged binder at 60 C (in Pa·s)	Single
MEAN OPTIMUM BINDER PCT	Mean Optimum Binder Content (MOBC), percent by dry mass of aggregate (e.g., if the design OBC is 5.0 to 5.3%, MOBC is 5.15).	Single
HALF RANGE OPTIMUM BINDER PCT	Half-range Optimum Binder Content (HROBC). Half the range of the design optimum binder content (OBC), percent by dry mass of aggregate (e.g., if the design OBC is 5.0 to 5.3%, MOBC is 5.15 and HROBC is 0.15).	Single
BINDER ADDITIVE FLAG	Is there additive in the binder?: 0=No, 1=Yes	Text
DOSAGE BINDER ADDITIVE IND	Binder additive content (%, by mass of binder)	Text
COARSE AGGREGATE DESC	Coarse aggregate type (granite, basalt, limestone, etc.)	Text
COARSE AGGREGATE SOURCE DESC	Name of quarry supplying coarse aggregates	Text
FINE AGGREGATE DESC	The type of fine aggregate (granite, basalt, limestone, etc.)	Text
FINE AGGREGATE SOURCE DESC	Name of quarry supplying fine aggregates	Text
MAX AGGREGATE SIZE MM QNTY	Nominal maximum aggregate size (mm)	Single
P25 PCT	Percent passing 25 mm sieve, by weight, used in the design	Single
P19 PCT	Percent passing 19 mm sieve, by weight, used in the design	Single
P125 PCT	Percent passing 12.5 mm sieve, by weight, used in the design	Single
P95 PCT	Percent passing 9.5 mm sieve, by weight, used in the design	Single
P635 PCT	Percent passing 6.35 mm sieve, by weight, used in the design	Single
P475 PCT	Percent passing 4.75 mm sieve, by weight, used in the design	Single
P235 PCT	Percent passing 2.35 mm sieve, by weight, used in the design	Single
P118 PCT	Percent passing 1.18 mm sieve, by weight, used in the design	Single
P06 PCT	Percent passing 0.6 mm sieve, by weight, used in the design	Single
P0425 PCT	Percent passing 0.425 mm sieve, by weight, used in the design	Single
P03 PCT	Percent passing 0.3 mm sieve, by weight, used in the design	Single
P015 PCT	Percent passing 0.15 mm sieve, by weight, used in the design	Single
P0075 PCT	Percent passing 0.075 mm sieve, by weight, used in the design	Single

Field Name	Detail Description	Data Type
SURFACE AREA SFperLB QNTY	Surface area of the graded aggregates (square feet/lb)	Single
LA100 PCT	Percentage (%) loss in the Los Angeles abrasion test after 100 revolutions	Single
LA500 PCT	Percentage (%) loss in the Los Angeles abrasion test after 500 revolutions	Single
SGC QNTY	Specific gravity of coarse aggregate (retained on 4.75 mm sieve)	Single
SGF QNTY	Specific gravity of fine aggregate (passing 4.75 mm sieve)	Single
COARSE CRUSHED PCT	Percentage (%) of crushed coarse aggregate	Single
FINE CRUSHED PCT	Percentage (%) of crushed fine aggregate	Single
AGGREGATE CRUSHED PCT	Percentage (%) of crushed combined aggregates	Single
SAND EQUIVALENT QNTY	Sand equivalent value of the aggregates	Single
STABILOMETER QNTY	Stabilometer value at optimum binder content	Single
OPTIMUM AIR VOID PCT	Air-void content at optimum binder content in the Hveem design (%)	Single
MIX SWELL QNTY	Swell at optimum binder content in the Hveem design (inches)	Single
FLUSHING IND	Surface flushing of Hveem specimens at optimum binder content: N=No, S=Slight, M=Medium	Text
MOIST ABSORBED PCT	Moisture absorbed in the Moisture Vapor Susceptibility test (%)	Single
STABILOMETER MOIST QNTY	Stabilometer value in the Moisture Vapor Susceptibility test	Single
DUST ASPHALT RATIO QNTY	Dust/asphalt ratio	Single
AGGREGATE ADDITIVE TEXT	The type of additive to the aggregate	Text
DOSAGE AGGREGATE ADDITIVE DESC	The content of aggregate additive (%, by dry mass of aggregate)	Text
METHOD AGGREGATE ADDITIVE DESC	Method of treating aggregate	Text
TENSILE STRENGTH RATIO TEXT	Tensile Strength Ratio, as determined by AASHTO T 283 or CTM 371 (%)	Text
MAX SPECIFIC GRAVITY QNTY	Theoretical maximum specific gravity of the mix	Single
AVG BINDER PCT	Average binder content in the field samples (%)	Single
STDEV BINDER PCT	Standard deviation of binder content in the field samples (%)	Single
AVG AIR VOID PCT	Average air-void content in the field samples (%)	Single
STDEV AIR VOID PCT	Standard deviation of air-void content in the field samples (%)	Single
COMPACTION SPEC CODE	Method used to determine the degree of compaction: QC/QA, non-QC/QA	Text
EXCESS DUST FLAG	Set to true (1) if dust content (passing 0.075 mm sieve) is greater than in job mix formula: 0=No; 1=Yes.	Binary
LOW BINDER FLAG	Set to true (1) if binder content is lower than in job mix formula: 0=No; 1=Yes.	Binary
WATERFLOW FLAG	Is water flowing over the pavement after rain?: 0=No; 1=Yes.	Binary
WATERPOND FLAG	Is water ponding on the pavement after	Binary

Field Name	Detail Description	Data Type
	rain?: 0=No; 1=Yes.	
TRANSVERSE SLOPE PCT	Transverse slope of the pavement (%)	Single
CUTFILL CODE	Location of pavement: CUT, FILL, ON GRADE or EMBANKMENT	Text
EDGE DRAIN COND CODE	Condition of edge drain system: No system, Working, Blocked	Text
DRAINDITCH CODE	Condition of drainage ditches: No ditches, Draining, Ponding	Text
SEGREGATION IND	Is segregation of material present? Segregation is the separation of coarse aggregates from fines: 0=No; 1=Yes (slight segregation, <10% of total surface area); 2=Yes (medium segregation, 10–40% of surface area); 3=Yes (severe segregation, >40% of total surface area).	Byte
LONGDISTRESS IND	Set to nonzero when distress is mainly along longitudinal joints: 0=No; 1=Yes (slight), 2=Yes (medium), 3=Yes (Severe).	Byte
DISTRESS FLAG	Set to true when no visual distress was observed: 0=No; 1=Yes.	Binary
PATCHING IND	Is patching present within the sample section?: 0=No; 1=Yes (0–20%); 2=Yes (20–40%); 3=Yes (40–60%); 4=Yes (>60%).	Byte
POTHOLES IND	Set to nonzero when *potholes* exist within the sample section. Potholes are a result of the loss of material in a distressed pavement. They may form a bowl-shaped hole, but usually are irregular due to the adjacent distressed pavement: 0=No; 1=Yes (Low: ≤2 potholes/mile, pothole diameter less than 2 inches); 2=Yes (Medium, 2–6 potholes/mile, pothole diameter less than 4 inches); 3=Yes (High, ≥6 potholes/mile, pothole diameter larger than 4 inches).	Byte
PUMPING IND	Set to nonzero when *pumping* exists within the sample section. Pumping is the ejection of water and base material fines through longitudinal joints, transverse joints, cracks, or pavement edge: 0=No; 1=Yes (Low, pumping section less than 10 meter per mile, and only slight amount of pumped fines observed on the surface); 2=Yes (Medium, pumping section 10–30 m long per mile, and no large amount of fines on the surface); 3=Yes (High, otherwise).	Byte
RAVELING IND	Set to nonzero when *raveling* exists within the sample section. Raveling is caused by the action of traffic on a weak surface: 0=No; 1=Yes (Low), 2=Yes (Medium), 3=Yes (High). The extent of raveling is judged by the surveyor.	Byte
LIGHT RAVEL IND	Set to nonzero when *fine raveling* exists within the sample section. Fine raveling is the wearing away of the pavement surface, resulting in an extremely roughened surface texture. This rough surface texture is due to	Byte

Field Name	Detail Description	Data Type
	the wearing away of fine aggregate and asphalt binder: 0=No; 1=Yes (Low), 2=Yes (Medium), 3=Yes (High). The extent of raveling is judged by the surveyor.	
COARSE RAVEL IND	Set to nonzero when *coarse raveling* exists within the sample section. Coarse raveling is the wearing away of the pavement surface, resulting in an extremely roughened surface texture. The rough surface texture is due to the dislodging of coarse aggregate and loss of asphalt binder: 0=No; 1=Yes (Low), 2=Yes (Medium), 3=Yes (High). The extent of raveling is judged by the surveyor.	Byte
RUTTING IND	Set to nonzero when *rutting* exists within the sample section. Rutting is a longitudinal surface depression in the wheelpath caused by the consolidation or lateral movement of roadbed material under heavy loads: 0=No; 1=Yes (Low, <5 mm), 2=Yes (Medium, 5–10 mm), 3=Yes (High, >10 mm).	Byte
SHOVING IND	Set to nonzero when *shoving* exists within the sample section. Shoving is localized displacement or bulging of pavement material in the direction of loading pressure: 0=No; 1=Yes (Low), 2=Yes (Medium), 3=Yes (High). The extent of shoving is judged by the surveyor.	Byte
STRIPPING IND	Set to nonzero if *stripping* is observed. Stripping is the loss of asphalt film from the aggregate surface due to the action of water: 0=No; 1=Yes (Low), 2=Yes (Medium), 3=Yes (High). The extent of stripping is judged by the surveyor.	Byte
BLEEDING IND	Set to nonzero when *bleeding* exists. Bleeding is a film of free asphalt on the surface of the pavement creating a shiny, reflective surface: 0=No; 1=Yes (Low, bleeding area <25%), 2=Yes (Medium, bleeding area between 25% and 50%), 3=Yes (High, bleeding area >50%).	Byte
DELAMINATION IND	Set to nonzero when *delamination* exists. Delamination is loss of bond between different layers of lifts, which is sometimes evidenced by the relative slippage of one layer to the adjacent layer: 0=No; 1=Yes (Low), 2=Yes (Medium), 3=Yes (High). The extent of delamination is judged by the surveyor.	Byte
ALLIGATOR A IND	Set to nonzero when *Alligator A* cracking exists with in the sample. Alligator A cracking is a load-related distress characterized by a single longitudinal crack in the wheelpath: 0=No; 1=Yes (Low, cracked area <25%), 2=Yes (Medium, cracked area between 25% and 50%), 3=Yes (High, cracked area >50%).	Byte

Field Name	Detail Description	Data Type
ALLIGATOR A SEVERITY IND	Severity of *Alligator A* cracking observed within the sample section. Severity is listed as "≤1/4 inch," ">1/4 inch," or "Closed."	Text
ALLIGATOR B IND	Set to nonzero when *Alligator B* cracking exists within the sample. *Alligator B* cracking is a load-related distress characterized by interconnected or interlaced cracks in the wheelpath forming a series of small polygons, generally less than 1 foot on each side: 0=No; 1=Yes (Low, cracked area <25%), 2=Yes (Medium, cracked area between 25% and 50%), 3=Yes (High, cracked area >50%).	Byte
ALLIGATOR B SEVERITY IND	Severity of *Alligator B* cracking observed within the sample section. Severity is listed as "≤1/4 inch," ">1/4 inch," or "Closed."	Text
ALLIGATOR C IND	Set to nonzero when *Alligator C* cracking exists within the sample section. Alligator C cracking is a load-related distress characterized by interconnected or interlaced cracks *outside* the wheelpath, forming a series of small polygons, generally less than 1 foot on each side: 0=No; 1=Yes (slight, cracked area <25%), 2=Yes (medium, cracked area between 25% and 50%), 3=Yes (severe, cracked area >50%).	Byte
ALLIGATOR C SEVERITY IND	Severity of *Alligator C* cracking observed within the sample section. Severity is listed as "≤1/4 inch," ">1/4 inch," or "Closed."	Text
LONG CRACKING IND	Set to nonzero when *longitudinal cracks* exist within the sample section. Longitudinal cracks are non-load associated single cracks approximately parallel to the centerline: 0=No; 1=Yes (slight, cracked area <25%), 2=Yes (medium, cracked area between 25% and 50%), 3=Yes (severe, cracked area >50%).	Byte
LONG CRACKING EXTENT IND	1 represents <100 feet, 2 represents 100 to 200 feet, and 3 represents >200 feet per mile.	Byte
LONG CRACKING SEVERITY IND	Overall crack width represented by either <1/4 inch or >1/4 inch.	Text
TRANSVERSE CRACKING IND	Set to nonzero when *transverse cracking* exists within the sample section. Transverse cracks are non-load associated cracks that appear approximately at right angles to the centerline: 0=no; 1=Yes (Low, cracked area <25%), 2=Yes (Medium, cracked area between 25% and 50%), 3=Yes (High, cracked area >50%).	Byte
TRANSVERSE CRACKING EXTENT IND	Number of cracks per 30 meters	Single
TRANSVERSE CRACKING SEVERITY IND	Overall crack width represented by either <1/4 inch or >1/4 inch.	Text
REFLECTIVE CRACKING IND	Set to nonzero when *reflective cracks* exist within the sample section: 0=No; 1=Yes (Low, cracked area <25%), 2=Yes (Medium,	Byte

Field Name	Detail Description	Data Type
	cracked area between 25% and 50%), 3=Yes (High, cracked area >50%).	
REFLECTIVE CRACKING EXTENT IND	1 represents low severity, 2 represents medium severity, and 3 represents high severity.	Byte
REFLECTIVE CRACKING SEVERITY IND	Overall crack width represented by either <1/4 inch or >1/4 inch.	Text
AADT QNTY	Annual average daily traffic (2 directions ,all lanes) in the first year open to traffic	Double
AADTT QNTY	Annual average daily truck traffic (two directions, all lanes) in the first year open to traffic	Double
TI10 QNTY	10-Year Truck Index (TI)	Double
SPEED QNTY	Average truck speed (km/hour)	Single
RAINFALL QNTY	Annual rainfall (mm)	Single
FREEZE THAW QNTY	Annual average freeze thaw cycles	Single
DD30 QNTY	Degree days greater than 30°C	Single
ELEVATION QNTY	Elevation (m)	Single
SNOW QNTY	Snow fall (mm)	Single
NEAREST TOWN TEXT	Name of the nearest town (to be used to find the nearest weather station)	Text
DISTRESS EXTENT PCT	Percentage of the pavement section that shows any kind of distress	Single
COMMENT TEXT	Additional comments on the section	Text
TAKE CORE FLAG	Was core taken?: 0=No, 1=Yes	Binary
OVERALL PERFORMANCE RATING CODE	Overall rating of pavement performance, based on field survey, core, and pavement age: **Good**—No obvious distress was observed and the cores were intact; **Fair**—slight distresses (slight rutting, unconnected cracks with width less than 1/4"; cores may be debonded but showed slight stripping or none, with some materials missing in the cores); **Poor**—Severe distress (raveling, a lot of patches, a few potholes, stage B fatigue cracking). Cores showed 20–50% stripping and lost a fair amount of material; **Very Poor**—A lot of potholes, patches, or digouts. Stage C fatigue cracking, severe rutting, pumping. Cores are disintegrated and show over 50% stripping.	Text

Table A.3: Core Record

Field Name	Detail Description	Data Type
CORING DATE	Date that coring took place in the field	Date/Time
SITE ID	Unique site identifier	Text
Core ID	Unique core identifier	Text
Diameter QNTY	Core diameter (inches)	Byte
Tot Height QNTY	Total core height (inches)	Byte
Pavement DESC	AC, AC/PCC, OGAC/AC/AC/CTB etc.	Text
Core Intact FLAG	If core came out in one piece (Yes) or not (No)	Binary
Core Method DESC	Two coring methods were used in the field: Dry or Wet	Text
Core Location DESC	Location of the core relative to the travelled way: Between wheelpath, Left wheelpath, Right wheelpath, or On the Shoulder	Text
GPS Make DESC	Make of the Geographic Positioning System device used to record latitude and longitude	Text
GPS Datum CODE	The reference datum used to report the measured latitudes and longitudes.	Text
Latitude Coord	Latitude coordinate	Text
Longitude Coord	Longitude coordinate	Text
WATERMIX IND	Is water present in mix cored dry?: 0=No; 1=Yes (0–20%); 2=Yes (20–40%); 3=Yes (40–60%); 4=Yes (>60%). NA applies to wet saw cores.	Text
BAREAGG IND	Are bare aggregates present in core?: 0=No; 1=Yes (0–20%); 2=Yes (20–40%); 3=Yes (40–60%); 4=Yes (>60%).	Byte
BROKENAGG IND	Are bare aggregates present in broken faces of cores?: 0=No; 1=Yes (0–20%); 2=Yes (20–40%); 3=Yes (40–60%); 4=Yes (>60%).	Byte
LACKBONDING FLAG	Is there lack of bonding between lifts of cores?: 0=No; 1=Yes.	Binary
TOPDOWNCRACK FLAG	Are there topdown cracks shown in cores: 0=No; 1=Yes.	Binary
Open Graded FLAG	Is the mix an open-graded mix?: 0=No; 1=Yes	Binary
Chip Slurry Seal FLAG	Was surface of the core treated with a chip slurry seal material?: 0=No, 1=Yes	Binary
WEAKMATERIAL FLAG	Is the cored mix so weak that it can be broken by hand?: 0=No; 1=Yes.	Byte
Interlayer FLAG	Was Interlayer present between layers?: 0=No; 1=Yes	Binary
Interlayer CODE	Type of interlayer material used: Stress Absorbing Membrane Interlayer (SAMI) or Pavement Reinforcement Fabric (PRF)	Text
Interlayer Location TEXT	Location of the interlayer material in the core	Text
Avg Moisture PCT	Average moisture content as a percent—averages the moisture contents of each lift of a core under consideration	Single
Avg Air Void PCT	Average air-void content as a percent—averages the air voids of each lift of a core under consideration	Single
Avg Saturation PCT	Average saturation as a percent—averages the saturation of each lift of a core under consideration	Single
Core Condition IND	Rank of the core condition: 1=No distress; 2=Debonded, little mix lost on sides of core;	Byte

Field Name	Detail Description	Data Type
	3=appreciable loss of mix/aggregate, 20–30% stripping, slight cracking; 4=severe loss of coarse aggregate, 40–60% stripping, cracked in more than one piece; 5=over 60% stripping.	
Last Rain QNTY	Number of days since last rain	Single
Distress Distance QNTY	Distance from the core to the distressed area (inches)	Double
QC/QA IND	Was the section a previous QC/QA project?: 0=Non QC/QA, 1=it was QC/QA project, 2=Unknown	Single
Comment TEXT	Additional comments	Text
Pavement Life QNTY	Number of years since construction	Single

Table A.4: Layer Thickness Data

Table Name	Detail Description	Data Type
SITE ID	Unique site identifier	Text
CORE ID	Unique core identifier	Text
LAYER NBR	Layer number corresponding to the reported thickness	Text
LAYER CODE	Material type found in a layer under consideration	Byte
LAYER THICKNESS mm QNTY	Layer thickness in mm	Single

Table A.5: Permeability Data

Field Name	Detail Description	Data Type
SITE ID	Unique site identifier	Text
TEST ID	Label applied to a permeability test location within a test section	Text
LOCATION DESC	Location of the measurement relative to the traveled way: center (between wheelpaths), in the right or left wheelpath, or on the shoulder	Text
TEST DATE	Test date, usually the same as the coring date	Date/Time
TEST TIME	Test time (HH:MM)	Date/Time
WEATHER COND DESC	Brief description of weather conditions at the time of field sampling	Text
AIR TEMPERATURE C QNTY	Air temperature measured at the time of field sampling	Single
PERMEAMETER CODE	Permeameter type/make	Text
BASE AREA CM2 QNTY	Base area specific to the permeameter type (cm^2)	Single
INITIAL READ MM QNTY	Initial head (height) of the water column at the beginning of the test (mm)	Single
FINAL READ MM QNTY	Final head (height) of the water column at the end of the test (mm)	Single
TEST DUR	Duration in seconds that it took the water column to get from the initial head to final head	Single
PVMT THICKNESS MM QNTY	Pavement thickness (mm)	Single
CROSS AREA CM2 QNTY	Cross area of the cylinder that water moved through (cm^2)	Single
PERMEABILITY	Calculated value of pavement surface permeability (10^{-5} cm/sec).	Single
LEAKAGE TEXT	Was water leaking during the test?	Text
IMPERMEABLE SURFACE FLAG	Was the measured surface impermeable?: 0=No; 1=Yes	Binary
COMMENT TEXT		Text

Table A.6: Hamburg Wheel Track Data

Field Name	Detail Description	Data Type
SITE ID	Unique site identifier	Text
LAYER NBR	Number of the layer of the core tested	Byte
CORE LOCATION DESC	Location of the core relative to the traveled way: Between wheelpaths, in the wheelpath	Text
CYCLE INFLECTION POINT QNTY	Number of test cycles to the point where the shape of the curve changes (Stripping Inflection Point)	Text
STRIPPING SLOPE QNTY	Stripping Slope Value (mm/1,000 pass)	Single
10K RUT mm QNTY	Rut depth (mm) after 10,000 cycles	Single
20K RUT mm QNTY	Rut depth (mm) after 20,000 cycles	Single
AIR VOID PCT	Air-void content (%)	Single

Table A.7: Air-Void Data

Field Name	Detail Description	Data Type
DATE	Date the air void test was performed in the lab	Date/Time
SITE ID	Unique site identifier	Text
CORE ID	Unique core identifier	Text
CORE Layer ID	Identifier of the core layer: A represents first layer, B represents second layer, and C represents third layer.	Text
WA QNTY	Weight of the core in air (grams)	Single
WAWP QNTY	Weight of the core in air wrapped in Parafilm (grams)	Single
WWWP QNTY	Weight of the core in water wrapped in Parafilm (grams)	Single
WW QNTY	Weight of the core in water	Single
RICE MAX SPG QNTY	Rice Maximum Specific Gravity	Single
SPG CORELOK QNTY	Bulk Specific Gravity measured using CoreLok® (vacuum sealing method)	Single
SPGWP QNTY	Specific gravity of the sample when using Parafilm	Long Integer
SPGNP QNTY	Specific gravity of the sample without Parafilm	Single
AVCORELOK QNTY	Air void calculated when CoreLok® (vacuum sealing method) was used to seal voids	Single
AVWP QNTY	Air void when core sealed with Parafilm	Double
AVNP QNTY	Air void when core was not sealed	Single
LOCATION CODE	Location of the core relative to the traveled way: C—Between the wheelpaths, L—Left wheelpath, R—Right wheelpath, S—Shoulder	Text
LAYER NBR	The number of the layer corresponding to the reported values. The number increases downward from pavement surface.	Single

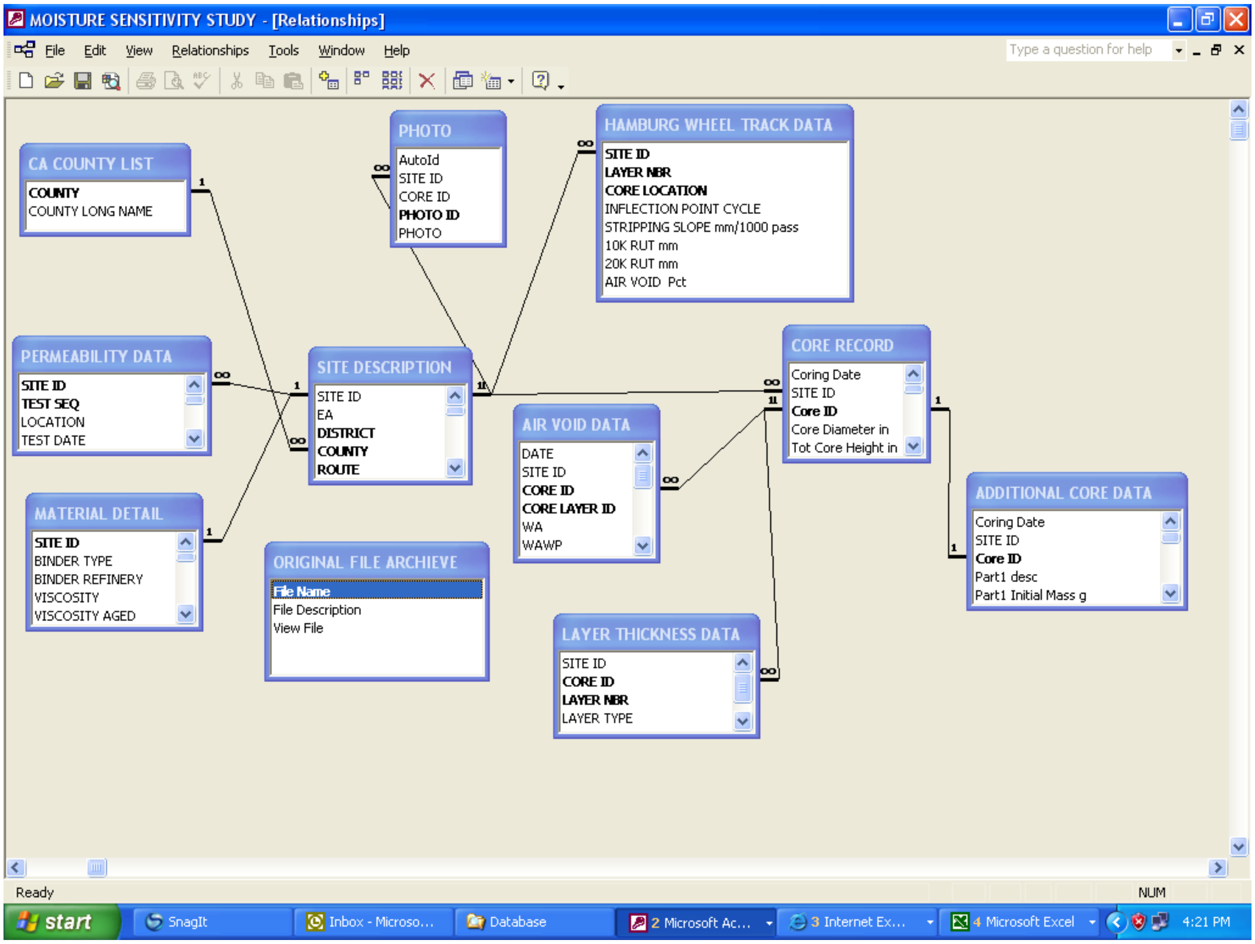

Figure A.1: Screen capture displaying the relationships among the database tables.