

Pavement Health Track (PHT) Graphical User Interface

User's Guide

Federal Highway Administration
Office of Asset Management



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Scope

This document provides the user guide and general information for the Pavement Health Track (PHT) analysis software tool version 1.0.

Reference Documents

The following documents form a part of this guide to the extent referenced herein.

- Pavement Health Track, RSL Forecasting Models, May 2010.
- HPMS Reassessment 2010 Data Specifications Document, September 2008.

Purpose

This program estimates the Remaining Service Life (RSL) for the highway sections described in the Highway Performance Monitoring System (HPMS) database maintained by the FHWA.

The source data for the Pavement Health Track (PHT) analysis tool is based on the HPMS 2010 format text file (see Table 12) and/or available electronic databases. The PHT tool acquires data from the external data sources and compiles a set of highway data made up of the data fields required for the PHT analysis. Each record in the highway data represents a highway section. The compiled highway data is permanently stored in the database for subsequent use in the PHT analysis.

Estimating RSL

Pavement RSL at the project level typically is defined as life of a pavement from the present time until application of the first significant rehabilitation treatment or reconstruction, which would be the first significant cost expenditure for the pavement. The placement of a structural overlay or reconstruction signals the end of a pavement's serviceable life; the application of minor maintenance treatments or thin overlays is not considered significant enough to indicate the end of service life.

Significant rehabilitation occurs due to some form of pavement failure. Failure typically is described as the pavement attaining first terminal distress as shown in Figure 1. Thus, RSL is simply the time in years or remaining ESALs that it would take a given pavement to attain the first terminal distress.

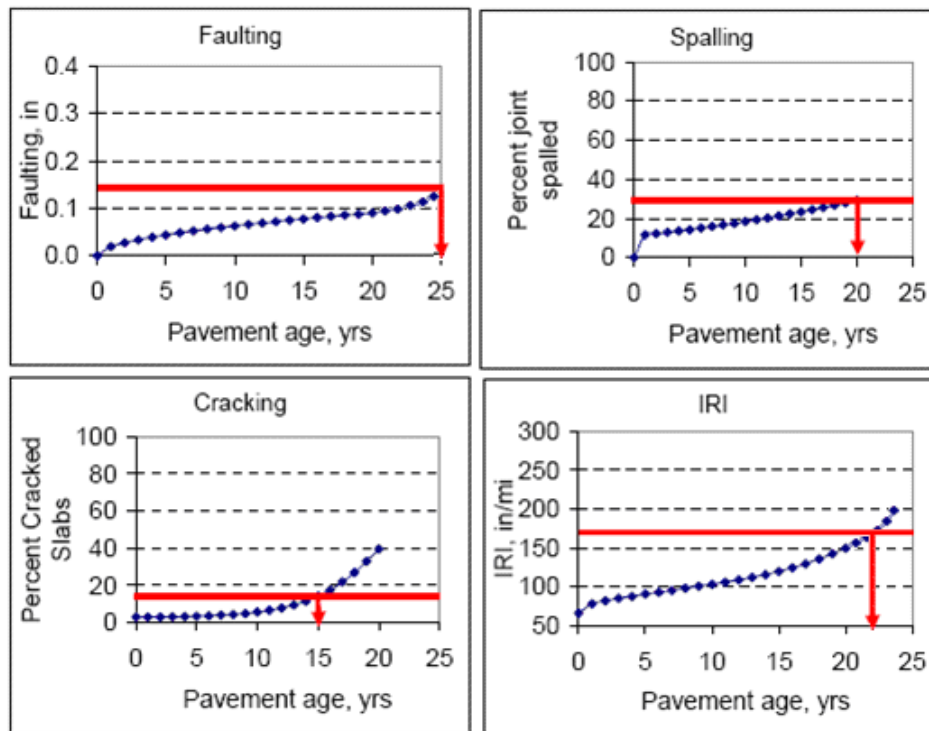


Figure 1. Predicted Pavement Distress and Estimated RSL

Critical RSL

The critical RSL is the estimated time until the first terminal distress occurs. Using the example illustrated in Figure 1, the critical RSL is estimated as shown in Table 1. In this example, the first terminal distress is cracking, which occurs at 15 years, since the pavement’s current age is 10 years; the RSL is the difference of 5 years.

Table 1. Estimation of Critical RSL

JPCP Distress/IRI	Predicted Life, yrs	Current Pavement Age, yrs	RSL, yrs	Critical RSL
Faulting	25	10	15	5
Spalling ¹	20	10	10	
Cracking	15	10	5	
IRI	22	10	12	

Weighted Average RSL

The weighted average RSL is the estimated time until each terminal distress occurs averaged together using a user defined weight for each distress type. Using the example illustrated in Figure 1, the weighted average RSL is estimated as shown in Table 2. In this example, each distress type is assigned an equal weight in the average calculation, resulting in an average RSL of 10.5 years.

Table 2. Estimation of Weighted Average RSL

JPCP Distress/IRI	Predicted Life, yrs	Current Pavement Age, yrs	RSL, yrs	Weight	Average RSL
Faulting	25	10	15	1	10.5
Spalling ¹	20	10	10	1	
Cracking	15	10	5	1	
IRI	22	10	12	1	

¹ A spalling RSL model is not currently implemented.

Calibrating the RSL Estimation

Local calibration of the RSL estimations of the pavement performance models will be done as presented by the steps below. An example of an adjusted RSL predicted faulting using the MEPDG computational model is shown in Table 3 and Figure 2.

1. Develop project-specific future estimates of pavement distress/IRI.
2. Assemble historic measured project-specific distress/IRI.
3. For the period with historic performance data, make a detailed comparison of predicted and actual pavement performance and determine the exact relationship (constant, linear, non-linear, etc.) with the RSL pavement performance predictions.
4. Based on the relationship determined in step 3, develop calibration, adjustment, or scaling factors for use in minimizing error between measured and RSL predicted distress/IRI.

Table 3. Adjusted RSL Predicted Faulting

HPMS Sample ID	Age	Measured (HPMS)	Predicted (RSL)	Adjusted Prediction (Linear Adjustment Factor = 3.45)	Ratio of Predicted and Measured Faulting
HPMS 0001	1.14	0.007	0.025	0.007	3.57
HPMS 0001	2.03	0.012	0.046	0.013	3.83
HPMS 0001	3.63	0.024	0.076	0.022	3.17
HPMS 0001	4.68	0.027	0.093	0.027	3.44
HPMS 0001	5.34	0.032	0.103	0.030	3.22

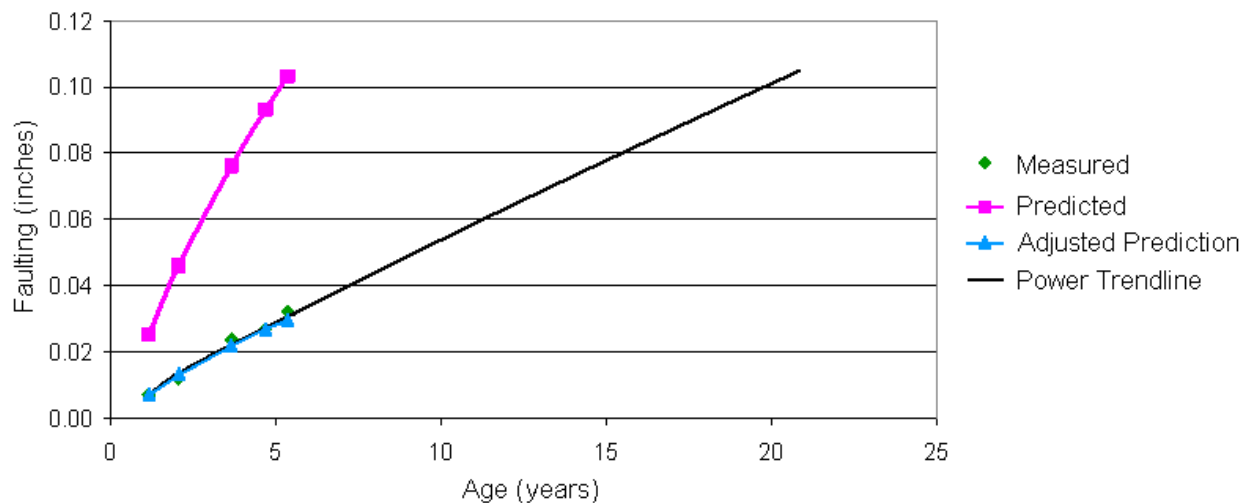


Figure 2. Adjusted RSL Predicted Faulting

Application GUI

The following sections describe the PHT application Graphical User Interface (GUI).

Welcome Window

When the application starts, the welcome window shown in Figure 3 will appear. This window allows you to quickly select what action you would like to take to begin working. You may create a new Study, open an existing Study, return to the last Study that you were working in, or begin working without an active Study.

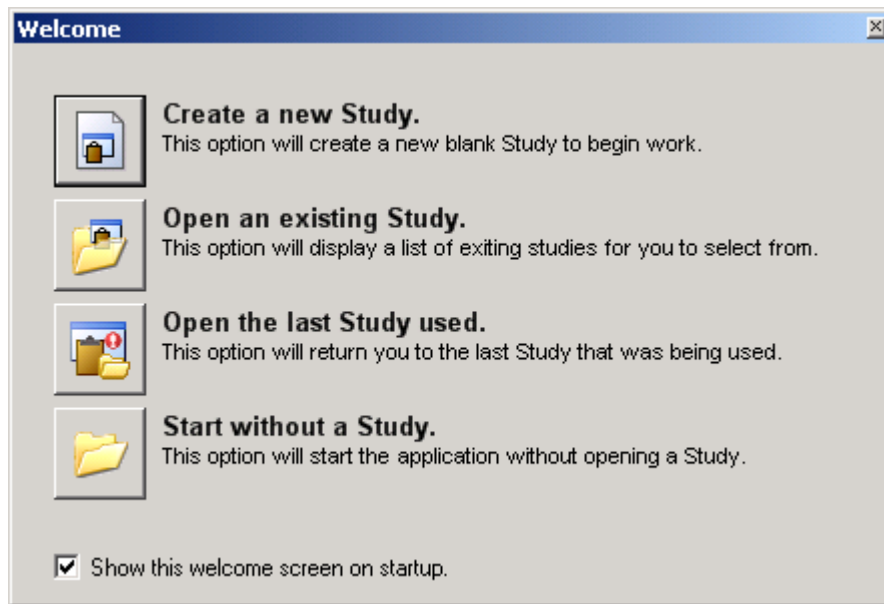


Figure 3. Application Welcome Window

The welcome window may be disabled, in which case the application will always begin without an active study being opened. If the welcome window is disabled, you may re-enable it from the applications options window available under the **Tools/Options** menu on the main application window.

Main Application Window

The Pavement Health Track (PHT) analysis tool serves as an add-in analysis module for the Battelle Multi-Faceted Analysis Tool (BMFAT) environment. The main application window hosting the PHT analysis tool is shown in Figure 4.

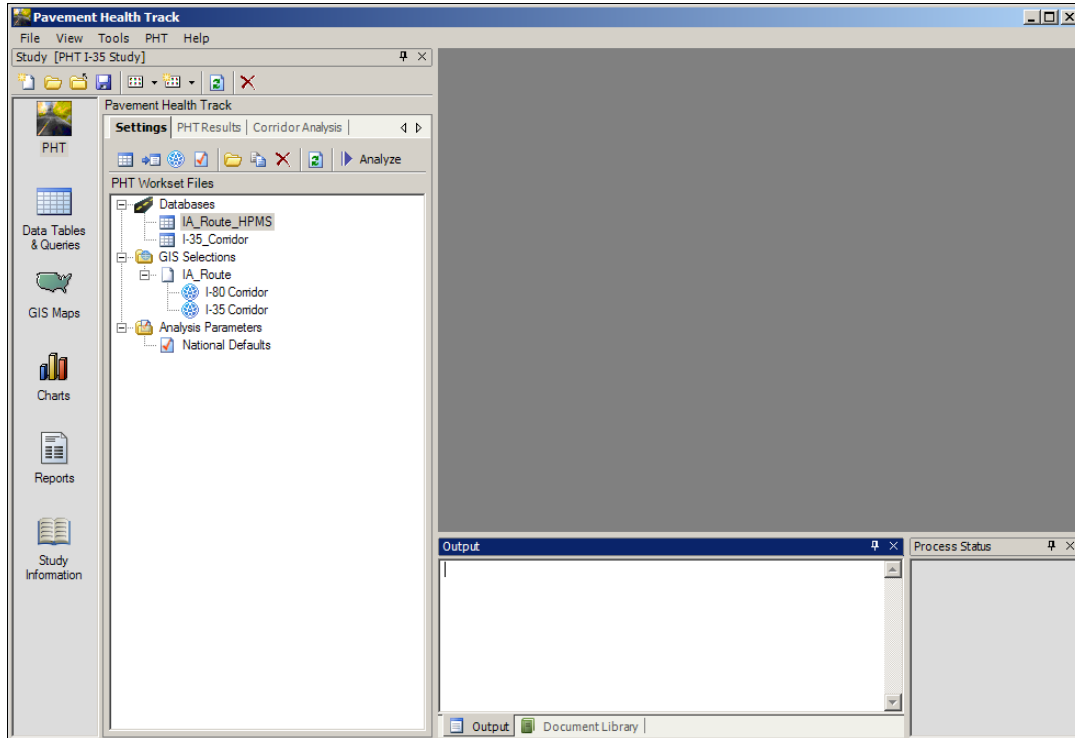




Figure 4. Main Application Window

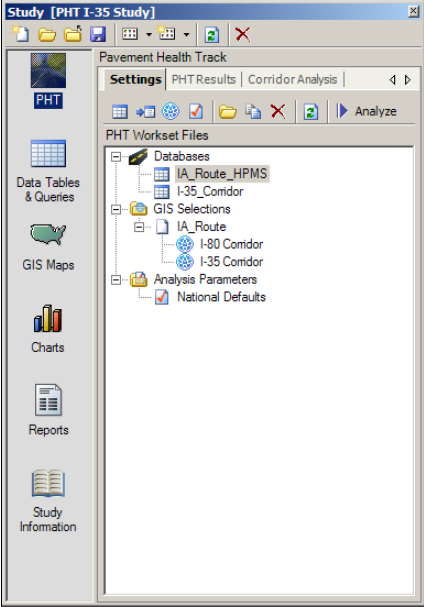
The main application window provides four panels and a main workspace area. The panels can be arranged, hidden, or displayed as desired. If any panel is not visible in the application workspace, you may activate it by selecting it under the **View** menu from the applications main menu.

- **Study.** This panel provides access to the PHT analysis module and serves to organize your efforts to study a particular issue. You can create any number of Studies and make their scope as broad or specific as you deem useful.
- **Document Library.** This panel provides access to the complete library of documents that are produced by the PHT analysis tool. All documents in the library are available here regardless of the Study that produced them.
- **Output.** This panel provides a communication platform for messages produced by the PHT analysis module to be displayed.
- **Process Status.** This panel provides status and progress bars to provide feedback.

The Study Window

The Study is displayed in the **Study** window shown in Figure 5. If it is not already visible in the application workspace, you may activate the Study window by clicking the **View/Study** menu item from the applications main menu. To create a new Study, click the **New**  button. To open a Study that has previously been created click the **Open**  button and select a Study from the list.

Note that only one Study can be open at a time.



The **PHT** icon displays the user interface for the PHT analysis tool.

The **Data Tables & Queries** icon displays a list of data tables and queries that are part of the Study. These tables contain the raw analysis data that has been stored in the data warehouse.

The **GIS Maps** icon displays a list of GIS documents that are part of the Study.









The **Charts** icon displays a list of chart documents that are part of the Study.

The **Reports** icon displays a list of report documents that are part of the Study.

The **Study Information** icon displays a window that contains general information about the Study such as its name, description, status, etc.

Figure 5. Study Window

The Study window toolbar provides the following functions.

-  **Create a New Study.** Creates a new blank Study.
-  **Open an Existing Study.** Display a dialog to select an existing Study.
-  **Close.** Closes the current Study.
-  **Save.** Saves all changes to the current Study.
-  **Add Existing Items.** Displays a dialog window that allows you to select an existing chart, map, report, table, or query and adds it to the Study.
-  **Create New Item.** Creates a new blank chart, map, report, or query and adds it to the current Study.
-  **Refresh.** Refresh the display.
-  **Remove.** Removes the currently selected item(s) from the Study.

PHT Analysis Window

The PHT analysis window is divided into three tabs. The first tab, shown in Figure 6, is the **Settings** tab and provides the user interface for working with highway data, GIS selections, and PHT analysis parameters and to run the PHT analysis. A hierarchical tree displays and organizes these items and a toolbar and RIGHT-click popup menus are provided to work with them.

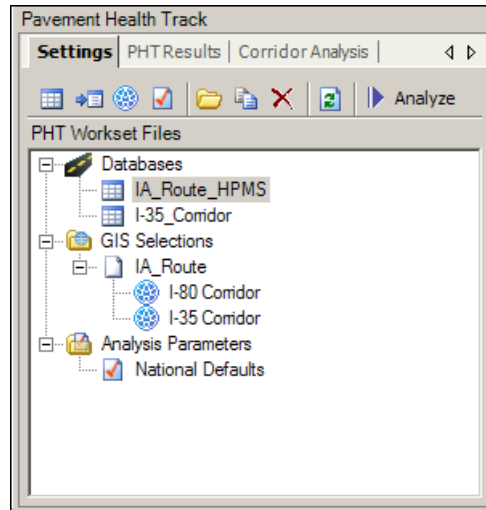








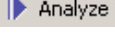


Figure 6. PHT Analysis Tool – Model Settings

The toolbar at the top of the window provides for following functions.

- 
Read HPMS Data. Open an HPMS 2010 formatted comma-delimited text file and read its contents into an PHT database.
- 
Read Non-HPMS Data. Connect to a Microsoft® Access, dBase, comma-delimited file, or other ODBC data source and import its contents into a PHT database using the import wizard.
- 
Create a new GIS Selection. Create a new GIS selection based on an existing a GIS shape file.
- 
Create a new set of Parameter Metrics. Create a new set of parameter metrics that is used to control the PHT analysis.
- 
Open. Open the item currently selected in the tree.
- 
Copy. Create a copy of the item currently selected in the tree.
- 
Delete. Delete the item currently selected in the tree.
- 
Refresh. Refresh the Display.
- 
Run PHT Analysis. Display the PHT run dialog window to initiate the PHT analysis process.

In addition to the functions provided by the toolbar, individual items in the tree structure have unique operations that can be performed. Access to these functions is provided by the popup menu that appears when you RIGHT-click on a specific item in the tree structure. The pop-up menu for each item type is shown in Figure 7.

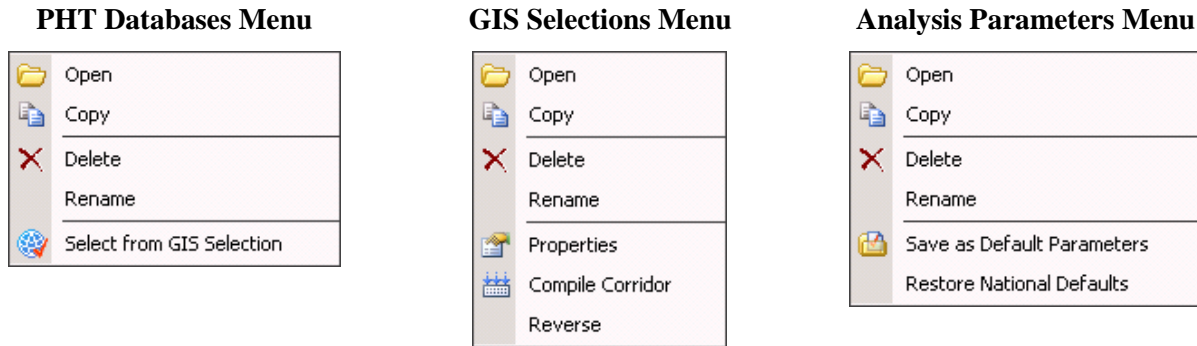









Figure 7. PHT Settings – Right-Click Popup Menus

The items in the pop-up menus provide the following functions.

-  **Open.** Open the item currently selected in the tree.
-  **Copy.** Create a copy of the item currently selected in the tree.
-  **Delete.** Delete the item currently selected in the tree.
- Rename.** Rename the currently selected item.
-  **Select from GIS Selection.** Select highway sections to be evaluated by the PHT analysis using an existing GIS selection.
-  **Properties.** Display the properties dialog of a GIS Selection.
-  **Compile Corridor.** Evaluate the highway sections that make up a GIS selection and determine if they form a continuous corridor.
- Reverse.** Reverse the direction of a corridor.
-  **Save as Default Parameters.** Save the currently selected set of parameter metrics as the default values to be automatically applied to new sets of parameters.
- Restore National Defaults.** Restore the original national default values to the currently selected set of parameter metrics.

The second tab in the PHT analysis window, shown in Figure 8, is the **PHT Results** tab, which provides the user interface for working with results data for the PHT analysis and allows you to generate automated reports. A hierarchical tree displays and organizes each set of results and a toolbar and RIGHT-click popup menus are provided to work with them.

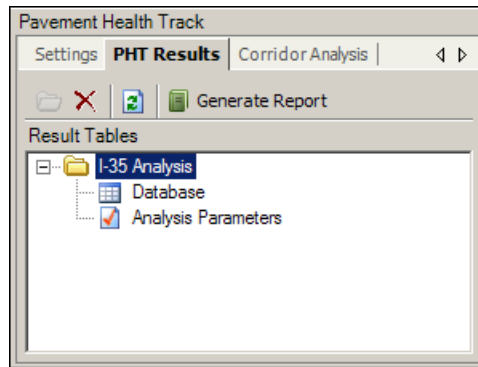



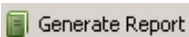


Figure 8. PHT Analysis Tool – PHT Results

The toolbar at the top of the window provides for following functions.



-  **Open.** Open the item currently selected in the tree.
-  **Delete.** Delete the currently selected set of PHT results.
-  **Refresh.** Refresh the Display.
-  **Generate a Report.** Display the PHT report wizard dialog window to automatically generate a report based on a selected set of PHT results and report template.

In addition to the functions provided by the toolbar, individual items also provide a pop-up menu that appears when you RIGHT-click on a specific item in the tree structure. The menu for each item type is shown in Figure 9.

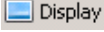


Figure 9. PHT Results – Right-Click Popup Menus

The items in the pop-up menu provide the following functions.

-  **Open.** Open the item currently selected in the tree.
-  **Delete.** Delete the item currently selected in the tree.
- Rename.** Rename the currently selected item.

The third tab in the PHT analysis window, shown in Figure 10, is the **Corridor Analysis** tab, which provides the user interface for evaluating the PHT results for any given corridor. The top pane displays a list of existing corridor profiles for you to select from, while the bottom pane displays the options for the selected corridor profile. You must select a set of PHT analysis results, a GIS selection that represents the continuous corridor, and up to four data items to profile.

Once you have selected the profiles options, click the **Display**  button in the toolbar to view the corridors profile as shown in Figure 11. After making any changes to the options for the profile, you must click the **Display** button again to refresh the display window.

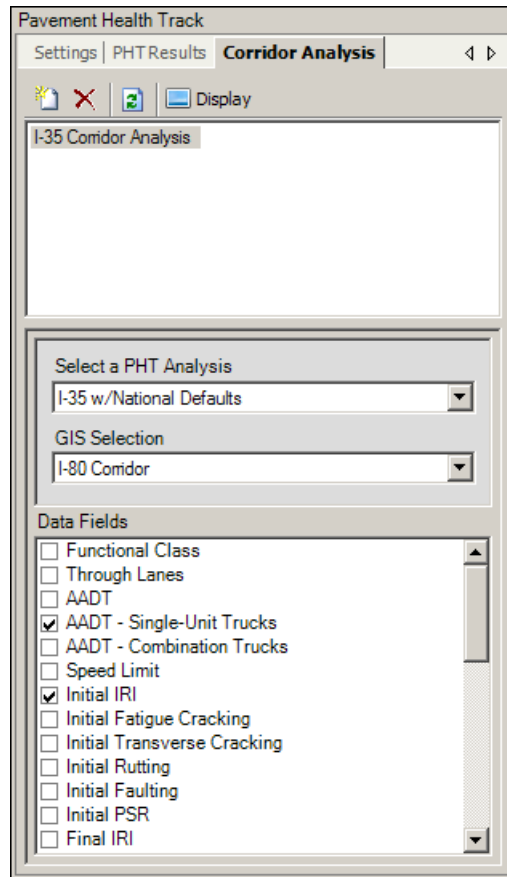



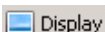


Figure 10. PHT Analysis Tool – Corridor Analysis

The toolbar at the top of the window provides for following functions.

-  **Create New.** Create a new profile analysis.
-  **Delete.** Delete the currently selected profile analysis.
-  **Refresh.** Refresh the Display.
-  **Display.** Display the results of the currently selected profile. Click this button after making any changes to refresh the display, of the corridor profile.

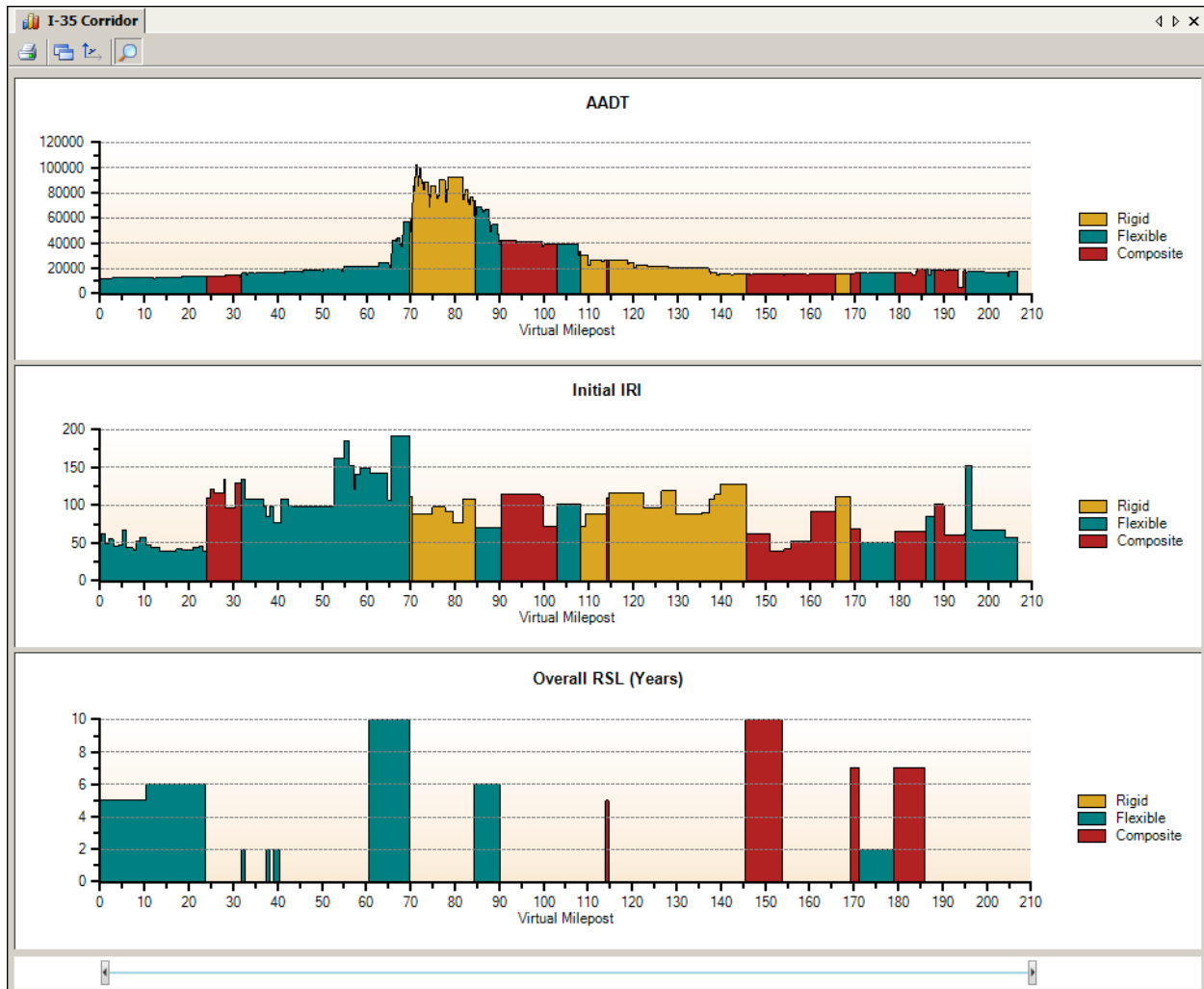


Figure 11. Corridor Profile Display

The corridor profile identifies the pavement type of each highway section as a color code depicting rigid, flexible, and composite pavements for those regions of the corridor that have sample PHT data. Regions without sample data appear gray. Corridors are characterized by virtual mileposts beginning at zero and incrementing based on the lengths of the highway sections that make up the corridor.

ZOOM

To zoom into an area of the corridor, click the **Zoom**  button on the toolbar. The zoom control will appear at the bottom of the window. Drag the beginning and ending markers left or right to adjust the zoom region. Click the zoom button on the toolbar again to remove all zooming from the charts and restore the profile to its original scale.

PHT Properties

The PHT properties window is displayed by clicking the **PHT/Properties** menu item in the application main menu. The PHT properties window has three tabs as follows.

PHT DATABASE

The PHT Database tab (shown in Figure 12) allows you to specify the database file used by the PHT analysis tool to store local information unique to the PHT tool. The user name and password requirements are not implemented at this time. The location of the PHT database file is set up during installation and will generally not need to be modified.

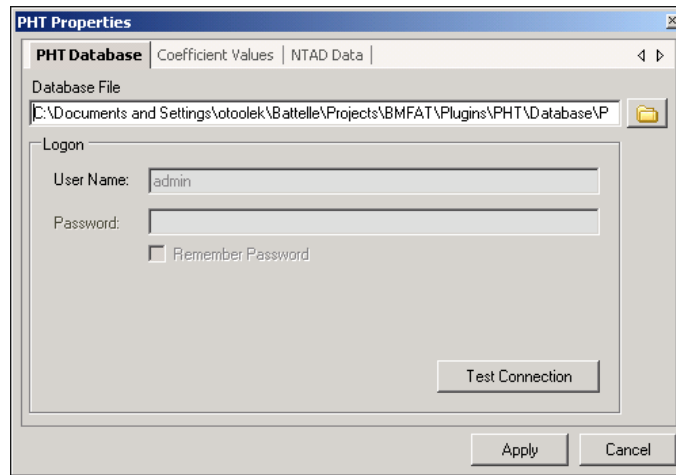


Figure 12. PHT Properties – PHT Database

COEFFICIENT VALUES

The PHT coefficient values, shown in Figure 13, are used by the analytical models employed by the analysis engine and are not editable without authorization.

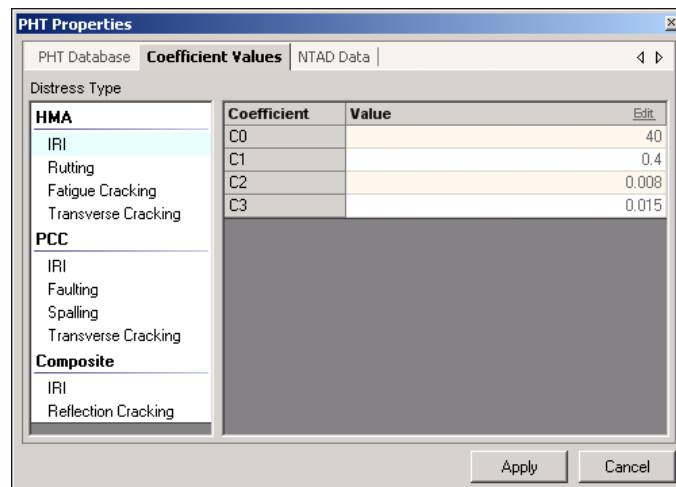


Figure 13. PHT Properties – Coefficient Values

The coefficient values apply to the model equations defined in the RSL Forecasting Models technical information document. A cross-reference between the coefficient values and the analysis model equations is provided in Table 4.

Table 4. Coefficient Reference Equations.

Distress Type	Coefficients	Reference Equations (Technical Information Document)
HMA IRI	C0 – C3	Equation 29
HMA Rutting	C0 – C8	Equations 23, 24, 25, 26
HMA Fatigue Cracking	C0 – C3	Equation 22
HMA Transverse Cracking	C0 – C8	Equation 27
PCC IRI	C0 – C3	Equation 7
PCC Faulting	C0 – C9	Equation 4
PCC Spalling	NA	
PCC Transverse Cracking	C0 – C11	Equations 1, 2, 3
Composite IRI	C0 – C1	Equation 31
Composite Cracking	C0 – C10	Equation 30

NTAD DATA

The National Transportation Atlas Database (NTAD) data, shown in Figure 14, is used to provide background images for the GIS maps used by the GIS selections. The NTAD backgrounds are useful to provide you with additional references when viewing the GIS maps but are otherwise optional. You can select which backgrounds that you would like to appear in the GIS maps.

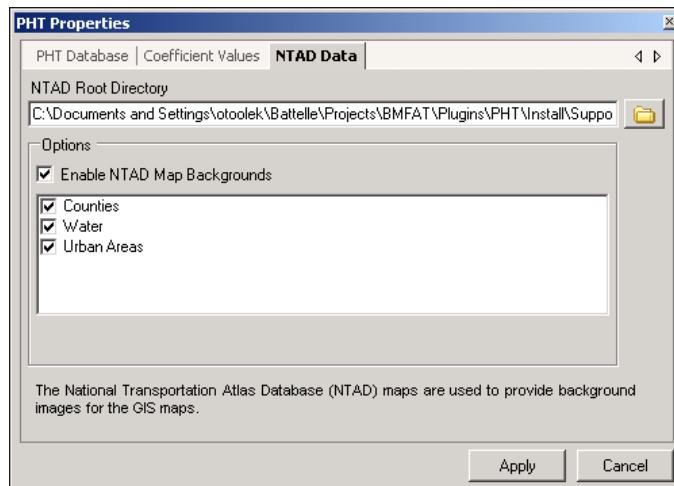


Figure 14. PHT Properties – NTAD Data

PHT Database Window

The PHT database window is display by selecting a database on the **Settings** tab of the PHT analysis window and clicking the **Open** button on the toolbar.










The PHT database is the source data for the RSL analysis. It contains the data fields that describe the condition of each highway section. Each record in the database represents a highway section. The PHT database is displayed in the data table window shown in Figure 15.

The second column in the table (**f_Select**) determines if a highway section will be included in the PHT analysis. If this field is set to a value of **True**, the record will be analyzed by the PHT tool when the analysis is ran. If it is set **False** it will be ignored.

n_ID	f_Select	n_Year_Record	n_State_Code	n_County_Code	s_Sample_ID	s_Route_ID	f_Begin_Point	f_End_P
1	False	2007	19		1 000000000064	00000008000	2.808	
2	False	2007	19		1 000000000077	00000008000	6.834	
3	False	2007	19		1 000000000083	00000008000	7.486	
4	False	2007	19		1 000000000088	00000008000	9.225	
5	False	2007	19		1 000000000091	00000008000	9.628	
6	True	2007	19		1 000000000101	00000008000	13.127	
7	True	2007	19		1 000000000115	00000008000	19.933	
8	True	2007	19		1 000000000116	00000008000	20.112	
9	True	2007	19		1 000000000117	00000008000	20.193	
10	True	2007	19		1 000000000119	00000008000	20.927	
11	True	2007	19		3 000000000194	00000003400	0.841	
12	False	2007	19		3 000000000199	00000003400	1.635	
13	False	2007	19		3 000000000201	00000003400	1.914	
14	False	2007	19		5 000000000512	00000005200	0.723	
15	False	2007	19		7 000000000755	00000000500	15.855	
16	False	2007	19		9 000000000900	00000007100	1.578	
17	False	2007	19		9 000000000931	00000007100	12.477	
18	False	2007	19		9 000000000934	00000007100	13.733	

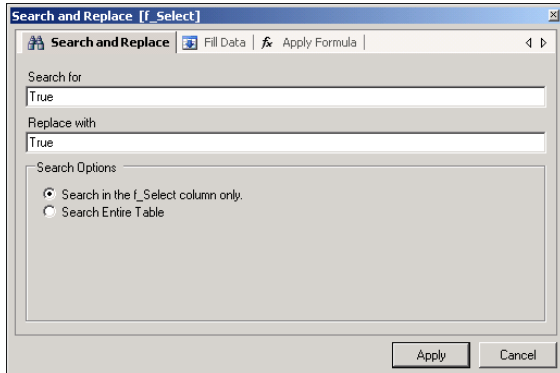
Figure 15. PHT Database Window

The toolbar at the top of the window provides for following functions.

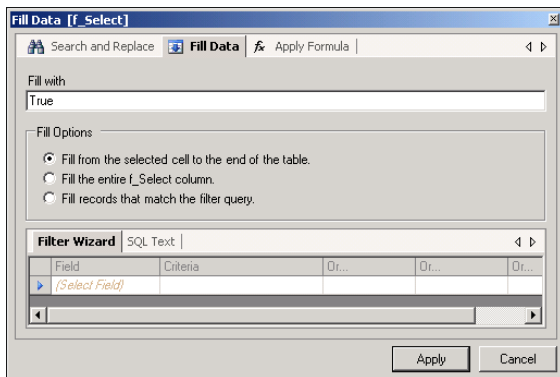
-  **New Record.** Create a new blank record and append it to the table.
-  **Delete.** Delete the currently selected records from the table.
-  **Save.** Save all changes.
-  **Select from GIS Selection.** This feature will select all highway sections that are included in an existing GIS selection. When complete, the table will be filtered to display only the selected highway sections.
-  **Search and Replace.** Search the contents of a column and replace one value with another value.
-  **Fill.** Fill the contents of a column with a new value.
-  **Apply Formula.** Calculate a new value for the contents of a column using a user specified mathematical formula.
-  **Apply Filter.** Filter the records that are visible in the table.
-  **Remove Filter.** Remove any filter and display all records in the table.

The data table window provides tools to add and delete records and to perform mass edits such as search and replace, fill and calculate data within the table. The mass editing window shown in Figure 16 is activated by clicking on one of the three mass editing buttons in the toolbar.

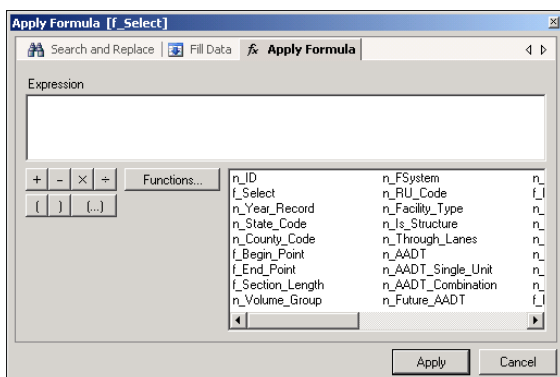
After editing a record in the table you must click the **Save** button in the toolbar to commit your changes before they are available to be used in the PHT analysis.



The **Search and Replace** window allows you to search the entire table or just the currently selected data column for a particular value and replace it with a new value.





The **Fill Data** window allows you to fill a column of data with a new value overwriting all previously existing values in the column. You can fill the entire column or just from the currently selected record through the end of the table. You can also apply a filter so that only records that match the filter query will be affected.



The **Apply Formula** window allows you to fill a column of data with new values that are based on a mathematical formula. The formula expression can use simple math, functions, and the values of the other columns in the record to calculate the new value.

Figure 16. Data Table Mass-Editing Window

The data table window also provides a means of filtering and sorting the data. Click the **Apply Filter**  button on the data table window to filter or sort the data. The data filter window shown in Figure 17 will appear. On the **Filter Wizard** tab, select the data fields you want to use to sort or filter the data and enter any filter criteria.

To remove the sorting and filtering from the data table, click the **Remove Filter**  button on the toolbar.

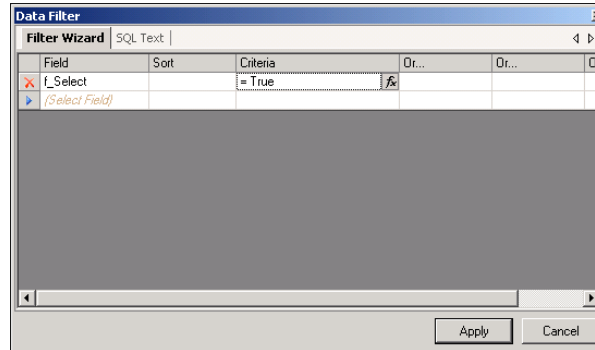


Figure 17. Data Table Filtering and Sorting

Users that are comfortable working directly with the SQL language may enter the SQL text using the SQL text window shown in Figure 18. The SQL text represents the WHERE clause of a SQL statement and must comply with all SQL syntax rules. This window provides a list of available data fields, operators, built-in functions, and a list of unique values for the selected field.

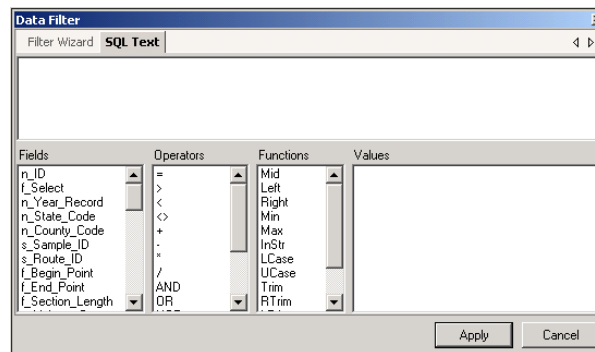


Figure 18. SQL Text Window

Click the **Apply** button to apply the filtering and sorting options to the table view.

GIS Selections

The GIS Selections are based on a GIS shape file that contains the geographical information about the highway sections associated with your PHT database. You can use the **GIS Selections** window shown in Figure 19 to select a group of highway sections to work with. The GIS selection has multiple uses in the PHT analysis tool including selecting highway sections for analysis and defining a continuous corridor for corridor profiling.

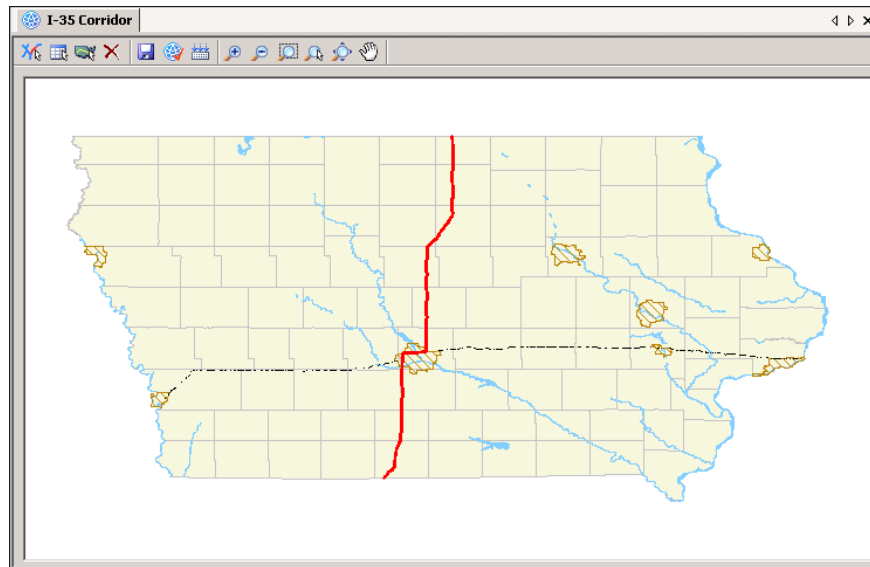







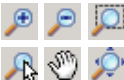


Figure 19. GIS Selection Window


The toolbar at the top of the window provides for following functions.

- 
Manual Selection. Select highway sections by manually clicking on them in the GIS map. Clicking a highway section will toggle it between selected and non-selected.
- 
Select by Attributes. Select highway sections by querying the attributes of the GIS map records. The GIS query builder dialog window will be displayed to write the SQL selection query.
- 
Shortest Path. Select highway sections by finding the shortest path between two points. You must click on two highway sections to serve as the beginning point and end point of the path.
- 
Clear. Clear the current selection.
- 
Save. Save the current selection of highway sections.
- 
Select Highway Sections. Use the GIS selection to select highway sections to be evaluated by the PHT analysis.
- 
Compile Corridor. Evaluate the highway sections that make up a GIS selection and determine if they form a continuous corridor.
- 
Zoom and Pan. Controls to zoom and pan through the GIS map.

GIS SELECTION PROPERTIES

When a GIS selection is first created, its properties window, shown in Figure 20, is displayed. For the GIS selection to work with the PHT database you must specify the data fields that will be used to link the PHT database with the GIS information. There are four fields you must specify:

- **State FIPS.** This item identifies the field that contains the state FIPS code.
- **County FIPS.** This item identifies the field that contains the county FIPS code.
- **Sample ID.** This item identifies the field that contains the unique highway section identifier.
- **Section Length.** This item identifies the field that contains section length information. This field is required when working with corridor profiles to provide length information for highway sections that are included in the GIS corridor, but for which there is no corresponding record in the PHT database.

The properties window for the GIS Selection can also be activated by clicking the **Properties**  option in the GIS selection RIGHT-click pop-up menu.

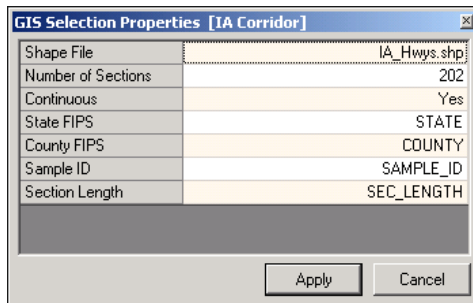



Figure 20. GIS Selection Properties

If a GIS selection is intended to be used for corridor profiling, all the highway sections in the selection must form a single continuous corridor. The properties window indicates if the GIS selection is or is not a continuous corridor, or if its state is unknown.

You can determine if the GIS selection is a continuous corridor using the **Compile Corridor**  option in the GIS selection RIGHT-click pop-up menu. After a GIS selection has been created or edited, its continuous state is defined as **Unknown** until it is compiled, after which it will be **Yes** or **No**.

Analysis Parameters

The PHT analysis parameters provide many settings that affect the results of the PHT analysis. The PHT tool provides a complete set of national default values for each metric; however you can modify the metrics to customize the PHT analysis as desired. Once modified, the customized parameters can be saved as the default values, overriding the original national defaults. You can restore any set of parameters to their original national defaults from the Analysis Parameters pop-up menu.

The analysis parameters are organized on four tabs. The first tab, shown in Figure 21, provides the settings for the pavement maximum service life. The maximum service life is specified in years for each type of surface treatment.

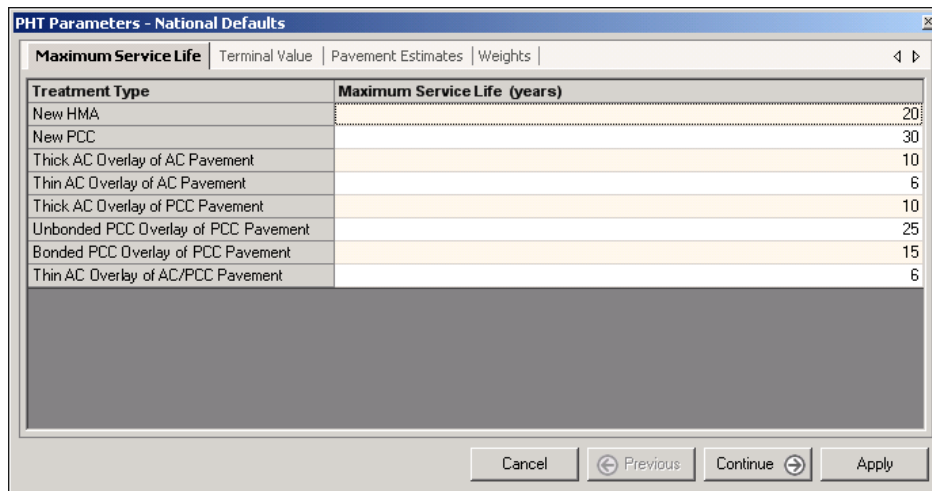


Figure 21. Parameters – Maximum Service Life

The next tab, shown in Figure 22, provides the settings for the terminal values for each type of distress associated with rigid, flexible, and composite surfaces. These values are the deficiency thresholds at which point the surface is considered to have reached the end of its service life.

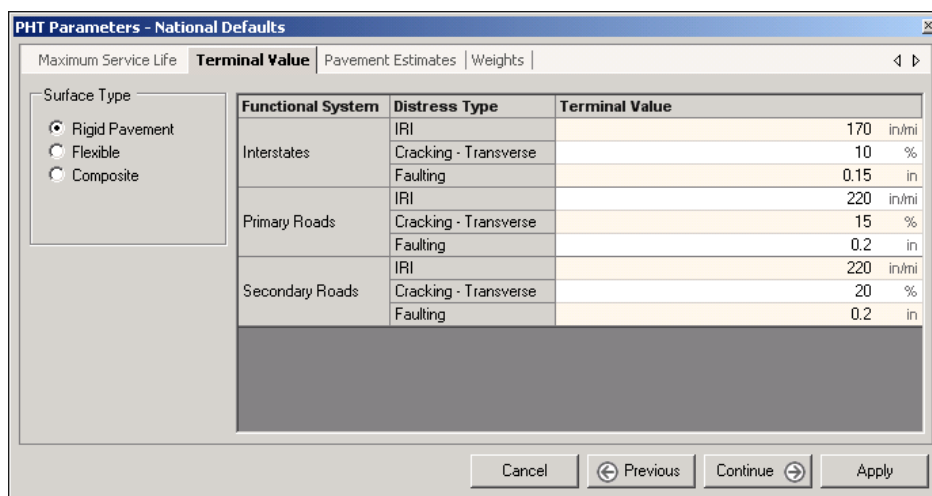


Figure 22. Parameters – Terminal Values

The next tab, shown in Figure 23, provides the pavement estimate settings that are used by the PHT analysis to estimate values that are missing from the PHT source data. Values are provided for each individual State for interstates, primary, and secondary roads.

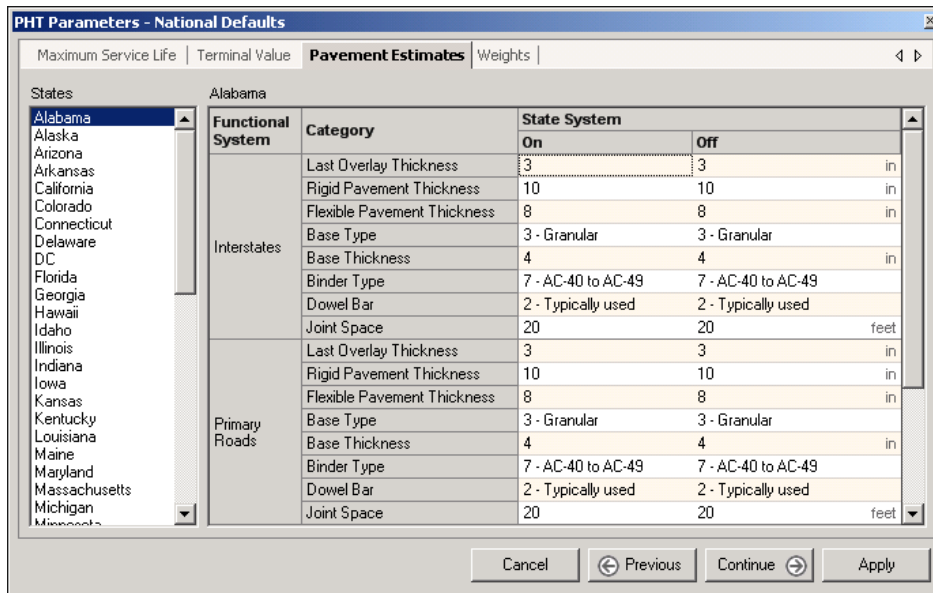


Figure 23. Parameters – Pavement Estimates

The last tab, shown in Figure 24, provides options on how the RSL is calculated. You can select to use the critical RSL or a weighted average. The distress weights are used to set the relative effect of each distress type on the RSL calculation when using weighted averages. Setting all weights to 1 will cause each distress type to have an equal effect.

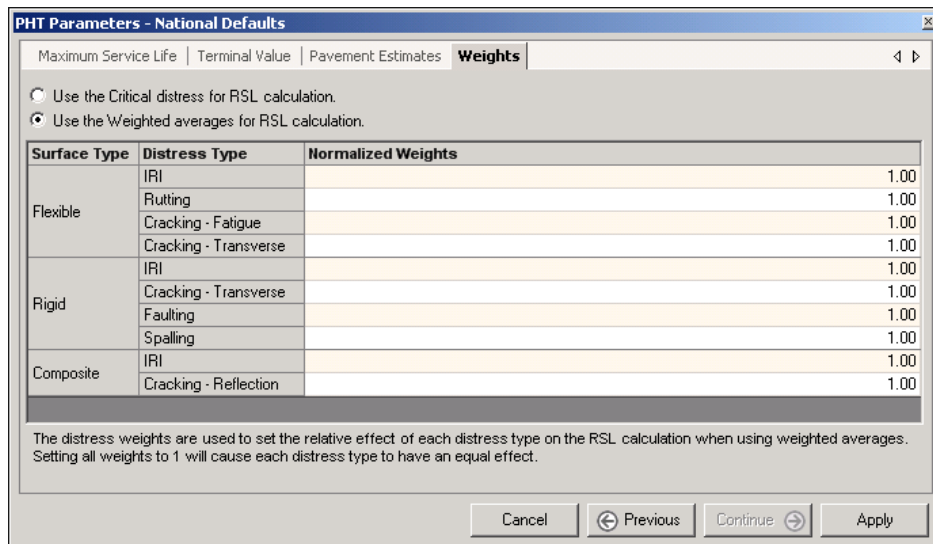



Figure 24. Parameters – Weights

Running the PHT Analysis

To run the PHT analysis, select a PHT database and click the **Analyze**  **Analyze** button in the toolbar of the **Settings** tab of the PHT analysis window. The run dialog window shown in Figure 25 will appear.

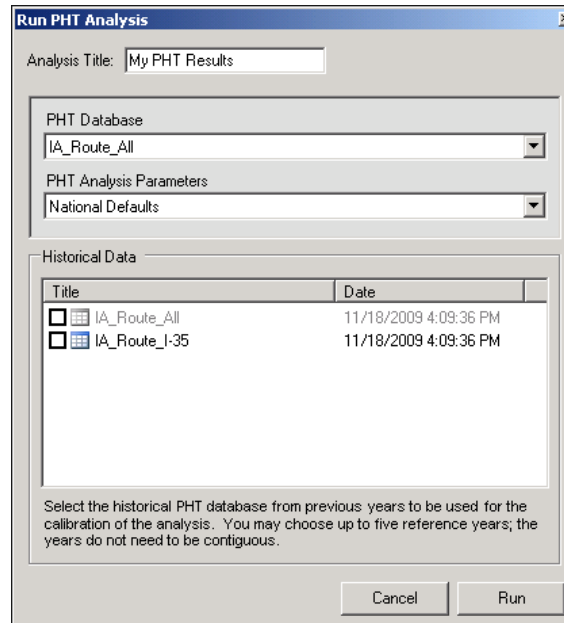


Figure 25. PHT Run Window

The PHT run dialog window allows you to select options that affect how the analysis is performed.

- The first option is to enter a descriptive title for the PHT analysis results. This is the title that will appear in the Results tree in the user interface. To avoid confusion with other PHT analysis runs you may perform, you should take time to enter a title that is both descriptive and unique.
- The second option is to select the PHT database and Parameter metrics that you want to use for the analysis. Select the desired PHT database and parameters from the drop-down lists.
- Finally you may select historical PHT databases from previous years to be used for the calibration of the analysis based on measured values. You may choose up to five historical reference years; the years do not need to be contiguous. The historical data is optional, but providing the actual measured distresses will improve the accuracy of the RSL predictions.

Click the **Run** button to start the PHT analysis.

During the PHT analysis a progress indicator is displayed to provide you with feedback about the analysis progress. Additionally textual messages are periodically displayed in the **Output** window, shown in Figure 26, to give more detailed information about the status of the analysis.

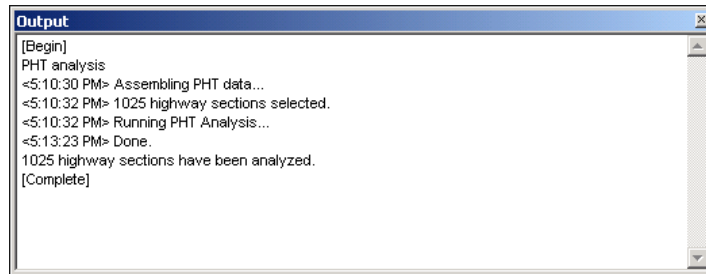


Figure 26. PHT Output Window

After the PHT analysis is complete, a message dialog window will display to inform you about the results of the PHT analysis. If all of the highway sections have been successfully analyzed then you will see the dialog window shown in Figure 27. Otherwise, if some sections were skipped, you will see the dialog shown in Figure 28. If some of the highway sections were not processed, an error log will be produced that identifies the records and the reason that they were skipped.

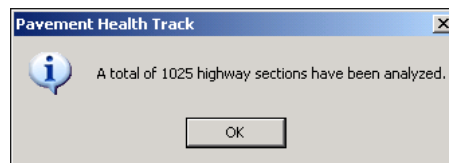


Figure 27. PHT Result – All Records Processed

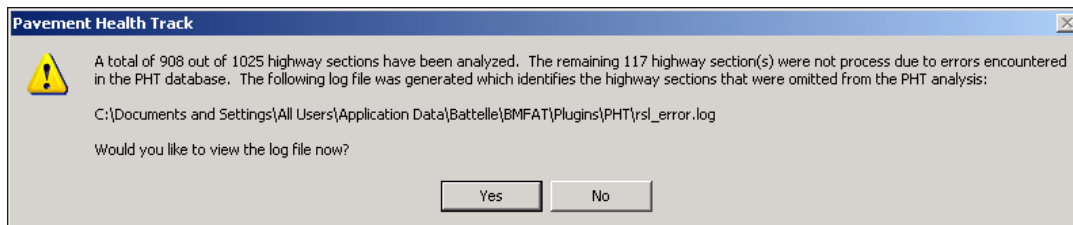


Figure 28. PHT Result – Some Records Skipped

The PHT results are displayed in the tree on the **PHT Results** tab of the PHT analysis window. A result set includes a copy of the parameter metrics used during the analysis and a copy of the original PHT database with the fields that contain the analysis results appended to the database table.

Note: if there are no successfully analyzed records, then no result set will be displayed.


PHT RESULTS

The PHT result data fields shown in Table 5 are appended to the end of the original PHT database.

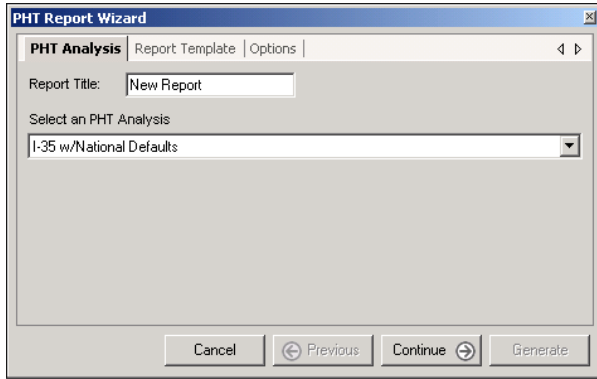
Table 5. PHT Result Fields

Field Name	Type	Description
f_RSL_Final_IRI	single	Predicted IRI at the end of the overall service life.
f_RSL_Final_Rutting	single	Predicted Rutting at the end overall service life.
f_RSL_Final_Cracking_Fatigue	single	Predicted Fatigue Cracking at the end of the overall service life.
f_RSL_Final_Cracking_Transverse	single	Predicted Transverse Cracking at the end of the overall service life.
f_RSL_Final_Faulting	single	Predicted Faulting at the end of the overall service life.
f_RSL_Term_IRI_Years	single	Number of years until the terminal IRI is reached.
f_RSL_Term_IRI_ESALs	single	Remaining ESALs until the terminal IRI is reached.
f_RSL_Term_Rutting_Years	single	Number of years until the terminal Rutting is reached.
f_RSL_Term_Rutting_ESALs	single	Remaining ESALs until the terminal Rutting is reached.
f_RSL_Term_Cracking_Fatigue_Years	single	Number of years until the terminal Fatigue Cracking is reached.
f_RSL_Term_Cracking_Fatigue_ESALs	single	Remaining ESALs until the terminal Fatigue Cracking is reached.
f_RSL_Term_Cracking_Transverse_Years	single	Number of years until the terminal Transverse Cracking is reached.
f_RSL_Term_Cracking_Transverse_ESALs	single	Remaining ESALs until the terminal Transverse Cracking is reached.
f_RSL_Term_Faulting_Years	single	Number of years until the terminal Faulting is reached.
f_RSL_Term_Faulting_ESALs	single	Remaining ESALs until the terminal Faulting is reached.
f_Overall_RSL_Years	single	Overall number of years remaining in the service life.
f_Overall_RSL_ESALs	single	Overall number of ESALs remaining in the service life.
n_Analysis_Result_Code	integer	Code (1) indicating the record was successfully analyzed.
f_UDF1	single	User defined data field.
f_UDF2	single	User defined data field.
f_UDF3	single	User defined data field.
f_UDF4	single	User defined data field.
f_UDF5	single	User defined data field.
f_UDF6	single	User defined data field.

PHT Report Wizard

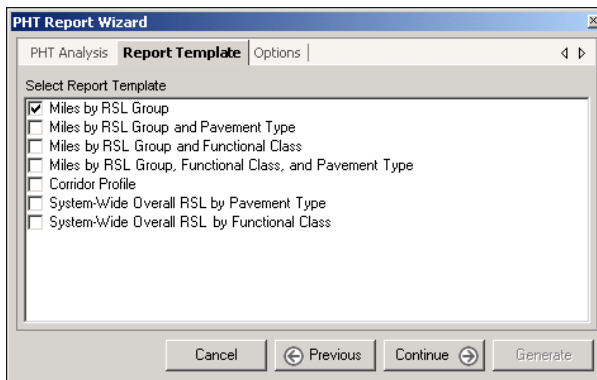
To activate the Report Wizard, click the **Generate**  **Generate Report** button on the toolbar of the **PHT Results** tab of the analysis window. This wizard provides several built-in report templates that can be used to visualize the results of the analysis.

The Report Wizard has the windows shown in Figure 29.



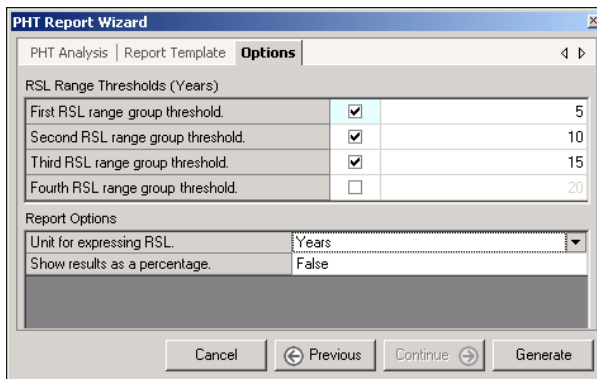
The **PHT Analysis** tab of the report wizard allows you to enter a descriptive title for the report and select the PHT analysis results that you want the report to be based on. To avoid confusion with other reports you may create, you should take time to enter a title that is both descriptive and unique.

Click the **Continue** button to continue.



The **Report Template** tab of the report wizard allows you to select the report template that you would like to use for the report. Select the checkbox next to the desired report template.

Click the **Continue** button to continue.

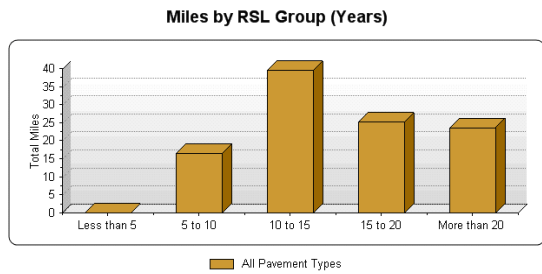


The **Options** tab of the report wizard allows you to set unique options specific for any given report template. The number and type of options will differ by template.

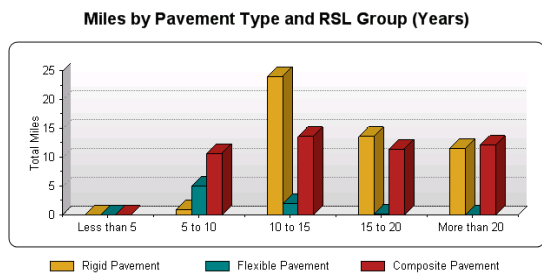
Click the **Generate** button to create the report.

Figure 29. Report Wizard

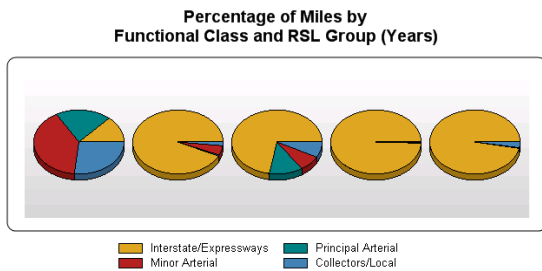
The following are some examples of the types of reports you can create.



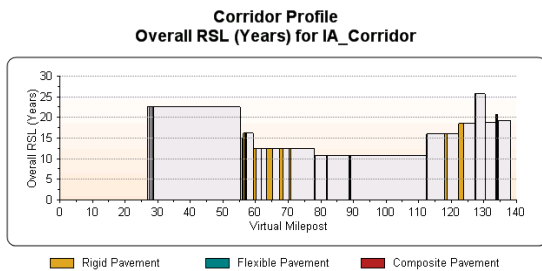
Miles by RSL Group. This chart shows how many highway miles exist for each RSL group.



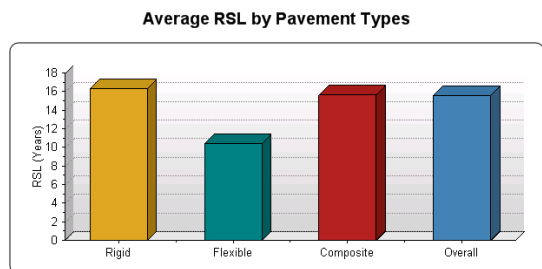
Miles by Pavement Type and RSL Group. This chart shows how many highway miles exist for each RSL group and disaggregates each group into the number of miles of rigid, flexible, and composite pavements.



Percentage of Miles by Functional Class and RSL Group. This chart shows the percentage of highway miles for each functional classification that exists in each RSL group.



Corridor Profile. This chart depicts the overall RSL profile for a continuous corridor by virtual milepost and shows the pavement types of each sample section.



Average RSL by Pavement Type. This chart show the weighted average RSL disaggregated for rigid, flexible, and composite pavements and the overall average RSL.

Non-HPMS Data Mapping

You can import highway data directly from a non-HPMS data source using a one-to-one field map to control how the data is loaded. Data can be read from an Access database, a flat comma-delimited file, a dBase file, or any predefined ODBC connected data source.

To activate the import wizard, click the **Open Non-HPMS** button on the **Settings** toolbar. The window shown in Figure 30 will appear. This first tab allows you to select the data source to read the highway data.

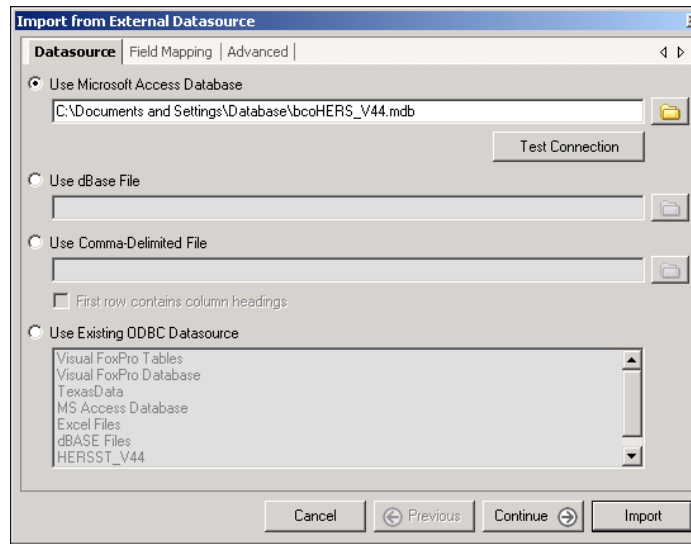


Figure 30. Import Wizard – Datasource

The next tab, shown in Figure 31, allows you to select the source table and define a one-to-one field map between the data fields in the source table and those of the PHT data table. For each PHT field, select a matching field that provides the data. You can also directly enter a hard-coded value or choose to leave a field blank if the source table has no matching item. The mapped field must have a compatible data type with the PHT field.

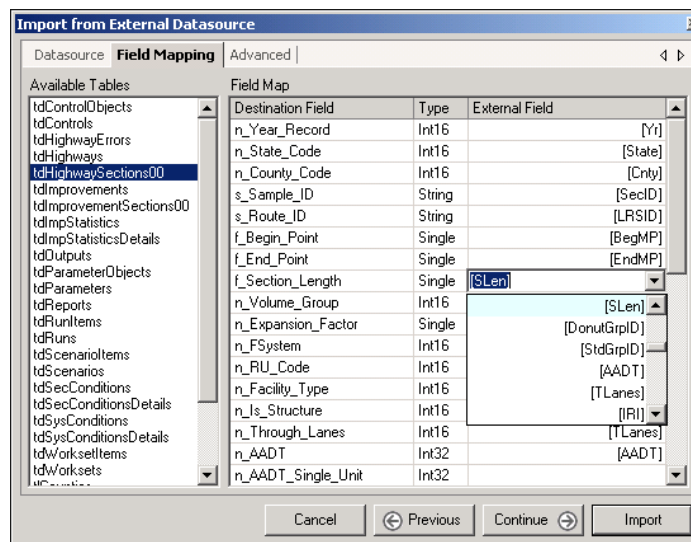


Figure 31. Import Wizard – Field Map

The final tab, shown in Figure 32, provides an advanced option to filter the records in the source table prior to importing the data to the PHT table. This is useful if you only want to read a sub-set of the records that are in the source table. Use the filter wizard to create the SQL clause to filter the data, or use the SQL Text window to enter the filter clause directly.

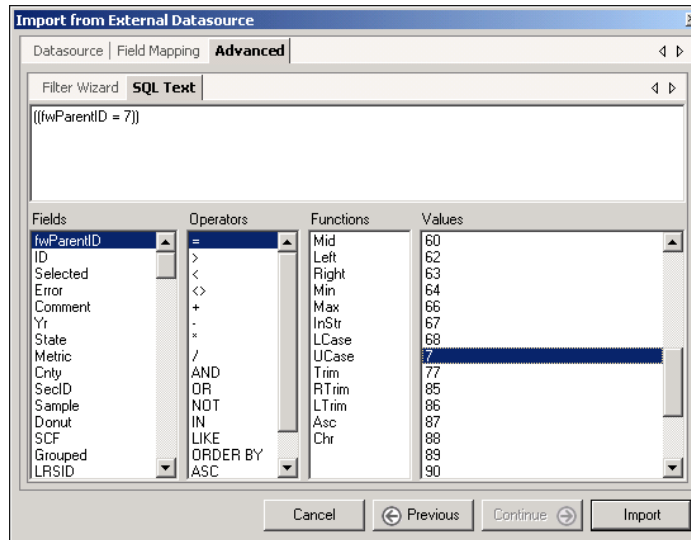
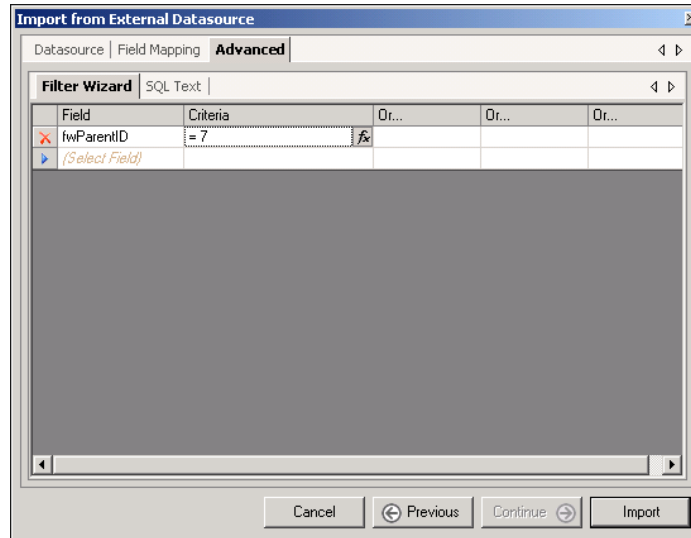


Figure 32. Import Wizard – Advanced Filtering

Technical Information

The PHT analysis engine quantifies the Remaining Service Life (RSL) of the pavement for each highway section using the simplified Mechanistic Empirical Pavement Design Guide (MEPDG) based pavement performance prediction models. The PHT analysis engine receives highway data and parameter metrics and determines the pavement RSL in accordance with its implementation process presented in Figure 33.

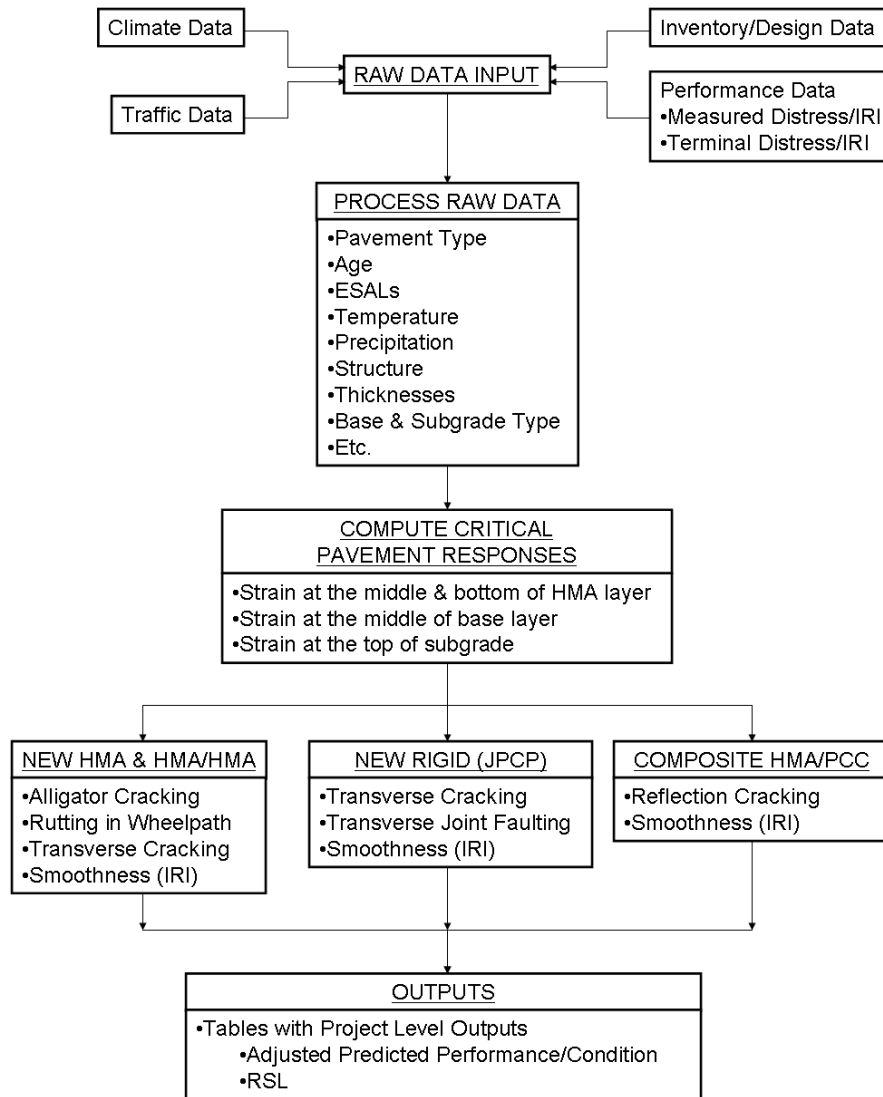


Figure 33. RSL Forecasting Process

PHT Data Schema

The PHT source data derived from HPMS 2010 are listed in Table 6.

Table 6. PHT Data Fields

n_ID	integer	Unique record identifier.
n_Year_Record	integer	Year of record.
n_State_Code	integer	State FIPS code.
n_County_Code	integer	County FIPS code.
s_Sample_ID	text	Unique sample identifier.
s_Route_ID	text	Route identifier.
f_Begin_Point	single	Beginning milepost.
f_End_Point	single	Ending milepost.
f_Section_Length	single	Overall section length.
n_Volume_Group	integer	The AADT volume group for the facility.
n_Expansion_Factor	single	Factor to expand sample data to represent the universe data.
n_FSystem	integer	The FHWA approved functional system classification.
n_RU_Code	integer	Rural/Urban code
n_Facility_Type	integer	Operational characteristics of the roadway.
n_Is_Structure	integer	Section is completely on a structure, tunnel, or causeway.
n_Through_Lanes	integer	Number of lanes of the entire facility.
n_AADT	integer	Annual average daily traffic.
n_AADT_Single_Unit	integer	AADT for single unit trucks.
n_AADT_Combination	integer	AADT for combination trucks.
n_Future_AADT	integer	Forecasted AADT.
n_Future_AADT_Year	integer	Year of forecasted AADT.
f_Lane_Width	single	Measure of existing lane width.
n_Shoulder_Type	integer	Type of existing shoulder.
n_Speed_Limit	integer	Posted speed limit.
n_Climate_Zone	integer	Climate zone for the facility.
n_Surface_Type	integer	Surface type of the facility.
n_Year_Last_Improved	integer	Year in which the roadway surface was last improved.
n_Year_Last_Construction	integer	Year the facility was last improved.
f_Last_Overlay_Thickness	single	Thickness of the most recent pavement overlay.
f_Thickness_Rigid	single	Thickness of the rigid pavement.
f_Thickness_Flexible	single	Thickness of the flexible pavement.
n_Base_Type	integer	The base pavement type.
f_Base_Thickness	single	Thickness of the base pavement.
n_Soil_Type	integer	Soil class type.
f_IRI	single	International roughness index.
f_Cracking_Fatigue	single	Estimate of total area or slabs with fatigue cracking.
f_Cracking_Transverse	single	Estimate of total feet/mile of transverse cracking.
f_Rutting	single	Estimate of average rutting.
f_Faulting	single	Estimate of average vertical displacement between adjacent slabs.
f_PSR	single	Present serviceability rating.

Data Aggregations

The PHT tool classifies pavement types as Rigid, Flexible, and Composite. The aggregation of the standard HPMS 2010 surface types into these three classifications is shown in Table 7.

Table 7. Surface Type Classifications

Classification	RSL Analysis	HPMS Code	Description
none	No	0	Not Reported
none	No	1	Unpaved
Flexible	Yes	2	Bituminous
Rigid	Yes	3	JPCP – Jointed Plain Concrete Pavement
Rigid	No	4	JRCP – Jointed Reinforced Concrete Pavement
Rigid	No	5	CRCP – Continuously Reinforced Concrete Pavement
Flexible	Yes	6	Asphalt-Concrete (AC) Overlay over Existing AC Pavement
Composite	Yes	7	AC Overlay over Existing Jointed Concrete Pavement
Composite	No	8	AC (Bi Overlay over Existing CRCP)
Rigid	No	9	Unbounded Jointed Concrete Overlay on PCC Pavements
Rigid	No	10	Unbounded CRCP Overlay on PCC Pavements
Rigid	No	11	Bonded PCC Overlays on PCC Pavements
none	No	12	Other

The PHT tool aggregates the standard HPMS 2010 functional classifications for highway sections into three categories of Interstate, Primary, and Secondary roadways as shown in Table 8.

Table 8. Functional System Classifications

Classification	HPMS Code	Description
Interstate	1	Interstate
Interstate	2	Principal Arterial – Other Freeways and Expressways
Interstate	3	Principal Arterial – Other
Primary	4	Minor Arterial
Primary	5	Major Collector
Secondary	6	Minor Collector
Secondary	7	Local

Parameter Metrics

The following tables describe the default values for the parameter metrics used by the PHT analysis tool including the terminal thresholds, maximum service life, and default pavement estimates. You may modify any of these values as needed.

Table 9. Default Terminal Values

Surface Type	Functional System	IRI	Cracking			Rutting	Faulting
			Fatigue	Transverse	Reflection		
Rigid	Interstate	170		10 %			0.15 in.
	Primary	220		15 %			0.20 in.
	Secondary	220		20 %			0.20 in.
Flexible	Interstate	170	20 %	640 ft/mi		0.40 in.	
	Primary	220	45 %	800 ft/mi		0.60 in.	
	Secondary	220	45 %	1270 ft/mi		0.80 in.	
Composite	Interstate	170			100 ft/mi		
	Primary	220			60 ft/mi		
	Secondary	220			60 ft/mi		

Table 10. Default Maximum Service Life

Treatment Type	Years
New HMA	20
New PCC	30
Thick AC Overlay of AC Pavement	10
Thin AC Overlay of AC Pavement	6
Thick AC Overlay of PCC Pavement	10
Unbonded PCC Overlay of PCC Pavement	25
Bonded PCC Overlay of PXX Pavement	15
Thin AC Overlay of AC/PCC Pavement	6

Table 11. Default Pavement Estimates (All Functional Systems)

Pavement Estimate Category	State System	
	On	Off
Last overlay Thickness	3 in.	3 in.
Rigid Pavement Thickness	10 in.	10 in.
Flexible Pavement Thickness	8 in.	8 in.
Base Type	Granular	Granular
Base Thickness	4 in.	4 in.
Binder Type	AC-40 to AC-49	AC-40 to AC-49
Dowel Bar	Typically used	Typically used
Joint Space	20 feet	20 feet

HPMS 2010 File Format

The following table describes the data fields for the Comma Separated Variable (CSV) file for the HPMS2010 formatted data that is used by the PHT analysis tool. This format is taken from the HPMS reassessment 2010 Data Specifications document, September 2008, paragraph 3.2.2.2, with three additional data fields (highlighted in bold) inserted as needed by the PHT analysis tool. Data fields shown in gray are not used in the analysis.

Table 12. PHT Data Fields.

Year_Record	Pct_Peak_Combination	Pct_Pass_Sight
State_Code	K_Factor	IRI
County_Code	Dir_Factor	PSR
Sample_ID	Future_AADT	Surface_Type
Route_ID	Future_AADT_Year	Rutting
Begin_Point	Type_Signal	Faulting
End_Point	Pct_Green_Time	Cracking_Fatigue
Section_Length	Number_Signals	Cracking_Transverse
F_System	Stop_Signs	Year_Last_Improv
Rural_Urban_Code	At_Grade_Other	Year_Last_Construction
Urban_Code	Lane_Width	Last_Overlay_Thickness
Facility_Type	Median_Type	Thickness_Rigid
Is_Structure	Median_Width	Thickness_Flexible
Access_Control	Shoulder_Type	Base_Type
Ownership	Shoulder_Width_R	Base_Thickness
Through_Lanes	Shoulder_Width_L	Climate_Zone
HOV_Type	Peak_Parking	Soil_Type
HOV_Lanes	Widening_Obstacle	NHS
Peak_Lanes	Widening_Potential	Future_Facility
Counter_Peak_Lanes	Curves_A	STRAHNET
Turn_Lanes_R	Curves_B	Truck_Net
Turn_Lanes_L	Curves_C	VSF
Speed_Limit	Curves_D	Capacity
Toll	Curves_E	Design_Speed
Toll_Type	Curves_F	Vertical_Alignment
Route_Number	Terrain_Type	Horizontal_Alignment
Route_Signing	Grades_A	Volume_Group
Route_Qualifier	Grades_B	Expansion_Factor
AADT	Grades_C	
AADT_Single	Grades_D	
Pct_Peak_Single	Grades_E	
AADT_Combination	Grades_F	