LTAP
LOCAL TECHNICAL ASSISTANCE PROGRAM

INDIANA LOCAL ROADS

An Asset Management Guide for Cities, Towns and Counties

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PURDUE UNIVERSITY

This Guide was developed for the Indiana LTAP by

Applied Pavement Technology, Inc.
115 West Main Street Suite 400
Urbana, Illinois 61801

(217) 398-3977

www. appliedpavement.com

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CHAPTER 1

An Introduction to Asset Management

INTRODUCTION

City, town, and county agencies in Indiana are responsible for taking care of their roads and bridges so people and goods travel safely within the community and across the state. This is not an easy job. There isn't enough money to fix everything so it's an ongoing struggle to keep up with the deterioration that takes place each year.

One way to tackle these challenges is to use asset management for preserving the road and bridge network. While asset management won't solve all your problems, it will help you establish a structured format for making decisions about which roads to fix and better prepare you for questions from stakeholders about how much money you need.

This Guide introduces you to asset management and outlines the five steps involved in developing an effective asset management plan. The Guide was developed by the Indiana Local Technical Assistance Program (LTAP) as a resource to help you better manage your pavements and bridges.

WHAT IS ASSET MANAGEMENT?

Although there are a lot of definitions for asset management, we like the definition used in Michigan, which defines it as:

> ***An ongoing process of maintaining, upgrading, and operating physical assets cost-effectively, based on a continuous physical inventory and condition assessment.***[1]

This definition captures several important points. First, it recognizes that taking care of assets is an

1 Michigan Public Act 499 of 2002, Section 9(a)(1)(a)

ongoing responsibility that must be managed. Second, it points out the importance of making the best choices possible when it comes to taking care of the network so resources are used as cost-effectively as possible. Finally, it stresses the importance of having current information about your assets—such as inventory and condition information—to help you make good decisions.

Asset management provides you with a process for making decisions that helps identify the best possible level of service you can provide for the funding you have available. As shown in figure 1-1, asset management helps balance your agency's goals as the "owner" of the network with effective management strategies that demonstrate that you are being a good steward of public funds.

Figure 1–1. Balancing agency goals through asset management

KEY ASSET MANAGEMENT CONCEPTS

Asset management supports decisions that are:

- ***Driven by Policy*** This means that your infrastructure budget is spent on items that help achieve the agency's goals and objectives. If you don't know what you are trying to achieve, it makes it difficult to decide what priorities to fund.
- ***Based on Performance*** The agency's goals and objectives drive daily decisions about where to spend maintenance and rehabilitation money.
- ***Founded on Life Cycle Needs*** Different treatment choices are considered over the life of an asset to keep the annual cost of maintaining the system as low as possible.
- ***Supported by Data*** Agencies use reliable information about asset inventory and conditions to make decisions about what projects should be funded.
- ***Defensible*** Since every need can't be addressed, it is important to have a reliable process for selecting projects that can be explained and supports the agency goals.

A key to asset management success is recognizing that it is much more cost-effective to do regular maintenance on an asset than to let it deteriorate to the point where only expensive repairs, like rehabilitation or reconstruction, can address the problem. In asset management, this is called the use of a "mix of fixes" rather than a "worst-first" strategy. These concepts are illustrated in the figure 1-2. When a "worst-first" strategy is used, an expensive repair is needed to bring the asset back up to good condition at the end of its service life. When a "mix of fixes" is used, low cost treatments are

Figure 1–2. Different approaches to managing assets

applied while the asset is still in relatively good condition. These preservation treatments slow down the rate at which assets deteriorate and so the asset lasts longer. When you compare the cost of these two strategies, it is *always* less expensive on an annual basis to use a "mix of fixes" than a "worst-first" strategy. A "mix of fixes" strategy allocates some money to assets that are still in relatively good condition to slow the rate of deterioration as well as money to assets that have deteriorated. The right mix of fixes depends on the condition of the assets and the amount of funding available.

The use of preservation treatments in your "mix of fixes" strategy is no different than how you manage other items you own, such as your car or truck. In order to keep your vehicle in peak condition and prevent major repair bills, you probably perform low-cost maintenance activities, such as oil changes and tire rotations, on a regular basis. If you didn't, there's a good chance your vehicle wouldn't last as long as you had hoped and your repair bills would likely be much higher than what you would have spent on routine maintenance activities. This is illustrated in figure 1-3. We understand these concepts when applied to our personal assets (like our car or truck), but they aren't always carried

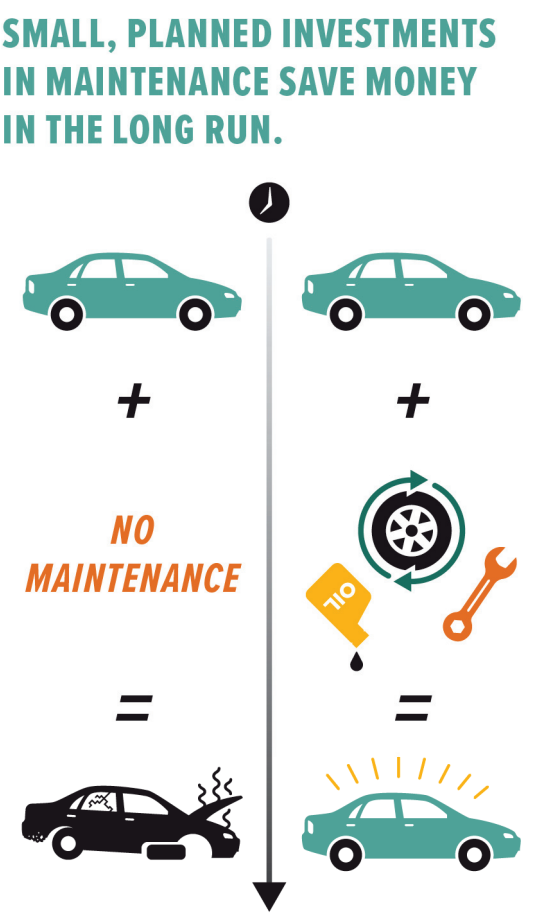


Figure 1–3. Importance of asset maintenance

over into the way we manage infrastructure assets. Asset management helps agencies understand these same concepts that are used to take care of our vehicles and homes should also be used to manage infrastructure assets.

There are many tools that help agencies decide what "mix of fixes" would best help them achieve their goals. For pavements, many transportation agencies have implemented pavement management systems to store pavement inventory and condition information, predict future conditions, and evaluate different combinations of projects and treatments to decide the best use of available funds. For bridges, bridge management programs are available to perform many of the same types of analyses. Predicted budget and work needs from pavement and bridge management systems provide valuable input to the asset management process, allowing an agency to make informed decisions across asset classes based on agency goals and objectives. Simpler approaches to managing pavements and bridges can also be used, as described in this document.

The concepts of asset management are used worldwide for managing all kinds of infrastructure assets in the transportation, water/wastewater, and utility sectors. This Guide limits the discussion to transportation assets, specifically pavements and bridges, but the same concepts could be used to manage sidewalks, signals, signs, culverts, and other infrastructure assets. Because of the focus on infrastructure assets, the Guide frequently uses the term Transportation Asset Management, or TAM, to reflect the focus on a specialized application of asset management.

WHY IS TAM IMPORTANT?

There is no question that the roads and bridges you manage are important to the economic well-being of your community. For most local agencies, roads and bridges represent the most significant investment of all the transportation infrastructure you manage. Because of this level of investment, it is important that transportation agencies do the best job they can to protect the value of its transportation assets through the use of sound asset management principles.

Although most people would agree that it is important to manage roads and bridges effectively, it can be a challenge to do so because of funding pressures, increased demand on the system, and an aging infrastructure. There never seems to be enough money to do what needs to be done and deteriorating conditions are an unfortunate consequence of that situation. When operating in that type of environment, it can be hard to see the reason for considering TAM as a worthwhile investment of agency resources.

In reality, asset management provides the most benefit to agencies that are facing these challenges to help make sure you get the best possible return for each dollar you invest in you network. It makes financial sense to manage your roads and bridges the same way you manage your vehicles and your home. Even agencies with a large part of its network in poor condition can take steps towards implementing an asset management strategy gradually. By investing a portion of each year's budget in low-cost treatments that preserve the portion of the network currently in good condition, you can actually begin to slow their rate of deterioration. The rest of your budget can be used to attack the portion of the network that needs more substantial improvements. Your asset management plan is a way for you to educate your community about your strategy

for managing the network and the level of service they can expect. The plan also helps you communicate to your elected officials the additional funding needed to take care of the road and bridge repairs that aren't being addressed at current funding levels.

Because of the importance of taking care of the local roads and bridges, the Indiana Legislature promotes the development of asset management plans for pavements and bridges managed by the cities, counties, towns, and townships within the state of Indiana. The plans are important for several reasons. For local agencies, the plans allow for additional funding for taking care of your roads and bridges. The plan information is also important from a State perspective because it provides the Indiana Legislature with valuable data to better determine current conditions and determine future statewide needs for local road and bridge funding.

REASONS TO USE TAM

Asset management enables your agency to improve the cost-effectiveness of your decisions and better communicate the impacts of available funding on road and bridge conditions. Because decisions are data driven, an asset management plan helps improve the agency's credibility with the public and elected officials and demonstrates an agency is accountable for its decisions.

Several specific benefits that an agency may realize are:

- Getting better value for each dollar invested in roads and bridges.
- Improving network conditions, even under constrained funding, by taking care of assets before they fall into poor condition.
- Making more informed, strategic decisions about how to invest available funding that are based on data.
- Being better able to communicate funding needs with agency officials, the public, and elected officials.

PURPOSE AND ORGANIZATION OF THE GUIDE

This Guide is designed to serve as a resource to agencies adopting an asset management philosophy. It presents an asset management process that can be used by any local agency in Indiana. It also introduces common terminology and helpful hints to get you started. The Guide promotes a statewide approach to gather and analyze the information you need to develop an asset management plan.

You can use this Guide to:

- Learn more about what asset management is.
- Identify the steps involved with implementing asset management.
- Discover ways to use data to better communicate with elected officials.
- Develop an effective asset management plan.

The focus of this Guide is on Transportation Asset Management, but the same concepts can be applied to other assets that your agency manages, such as sewers and water treatment plants.

The Guide is organized into seven chapters, each of which addresses an important step in developing a robust asset management process. The information contained in the seven chapters is summarized below.

- ***Chapter 1: An Introduction to Asset Management*** This chapter introduces asset management and why it is important.
- ***Chapter 2: Key Components of a TAM Process*** This chapter introduces the key components of a transportation asset management process and explains how agencies can follow the process without significant resource requirements.
- ***Chapter 3: Building an Asset Inventory*** The first step in the TAM process involves developing an asset inventory. This chapter explains what information is needed and how the data can be managed.
- ***Chapter 4: Rating Asset Conditions*** Asset needs are based on objective assessments of condition, so this chapter introduces methods of rating pavement and bridge conditions.
- ***Chapter 5: Using Information to Manage Assets*** This chapter illustrates how the inventory and condition information can be used to manage roads and bridges.
- ***Chapter 6: Developing a Cost-Effective Program*** This chapter introduces methods of selecting projects and cost-effective treatments.
- ***Chapter 7: Reporting Results and Developing the Plan*** The final chapter provides examples of how pavement and bridge information can be presented and used to develop an asset management plan.

The Guide also includes three appendices. Appendix A includes typical treatments for road and bridge needs. Appendix B includes the template for developing a pavement asset management plan, and Appendix C includes the template for developing a bridge asset management plan. ■

CHAPTER 2

Key Components of a TAM Process

THE TAM PROCESS

The Guide introduces a 5-step process to implementing TAM and using the information effectively. Within each step, there are choices you can make regarding the complexity of the data you collect and the types of analyses that can be conducted. The Guide focuses primarily on the basic steps involved in setting up an asset management program, but introduces additional steps you can take if you are interested in building a more mature program over time.

The five steps to implementing a TAM process are shown in figure 2-1.

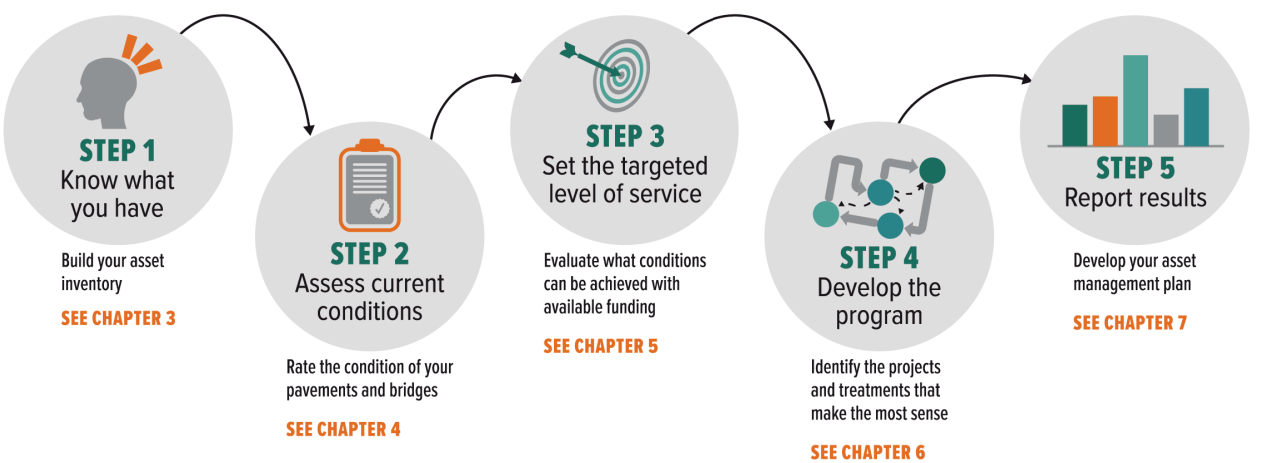


Figure 2-1. The steps in the TAM process. © 2017 Applied Pavement Technology, Inc.

The Guide explains each of these steps in more detail in chapters 3 through 7.

DIFFERENT APPROACHES TO IMPLEMENTATION

Any agency can begin implementation of an asset management process with basic inventory and condition information stored in a spreadsheet, database, or Geographic Information System (GIS). There are also more sophisticated computer programs available that can be used to predict future conditions and analyze the cost-effectiveness of different treatment options over an analysis period. These programs are known as pavement and bridge management systems.

Pavement and bridge management systems can be either public domain or proprietary software programs. A public domain system is usually developed by a governmental or educational organization, and is provided to local agencies at a very low cost. The software programs are fairly easy to use but there are limited opportunities to configure the program to your specific needs. A proprietary system is typically developed by private industry. These systems are usually more expensive than public domain programs, but the analysis capabilities and configurability of the software are better. Some characteristics associated with each of the common approaches to managing TAM data are described in figure 2-2.[2]

The implementation of TAM should not be entirely new since most agencies have some knowledge of the number of road miles or bridges they manage. The difference for most agencies is the development of a more formal process that helps ensure that data is kept current and a "mix of fixes" is used to get the best results from available funding. Asset management often involves a more strategic view of system needs to help ensure that the agency is investing in projects that make sense from a long-term perspective.

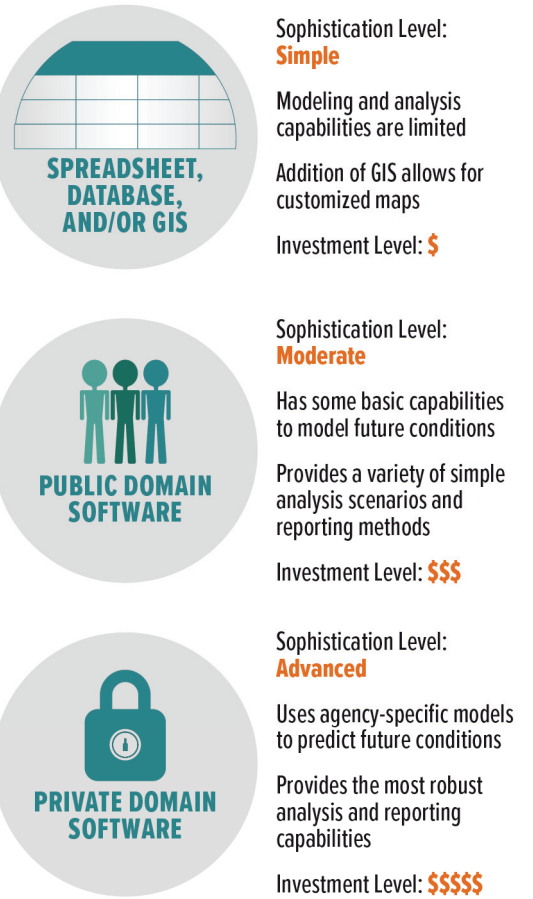


Figure 2-2. Characteristics of each approach to managing TAM data. © 2017 Applied Pavement Technology, Inc.

Another change that often accompanies a TAM implementation is a shift towards a "network" rather than a "project" perspective when selecting projects and

2 Illinois Center for Transportation. 2011. Implementing Pavement Management Systems for Local Agencies. https://apps.ict.illinois.edu/projects/getfile.asp?id=3059

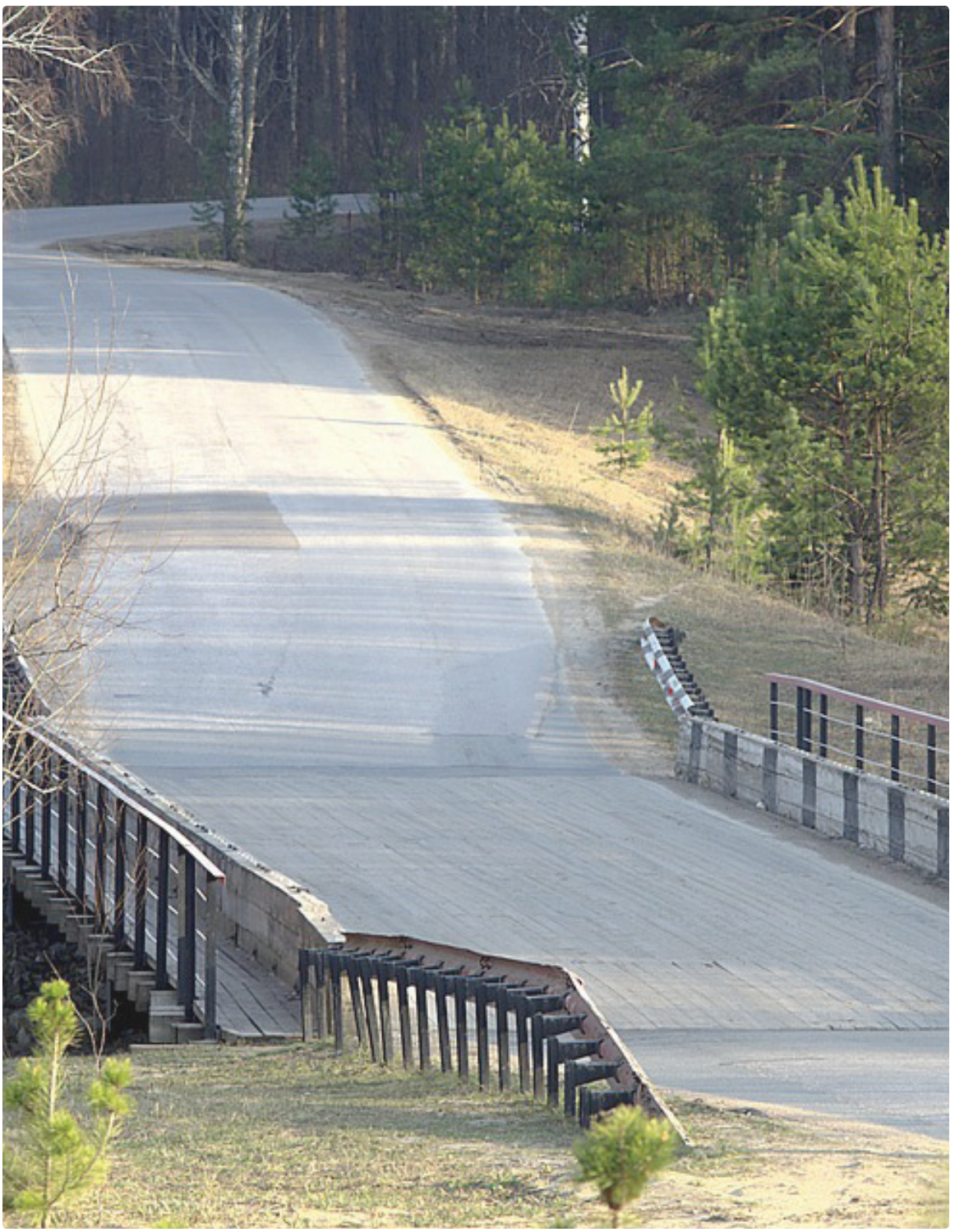
treatments. Agencies with strong asset management processes recognize that the best investment for the entire network is different than making the best investment for each individual project. For example, it might be better for the system to mill and overlay several miles of roads rather than reconstruct one road. This shift in perspectives is often one of the most difficult aspects of the implementation process.

For these reasons, it is important to recognize that the implementation of a TAM process is more than just collecting information and putting it into a database. In most instances, the implementation of asset management leads to changes in existing practices and training of agency personnel to change the organizational culture. Therefore, in addition to allocating resources for the data and systems needed to support asset management, agencies should also consider allocating resources to align business processes with the new way of doing business and to build buy-in among agency staff.

SIGNS OF A SUCCESSFUL IMPLEMENTATION

Regardless of whether you are using a simple program or have access to a sophisticated pavement or bridge management program, there are several signs that indicate your program is successful. These signs include the following:

- Condition information is being used to select projects and treatments.
- Your program includes a mix of fixes, with a portion of the budget going to preserve pavements and bridges that are still in relatively good condition to slow the rate of deterioration.
- You have confidence in your ability to share information on current and projected levels of service and funding needs.
- Your agency recognizes that pavements and assets are valuable assets that are worth preserving. ■



CHAPTER 3

Building an Asset Inventory

INTRODUCTION

The first step in developing a TAM process is to identify the assets you manage. The inventory can include any or all of the assets you manage, but agencies usually begin by focusing on the assets that they spend the most on or are most important from a safety perspective. Because pavement and bridge repairs typically represent the most significant portion of an agency's public works budget, most agencies build their pavement and bridge inventories first. Once those inventories are established, they may begin building other asset inventories for other assets, such as signs, signals, or culverts.

Deciding What Information to Include

This chapter describes the basic inventory information that should be collected to manage pavements and bridges separately. As you're developing your inventory, keep in mind that you need to be able to keep your inventory current at all times, so try to avoid collecting information that is either difficult to maintain or not useful in making project and treatment decisions. It is better to do a good job maintaining a small amount of useful information than having a comprehensive inventory that's out of date within a year.

The following questions will help you identify the basic information that should be included in your inventory.

- ***What type of asset is it?*** For instance, is it a bridge, a pavement, or something else?
- ***How is this asset identified?*** It is important to track data by road segment or bridge, so each item needs its own unique identifier. For roads, the common name of the road may be used and the section limits may be defined by intersections or distance from a reference point. For bridges, a location reference or bridge number is often used.
- ***Where is it located?*** It is important to be able to have some way of locating the asset in the field, whether it's through a common reference point (such as an intersection) or an exact

location using Global Positioning System (GPS) coordinates.

- ***Who is responsible for it?*** In some cases, assets may be managed by another agency. For example, bridge inventory and condition information is managed at the state level rather than the local level.
- ***What are the asset's dimensions?*** The dimensions provide you information that allows you to estimate the amount of repair work that is needed so you can calculate project costs.
- ***What is the asset made of?*** This will help you determine the rate of deterioration and the type of repairs that might be needed.
- ***When was the asset built or last repaired?*** This information will help you estimate the asset's age, which may be an important indication of when repairs might be needed.
- ***How is the asset used?*** This information can be useful for determining the rate of deterioration or for setting repair priorities. For example, a road that serves as a city bus route will probably deteriorate faster than a road that is used primarily by cars.

More information about storing and managing inventory information is provided at the end of this chapter.

BUILDING A PAVEMENT INVENTORY

The following list includes the basic information that should be added to your pavement inventory and your pavement asset management plan.

- The most commonly used road or street name.
- From and to identifiers that indicate the beginning and end of the road section being considered. One road may have several sections over its entire length. Each section may represent a block in a city, or may represent the typical length of a resurfacing project on a county road.
- A unique identification number or name. For instance, the first block on Green Street might be referred to as GreenST01 and the second block might be GreenST02.
- The length and width of the pavement section. When measuring the road width, agencies generally include shoulders in the calculation if they would repair the shoulders at the same time they would repair the driving surface. It may be important to know how many drive lanes there are, especially if you might decide to repair one lane but not the other.
- The visible surface type. At the most basic level, it is important to distinguish paved roads as either asphalt or concrete pavements. If possible, it's helpful to know if the asphalt is on top of a concrete road (in which case it would be called a composite pavement) or whether a chip seal has been applied. Brick, gravel, and unpaved surfaces should also be identified as separate surface types.
- The functional classification or Average Daily Traffic (ADT) counts. Traffic information is important because it impacts the rate at which the road deteriorates and it might be used to determine which projects will be funded. For instance, if there are two roads with the exact same condition, the one serving the higher traffic volumes would probably be repaired before the other

one. However, since most agencies don't have good traffic counts available, they use the road functional classification as a substitute for traffic data. The idea is that a primary road would have higher traffic volumes than a collector or residential road. This doesn't always hold true, but it works well enough to be an acceptable substitution for traffic volumes.

The Fulton County Pavement Asset Management Plan includes a summary of centerline miles and length (in feet) by functional class (Primary, Secondary, and Residential) as well as by surface type (asphalt, pug mix, chip seal, gravel, and concrete).

Other Useful Pavement Inventory Information

Although not required for developing a pavement asset management plan, there may be other useful pavement-related information that is included in your inventory. Some of the common types of additional information that might be considered are discussed next.

In addition to the basic inventory information previously discussed, Hendricks County includes subdivision names and Ripley County includes the district number in its pavement inventory.

Age or Last Major Construction Date

The age of a pavement, or the last date that major work was performed, gives an idea of when the next repairs will be needed or when the road might need to be replaced. This information is more important if you are developing deterioration models to predict future conditions. Combining pavement age with pavement condition information can determine whether you are getting the level of service expected from each treatment. For instance, if an overlay was designed to last 10 years, but after 7 years there is little evidence of cracking, there is a good likelihood that you may get a few more years out of the pavement before repairs are needed.

It can be hard to obtain this information for an existing pavement network, but there are a few "tricks of the trade" that might be helpful if digging through records seems too difficult. You may be surprised at how much information you can get just by asking people who have worked for the agency for a long time. Their memory may be sufficient for a first cut. Your pavement condition ratings may also provide enough information to estimate pavement age. For purposes of setting up your inventory, in the absence of other information, you may estimate that roads in Excellent condition were last worked on in the past 1 to 3 years, those in *Very Good* condition are 3 to 5 years old, and so on. When you estimate pavement age in this manner, it's a good idea to use a code to alert you that the date is estimated. For instance, using a date that indicates a road was built on January 1ST of any year could be code that indicates you are using an estimated date. Actual construction dates would show a more realistic construction date, most likely between the months of March and November.

As projects are constructed in the field, the inventory should be updated with a new construction date and surface type. Over time, the new information will replace the older records and you'll have a good record of when a road section was last addressed.

Shoulder Information

Shoulder information may be important to an agency from a safety perspective. In many instances, especially in rural locations, shoulders are not built to current design standards. Therefore, having this information in the inventory allows an agency to recognize when shoulder work will need to be added to the cost of a pavement rehabilitation project.

Very little information about shoulders needs to be included in the inventory. At the most basic level, an agency might include a) whether a shoulder is present, b) the width of the shoulder, and c) the material used to construct the shoulder, especially if it's different from the road surface.

Drainage Features (Including Curb and Gutters)

Drainage features play a significant role in removing water from a road and preventing it from damaging underlying layers. Roads with drainage features that are working as expected will typically last longer than a road that has poor drainage characteristics. The presence of drainage features may limit your treatment options if you have to limit the treatment thickness to maintain curb reveal. Their presence may also impact the cost of an improvement if drainage features have to be addressed as part of the project. For these reasons an agency may want to add to its inventory a) information about whether drainage features are present, b) the type of drainage feature used, c) the material used, d) the dimensions of the feature, and e) the condition of the drainage feature.

Special Notes

There may be other information that is important to include in the inventory, such as notes about whether the road has been abandoned and is no longer maintained. This type of information is especially helpful to keep the road section from showing up in a list of projects eligible for funding.

USING THE STATE BRIDGE INVENTORY

Bridges are often managed by components, or elements, since each component behaves differently and is repaired differently. Examples of bridge components include the deck, the superstructure, and the substructure. By definition, bridges include any structures that carry public roadways with a span length of 20 feet or more. For that reason, large culverts may be included in your bridge inventory.

A statewide bridge inventory, known as the Bridge Inspection Application System (BIAS), is maintained by the Indiana Department of Transportation. The BIAS database is accessible by local agencies for developing their bridge asset management plan. It is also reported to the FHWA on a regular basis to be included in the National Bridge Inventory (NBI) inventory. The most relevant information from the BIAS database will be used in developing your bridge asset management plan includes the State and NBI structure numbers, descriptive information about the type of structure (such as bridge type, number of spans, and so on), the year the structure was built, its dimensions, and the results of the bridge inspections.

As with pavements, knowing the year the bridge was constructed or reconstructed can be useful for estimating when repairs will be needed or determining the rate of deterioration. Other information, such as historic designations, traffic levels, or functional classification of the inventory route, might also be extracted from the BIAS database if that information will help you decide what type of repair is needed or whether the bridge is a high priority to your agency.

BUILDING AN INVENTORY FOR OTHER ASSETS

Since local agencies manage many transportation assets, there may be many other assets that are added to the inventory over time. Curbs and gutters, signs, street lights, small culverts, guardrail, and pavement markings are all types of assets that could be included in an asset inventory if resources are available to collect the information and keep it current over time.

Types of Inventory Information Collected

The same guidance used to identify pavement and bridge inventory items can be applied to any asset. In general, it is important to add information that addresses the questions at the beginning of the chapter. This typically leads to inventory information that:

- Identifies the type of asset.
- Provides a unique identifier.
- Links the asset to a location in the field.
- Captures relevant dimensions.
- Indicates the type of material used for its construction.

Other information that might influence the way an asset is repaired, its priority for funding, or the project cost should also be included in the inventory.

STORING AND MANAGING INVENTORY DATA

As you build your asset inventory, it is important that you consider how you will store and manage the data. There are several different options available to help you with these tasks, representing a range of costs and sophistication. Regardless of the approach used, it is important to establish protocols to ensure data integrity and security.

Some of the common approaches for storing and managing inventory data are discussed below.

Storing Inventory Data

There are several different approaches to storing inventory information, ranging from paper records to more sophisticated, computerized databases. For bridges, inventory and condition information is housed in an INDOT database that is accessible by local agencies. Therefore, the following discussion focuses primarily on storing pavement inventory data.

PAPER METHODS

The most basic approach to managing a pavement inventory involves tracking information on paper records. Some agencies use note cards for each pavement section in their network, making notations when work is completed or inspections are conducted. This approach is easy to put in place, but it requires manual intervention any time you want to analyze or summarize the results. For example, to determine the average condition of your network, you would have to manually

perform the calculation from the paper files. It is also difficult to share paper records with others.

SPREADSHEETS

A slightly more sophisticated approach is to create a spreadsheet to store inventory information. A spreadsheet is an easy way to build an inventory since most computers contain spreadsheet programs and many people are familiar with their use.

When building a spreadsheet inventory, each row typically represents a pavement section and the columns are used for entering inventory data. Columns can also be used for storing pavement condition information from each historical condition survey.

There are several advantages to using a spreadsheet to store data. In addition to its ease of use and availability, it is relatively easy to perform calculations and generate graphs with the data. Using features built into the spreadsheet tools, data can be sorted, summarized, and compared without much difficulty or training.

There are also several disadvantages to the use of spreadsheets. One disadvantage is the ease with which data can be deleted or overwritten. To protect the data in a spreadsheet, it is especially important the information is backed up regularly. Version control is another disadvantage with using spreadsheets as a database. Using a clear file labeling approach and storing files on a server are two strategies to help overcome version control issues. There are several other disadvantages, such as having limits on the number of users who can access the file concurrently and limits to the number of records that can be stored, but these may not be significant issues to a local agency.

DATABASES

A more sophisticated approach is to store the inventory data in a database created by the agency using standard database tools or in a pavement management database that is part of a pavement management system. Today, many databases are relational, linking information in separate data tables using a unique identifier for each pavement section. Databases often provide standard and customized reporting capabilities so it is easy to report and share data. They also provide better security to protect the data from corruption and they can easily be linked to other agency files.

There are also several disadvantages to storing data in a database. For instance, fewer people are familiar with setting up and using a database program, so the agency may have to rely on outside assistance to start and maintain the system. If the database is contained within a pavement management system, it may also require agency personnel to learn how to operate a new software program. If only one person is trained on the operation of the software, and that person leaves the agency, it's possible that the entire investment in the software could be lost. Therefore, agencies may have to invest more in training and cross-training to keep the system operational when a database is used to store data.

A database makes more sense than a spreadsheet when:

- Multiple spreadsheets are being created containing similar types of data.
- Changes in one spreadsheet require changes in one or more additional spreadsheets.
- Data needs to be shared with other uses.
- More than one person needs to access the data at any one time.

GIS

A GIS is a computerized database management system that allows spatial data to be sorted, managed, retrieved, analyzed, and presented in an interactive map display. Pavement inventory information can be managed in this way, with different layers used to store different types of data. The primary advantage of GIS is the accessibility of the information by other users. Its use allows you to make decisions that consider not just the pavement and bridge needs, but also other factors, such as the presence of accessibility ramps at an intersection or areas where road geometry might contribute to the number of crashes.

One disadvantage to the use of GIS as the primary pavement database is ownership. A GIS database is usually considered an agency database, so responsibility for database administration may reside out of the control of the asset manager. GIS may also require specialized expertise that may not be readily available in all agencies. While most agencies have some form of GIS layer showing their road network, they may not have staff with sufficient training in data management to be able to add, modify, or report information from a GIS database.

One other important consideration is the challenge that may arise if the GIS doesn't have the ability to manage and present several integrated data sets in a single feature, like a pavement management section. If GIS combines relevant data sets into a single table, this could result in data redundancy if new records have to be created each time attributes change. This limitation can be overcome by establishing separate attribute tables or by using a feature called dynamic segmentation.[3]

Managing Inventory Data

Pavement and bridge inventories provide important information needed in an asset management plan. You will also find the information is useful to help respond to questions about your network, such as:

- How many miles of asphalt roads do we have?
- What is the average age of our bridges?
- How many miles of residential streets do we maintain?

This section will provide suggestions for keeping your inventory current, maintaining data quality, and making data accessible.

KEEPING DATA CURRENT

Some types of inventory information change regularly and other information doesn't. It is important to classify each type of data and establish procedures for its maintenance. For example, information about a road's functional classification does not change regularly. Therefore, once it is established in the inventory, it does not need to be revisited unless a formal change is made. Other information, like the last time a bridge deck was replaced or a road was resurfaced, will change periodically. Complicating this issue further is that some of these periodic changes impact other information in the database, so those links between data elements need to be understood. For instance, if a concrete road is resurfaced with asphalt, the pavement type changes from concrete to asphalt. Defining these links is a key to keeping your inventory data current.

ADDRESSING ROAD SEGMENTATION CHANGES

One of the most challenging changes that impacts pavement inventories is deciding how to handle

3 Dynamic segmentation is the process of transforming data from multiple sets of attribute data to any portion of a linear feature.

changes in road segments from year to year. This is especially true on rural roads where pavement sections have been defined based on prior project boundaries. When those boundaries change with a new project, the agency has to decide how to handle the discrepancies in section limits and what to do with historical data.

For example, imagine a road segment that was established based on an old resurfacing project that went from point A to point B, as shown in the top portion of figure 3-1. For pavement management purposes, this section was defined as section 1. A portion of the section was resurfaced in 2016, but the project limits did not match the original section. Therefore, the condition of the newly resurfaced section will be much better than the condition of the original section that was not resurfaced. For pavement management purposes, it makes sense to split this section into two sections, based on the limits of the new resurfacing project, as shown in the bottom portion of the figure. To retain the reference to the original section, note that the new section identifiers indicate that these are subsets of section 1 (i.e., Section 1.1 and Section 1.2). This is just one approach that can be used to label new sections; there are plenty of other viable approaches that can be used. Whatever method is used, it is important that updates are done consistently and in a timely manner.

In the database, the agency should retain the historical records from the original section 1 for both of the new sections. However, new information will be added to the inventory for section 1.1 because of the new resurfacing project.

It is not always as clear cut as to when a new section should be created. In general, you do not want to establish a new pavement management section unless each section is long enough to represent a reasonable project length.

IDENTIFYING AND ADDRESSING DATA GAPS

Few agencies are able to obtain all the data needed for managing their pavements and bridges. There are several different types of data gaps that may exist, as noted below.

- ***Incomplete records*** When populating the database with certain records, it is possible there will be some instances when it is too difficult to collect a specific data element for one or more sections in the network. The last time major work

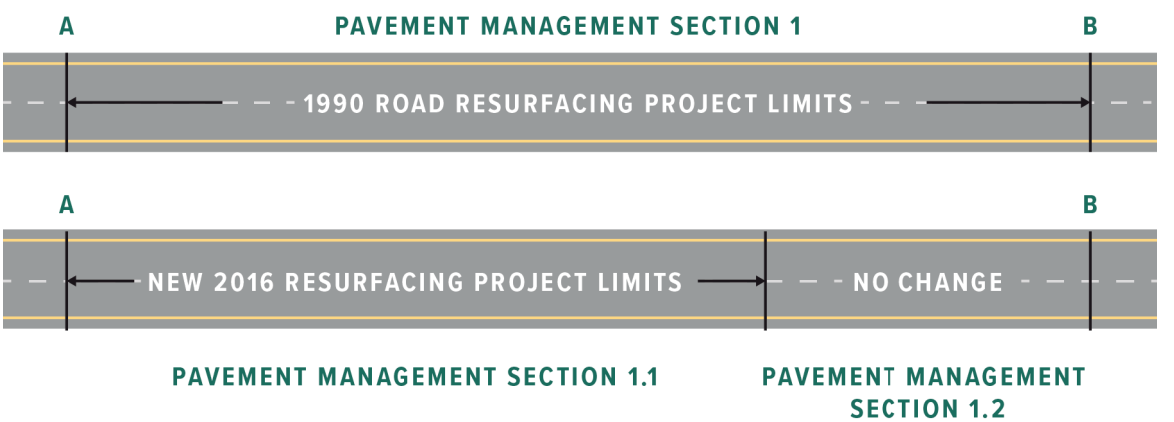


Figure 3-1. Example road segmentation change.

was performed on a bridge or road is an example of a situation where missing data may occur. The information may be known for a large part of the network, but not for every bridge or road segment. In these instances, it is important to differentiate between known work dates and "educated guesses" as to when the last work was conducted. As noted earlier, you may choose to use certain dates in your database as a code that the date is an estimate. For instance, always using January 1ST as the construction date is one way of indicating that it is an assumed construction date. In general, it is better to make an attempt at populating the entire database rather than leaving anything blank. But, where possible, use codes that let you know the information has been estimated.

- ***Desired, but uncollected data*** Over time, as you become more comfortable with your data, you will probably identify additional information to add to your inventory, but haven't collected. For instance, you may decide to have material properties or traffic data added to your inventory. When these data elements are being considered, you should think about whether your agency has the resources to collect data the first time, and whether you can keep the information current over time. You also need to think about whether there are other data elements that might be easier to collect that could be used as a substitute for what you want. Traffic data is a great example of this. To keep traffic data current, traffic counts would have to be performed regularly. This can be expensive and resource-intensive. Many agencies find that using functional classification is an acceptable substitution for traffic, with primary or arterial roads representing the highest traffic volumes and tertiary or residential roads representing lower traffic volumes. If an agency is worried about the impact of city buses on roads, it may be possible to work with the transit operator to overlay the bus routes on an agency map to identify principal routes with buses as a way to avoid regular traffic count requirements. If there are not substitutes for the data desired, first check to make sure no one else in your agency has the information you need. If not, you may have to develop procedures for obtaining the information you want to add.

Managing Data Quality

The quality of the data has a direct influence on project and treatment recommendations. If quality is suspect, an agency will have little confidence in the recommendations being made. There are two key data quality considerations, data consistency and reliability.

- ***Data Consistency*** Inventory information is usually collected by more than one person, so it is important that everyone uses the same rules for collecting and reporting data. For example, if one person identifies a street as 24TH Street and another enters it as Twenty-Fourth Street, the information will likely be stored as two different streets.
- ***Data Reliability*** The more people can rely on the accuracy of the information in your inventory, the more the information will be used with confidence. However, as you begin building your inventory, it is likely that you will occasionally have to use educated guesses or estimates to fill in some data gaps. Suggestions for addressing these types of data gaps were discussed earlier. The more you can populate your inventory with real data that is kept current, the better off you

will be. In addition, agencies should set up processes to check for routine data errors, such as missing data, data that doesn't make sense (e.g., improvements in condition without work having been performed), or data outside normal data ranges (e.g., pavement width > 30 ft on a 2-lane rural road).

Making Data Accessible

Over time you may find that inventory information could be useful to other people within your agency. To help make your data as accessible as possible, consider the following factors:

- ***Who uses the data?*** If you regularly receive requests for information about bridges or pavements, it is possible that others would benefit from the data. Ask these users about their needs to determine whether they need a report, a spreadsheet, or access to the data itself to perform their duties. It is a good idea to document users of your data so they are alerted any time there are changes to data formats and are protected should the data be deleted for any reason.
- ***Do you have geo-location data?*** Many local agencies have GIS or mapping capabilities for displaying agency data. If asset inventory and condition information is collected using spatial data, the information can easily be overlaid onto a map for display purposes.
- ***Is your inventory computerized?*** Depending on the tools you are using to store your inventory, there may be ways for users to have rights to view data or run basic reports. If you are using a spreadsheet, it is more difficult to share data because different versions of the spreadsheet may be accessed by different users. In these instances, it is a good idea to identify the "owner" of the spreadsheet tool with responsibility for maintaining the current version on an agency server. Adding password protections help to ensure the spreadsheet isn't accidentally corrupted in some way. ■

CHAPTER 4

Rating Asset Conditions

THE IMPORTANCE OF ASSET CONDITION INFORMATION

One of the most important things you need to know about assets is their condition. This information allows you to decide what repairs are needed now or estimate how long before those repairs will be needed. Asset condition information also lets you report your needs and accomplishments to agency leadership and elected officials. Condition information also supports agency accountability by allowing you to track what you were able to accomplish with the funding that was provided.

Uses of Condition Information

Asset condition information can be used in many different ways. Some of the most common ways of using information are introduced here. More details on how to use this information to manage your network are provided in chapter 5.

- ***Reporting Network Conditions*** Once you have completed a survey of pavement or bridge conditions, you can develop graphs and reports that summarize network conditions for sharing both internally and externally. When reporting asset conditions, many agencies report an average network condition for each asset and may further report conditions based on a subset of the network, such as functional classification or bridge element. Figure 4-1 illustrates the type of report that might be used for pavement conditions.

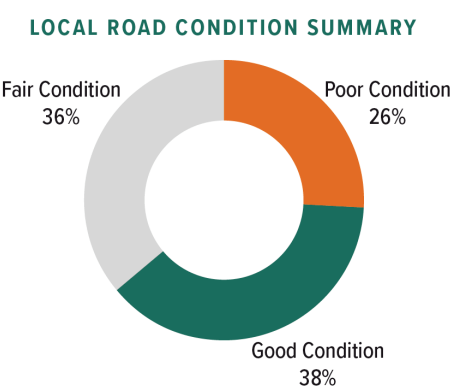


Figure 4-1. Example of a report showing pavement conditions.

- ***Setting Targets*** You can use your asset condition information to set targets for the level of service you want to provide to the public. You might refer to these targets as "desirable" or "aspirational" targets, since they are usually independent of available funding. For instance, you might decide that you want the average condition of your principal and minor arterials to be higher than a Pavement Surface Evaluation Rating (PASER) of 8. Depending on the availability of funding, you may not be able to achieve that condition. For that reason, agencies often set "constrained" or "realistic" targets to explain to elected officials and the public the level of service that they can actually achieve with the funding provided. The difference between the "desirable" and the "constrained" targets represent the "unfunded", or "performance", gap. Many agencies convert this gap to a dollar figure representing the additional funding needed to achieve desired conditions.
- ***Identifying Repairs*** Asset condition information is also used to identify the level of repair that is needed so you can select projects and treatments that match the available funding. As presented later in this chapter, the overall rating assigned to a pavement section or bridge gives you a good indication of what type of work is needed, as illustrated below.

  For paved roads (PASER scores range from 1 to 10 with a 10 representing a pavement in Excellent condition):

  - PASER ratings of 8, 9, or 10 indicate that little or no maintenance is needed.
  - PASER ratings of 5, 6, or 7 indicate that some preventive maintenance and patching might be needed.
  - PASER ratings of 4 or lower indicate that rehabilitation or reconstruction might be needed.

  For bridges (NBI ratings range from 0 to 9, with a 9 representing a bridge in *Excellent* condition):

  - NBI ratings of 8 or 9 indicate that little or no maintenance is needed.
  - NBI ratings of 5, 6, or 7 indicate that some routine or capital preventive maintenance work might be needed to restore the integrity and serviceability of the bridge.
  - NBI ratings of 4 or lower indicate that structural improvements, such as rehabilitation or replacement, are needed.
- ***Predicting Future Conditions*** After you have several years of asset condition information, you can begin to estimate rates of deterioration. These deterioration rates allow you to predict how conditions will change with time so you can plan future funding needs. The ability to predict conditions also improves the way you communicate your needs because it allows you to show what will happen in terms of your network conditions with different levels of funding. The ability to predict future conditions is not required to develop an asset management plan, but it represents a good practice to improve your asset management capabilities.

THE IMPORTANCE OF GOOD QUALITY ASSET CONDITION DATA

Because of the many ways that asset condition data is used, it is especially important that steps be taken to ensure its quality. Suggestions for good practice include the following:

- ***Train your raters*** INDOT requires that Bridge Inspection Engineers and Consultants, as well as Inspection Team Leaders, are trained and qualified to perform these duties in the state.[4] The FHWA's National Highway Institute provides formal training that must be completed for these positions. For pavements, there is no formal requirement, but the Indiana LTAP offers courses on pavement condition ratings each year throughout the state. Even though the PASER rating method is fairly easy to use, it is a good idea for everyone who will be conducting the surveys to complete the training before inspecting any roads for the first time. This training is important to ensure that ratings across the state are consistent and comparable. For that reason, it is also important that raters complete refresher courses every year or two to make sure that they are following the same instructions that others are being given.

63% of the respondents to a recent survey indicated they had attended PASER training through LTAP in the past year.

- ***Check your raters*** One way to keep your raters motivated and assure yourself that you're getting good data is to randomly select a portion of the network and have an independent, trained rater inspect the same samples. Compare any differences between the two ratings to determine whether the rater needs additional training or whether other changes are needed to improve consistency with other raters. It is a good idea to perform these checks towards the beginning of each inspection cycle so that if adjustments are needed to the way the ratings are being conducted, you can make the changes before too many surveys have been completed.
- ***Conduct reasonableness checks on the data*** Once you receive the survey results, it is a good idea to check the reasonableness of the data using simple rules. For instance, if you have several years of data, you might check to see there are no increases in condition unless some type of work has been conducted. Changes in condition that exceed the normal rate of deterioration might be a flag for validation of survey results. Another easy check is to verify that you have a rating for each bridge element and pavement section so you can see if anything was missed during the survey. These types of checks can be done very quickly in a spreadsheet to highlight possible data omissions or errors to resolve.

4 http://www.in.gov/dot/div/contracts/standards/bridge/inspector_manual/Part1.pdf

MONITORING PAVEMENT CONDITIONS

Indiana LTAP supports the use of the PASER system for determining the condition of the roads throughout the state. The PASER method was initially developed by the University of Wisconsin for use by local agencies within the State of Wisconsin. Local agencies in Michigan also use the PASER system for evaluating the condition of their roads on a statewide basis, as do other local agencies across the country. Rating manuals for using the PASER system are available at no cost through the University of Wisconsin.[5]

There are some agencies that use other methods of evaluating pavement conditions. There are many reasons why another method might be used, but most instances are due to the fact their pavement management software requires a particular method or they have been using the other approach for many years and would hate to lose their historical data. Regardless of what method is used to evaluate pavement conditions, it is important to keep the inspections current and to take whatever steps you can to ensure the quality and completeness of the data.

Methods of Evaluating Pavement Condition

There are two general approaches that are used to evaluate pavement conditions, as described below.

ORDERED STATE RATING SYSTEM

An Ordered State Rating System is a method of visual assessment that identifies distresses by type, severity, and location and assigns a prescribed condition rating according to type of distress. The NBI bridge rating system is an example of this type of rating for bridges. PASER is an example of this rating system for pavements. PASER is based on engineering principals and allows for a quick and low cost assessment of pavement conditions that can be repeated over time to measure deterioration of pavements and effectiveness of treatments. This makes PASER popular among local agencies and widely used throughout Indiana, Michigan, and Wisconsin. This type of rating system requires standardized training, quality control (QC), and quality assurance (QA) measures to make sure the quality of the data is in close compliance to the standards. There will be rating variations between inspectors, but this can be minimized with proper training, re-training, and a QA/QC program. PASER is a good rating system for local agencies for reasons mentioned here and can be used to analyze an agency network needs, but does not replace an engineering assessment in determining proper treatments.

MEASURED ASSESSMENT METHODS

Another approach to evaluate the condition of a pavement is to measure the amount of distress present and use the measurements to calculate a condition index. The Pavement Condition Index (PCI) method developed by the U.S. Army Corps of Engineers and documented in an ASTM standard[6] is a common measured assessment method for local agencies. Agencies using this methodology inspect samples that adhere to defined size requirements and record the type of distress present, the severity of each distress, and the quantity of distress. The sample results are combined to calculate a PCI for each section using a 0 to 100 scale, with 100 representing a new road. The advantages to measuring distress are that repair quantities can be estimated and the ratings are very consistent from rater to

5 https://epd.wisc.edu/tic/publication/

6 https://www.astm.org/Standards/D6433.htm

rater and year to year. The biggest disadvantage is that the ratings require more resources than a visual method, which may be prohibitive for many local agencies.

Methods of Collecting Data

Pavement condition surveys can be conducted using either manual or automated processes. Manual surveys are conducted by individuals who walk along the road or drive slowly over a pavement. They do not require any special equipment beyond traffic control devices for rater safety and can be conducted during daylight hours at the convenience of the crew. The survey results can be entered either on paper or in a handheld device, like a tablet computer. Manual surveys typically require a two or three person inspection team so one person can drive while keeping an eye on traffic and the others can conduct the rating. These surveys are fairly labor intensive and they require crews to interact with traffic, which can be a safety hazard. PASER surveys are usually conducted using manual surveys.

Figure 4–2. Illustration of automated data collection equipment © 2017 Applied Pavement Technology, Inc.

The other approach to collecting pavement condition information is to use specialized equipment that uses lasers and high-resolution cameras to capture pavement rutting and roughness, pavement surface images for distress, right-of-way images, grade and cross slope, and GPS coordinates. This type of equipment is illustrated in figure 4-2. These vehicles travel at traffic speeds, so they reduce the safety issues with traffic, but the equipment usually requires specialized contractors. The biggest advantage to the use of automated equipment is that other asset data can be collected at the same time that pavement condition data is collected. For instance, the cameras can collect images of signs, guardrails, and other assets that are visible from the travel lane. Data collected with these vans is processed in computers using automated and semi-automated techniques.

68% of the local agencies in Indiana that responded to a survey collect their PASER data themselves. 30% use a contractor and 2% have data collected by another government agency.

According to a recent survey of practice conducted among local agencies in Indiana, 57 percent of the 65 agencies indicated that they record survey information on paper. Some agencies indicated that they use several methods of recording information, so the total number of responses is more than 100 percent. These additional responses indicate that agencies also use laptops (37 percent) and handheld devices (18 percent). Several local agencies also indicated that they are moving towards the use of tablets, are developing an editable form for entering data, or use a combination of paper and Excel or Access.

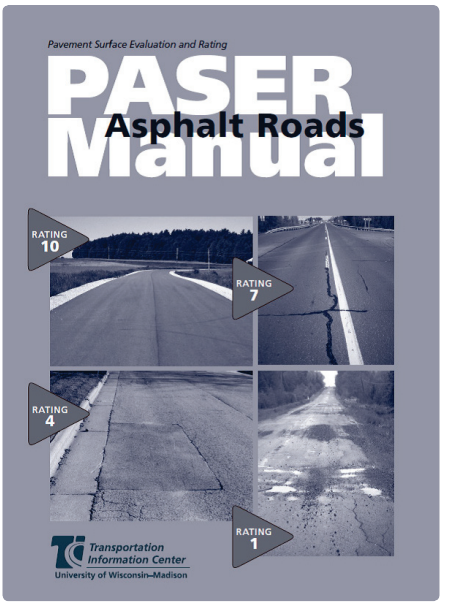


Figure 4-3. Cover of the PASER Manual for asphalt roads.

Overview of the PASER Methodology

The PASER rating methodology was developed by the University of Wisconsin for use by local agencies so they could easily evaluate the condition of their pavements to better manage their road network. The PASER rating method focuses on evaluating the condition of the pavement surface, since the types of distress that are observed provide indications of whether the deterioration is due to structural, climatic, or material properties. Understanding the differences in the types of distress that may be observed in a pavement surface is a key to using the PASER system effectively.

> ***89% of the local agencies in Indiana that responded to a recent survey are using PASER***

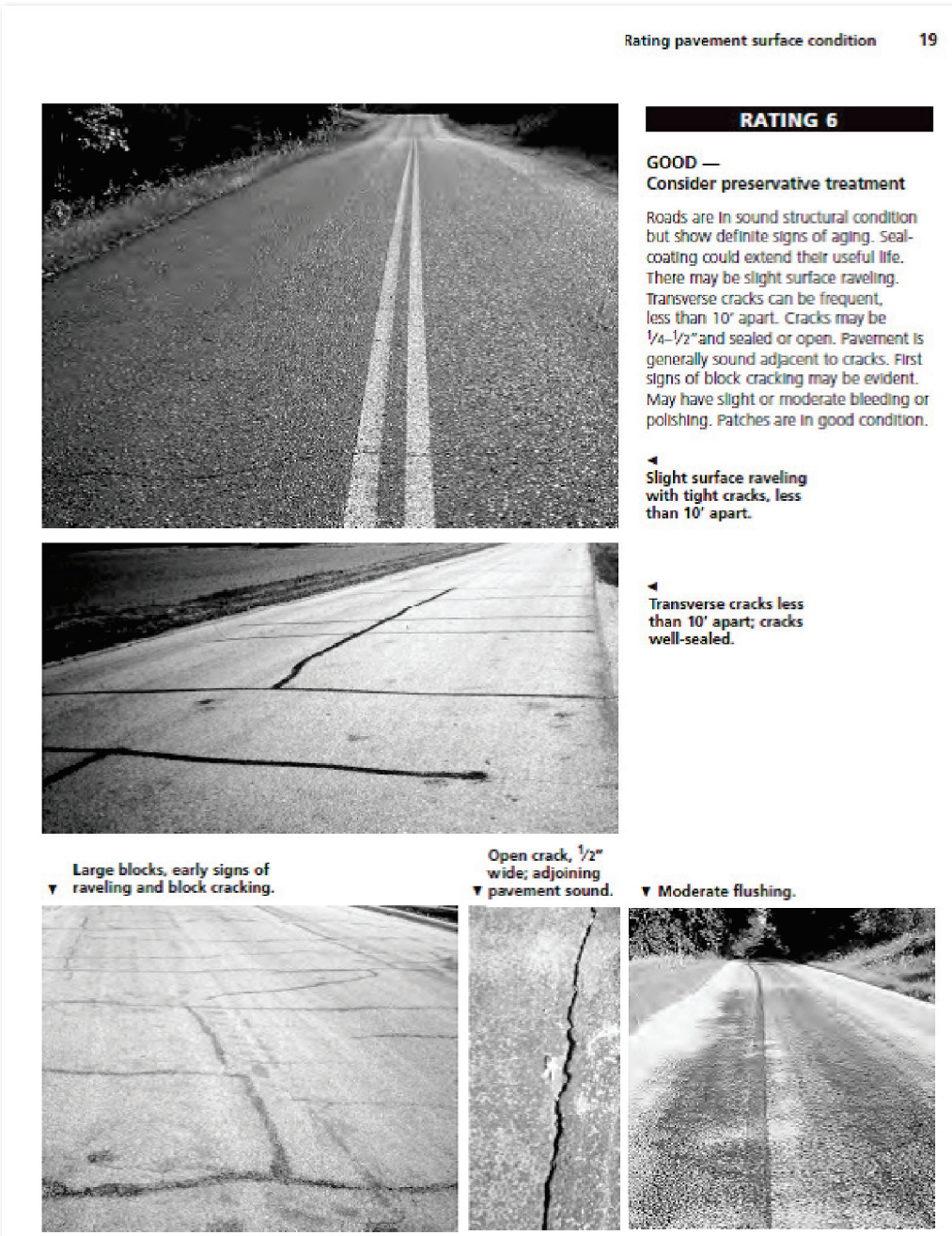
PASER manuals and rating methods are available for the following road surfaces[7]:

- Asphalt pavements.
- Concrete pavements.
- Sealcoat pavements (for gravel roads with a sealcoat surface).
- Gravel roads.
- Brick and block roads.
- Unimproved roads.

The rating system for asphalt and concrete pavements uses a 1 to 10 scale, with a 10 representing a road in *Excellent* condition and a 1 representing a *Failed* road. The sealcoat and gravel road rating methodologies each use a 5-point scale with 5 representing a road in *Excellent* condition and 1 representing a *Failed* road. The brick and block road rating method and the unimproved road rating use a 1 to 4 scale, with 4 representing a road in *Very Good* condition and a 1 representing a road in *Poor* condition.

An example page from the PASER Manual for Asphalt Roads is shown in figure 4-4. The PASER Manual introduces each type of distress common to the particular pavement surface and provides photos showing distress at different severity levels. For each numerical rating, the Manual describes the characteristics that should be found and the limits on distress that should be considered when assigning this rating to a road.

7 https://epd.wisc.edu/tic/publication/



Rating pavement surface condition 19

RATING 6

GOOD —
Consider preservative treatment

Roads are in sound structural condition but show definite signs of aging. Seal-coating could extend their useful life. There may be slight surface raveling. Transverse cracks can be frequent, less than 10' apart. Cracks may be 1/4–1/2" and sealed or open. Pavement is generally sound adjacent to cracks. First signs of block cracking may be evident. May have slight or moderate bleeding or polishing. Patches are in good condition.

◄ Slight surface raveling with tight cracks, less than 10' apart.

◄ Transverse cracks less than 10' apart; cracks well-sealed.

▼ Large blocks, early signs of raveling and block cracking.

▼ Open crack, 1/2" wide; adjoining pavement sound.

▼ Moderate flushing.

Figure 4-4. Page from the PASER Manual showing different roads with a rating of 6.

Distress Types Included in the PASER Method

The PASER method relies on a visual inspection of a pavement surface to determine the appropriate rating. The inspection is based on an evaluation of the types of distress that you observe and the amount of distress present. Understanding the different types of distress, and their causes, allows you to better identify the appropriate maintenance or repair that is needed. The first pages in each PASER manual address the different types of distress that are considered during the inspection. A summary of the key distress found on asphalt, concrete, and gravel roads is presented in table 4-1.

Table 4-1. PASER distress types for asphalt, concrete, and gravel roads.

SURFACE TYPE	DEFECT CATEGORY	DISTRESS TYPES
Asphalt	Surface Defects	Raveling, flushing, polishing
	Surface Deformation	Rutting and distortions
	Cracks	Transverse, longitudinal, reflection, block, alligator, and slippage cracks
	Patches and Potholes	Patches and potholes
Concrete	Surface Defects	Wear and polishing, map cracking, pop-outs, scaling, shallow reinforcing, and spalling
	Joints	Longitudinal and transverse joints
	Pavement Cracks	Transverse slab cracks, D-cracking, corner cracks, and meander cracks
	Pavement Deformation	Blow ups; faulting; pavement settlement or heave; utility repairs, patches, or potholes; manhole and inlet cracking; and curb or shoulder deformation
Gravel	Crown	Height and condition of crown, slope from the center of the road to the ditches
	Drainage	Lack of adequate drainage, blocked flow, collapse or damage to culverts
	Gravel Layer	Lack of adequate thickness and gravel quality
	Surface Deformation	Washboarding, potholes, and ruts
	Surface Defects	Dust and loose aggregate

When conducting a PASER inspection, it is important to evaluate the types of distress that you see on the road to assign the right rating. The manuals provide you with guidance regarding the amount of distress and distress severity that is common to each rating. You do not have to have all of the distress listed in the description for a particular rating, but you should select the rating description that best matches what you are seeing in the field. Practical advice on conducting inspections is provided in the PASER manual and is also an important part of the LTAP training on PASER conducted each year.

According to a survey of local agencies in Indiana, 62% of the respondents indicate that they intend to collect PASER data every year or every other year. 17% either hadn't determined the frequency of inspections yet or used a less frequent interval for inspections.

Frequency of PASER Inspections

It is a good idea to keep pavement condition ratings current so you know the condition of your roads at any point in time. However, it may not be practical to conduct inspections each year. For that reason, Indiana LTAP recommends that you inspect your roads every 2 years. If you don't have the resources to inspect roads that frequently, you might consider inspecting your high-volume roads, or roads with higher functional classifications, every 2 years and your lower volume roads at least every 3 to 4 years. At a minimum, you should update your asset management plan annually with the improvements made in your network and rate all roads every two years.

Links Between PASER Ratings and Levels of Repair

The product of pavement inspection is a PASER rating that gives you a good idea of the amount of deterioration present and the level of repair that is needed to remove the deterioration and improve the road condition. The PASER rating is helpful for providing local officials with general information about the level of repair that might be needed, but it doesn't replace the need for a more detailed engineering analysis to design the appropriate repair. The information can also be used to help local officials understand why one road might be addressed before another road or why a certain treatment may, or may not, be a good choice for a particular road.

Table 4-2 illustrates how PASER ratings can be used to estimate the type of repair that might be needed for developing your pavement asset management plan. The table links PASER ratings with the expected level of repair for both asphalt and concrete roads. Using this table with local cost estimates for each level of repair, you can quickly put together an estimate of your funding needs to repair your pavement network. For example, if you have 20 miles of asphalt roads with a PASER score of 5, you need approximately $2M to address all of those roads (assuming a repair cost of $100,000 per mile).

Advantages to the PASER Method

The advantages to using the PASER method rather than another method are listed below.

- ***Cost*** The PASER method is a relatively quick method of collecting pavement condition information. Raters do not need a lot of training and the surveys can be conducted whenever the inspectors are available.
- ***Repeatability*** Even though the PASER method is fast, the results are very consistent from rater to rater and year to year, as long as the guidelines provided in the manuals are followed.
- ***Statewide consistency*** In addition to having consistent ratings within your locale, the use of a single method of rating pavement conditions makes it much easier to determine local road funding needs on a statewide basis. It also allows local agencies in Indiana to share strategies for managing their roads as effectively as possible.

Table 4-2. Levels of repair for asphalt and concrete roads by PASER rating[8, 9]

PASER RATING	CONDITION	LEVEL OF REPAIR SUGGESTED	TYPICAL REPAIR COSTS (PER LANE MILE)
Asphalt Roads			
9 and 10	Excellent	No maintenance required	$0 to $3,000
8	Very Good	Little to no maintenance	
7	Good	Preventive maintenance	$5,000 to $100,000
5 and 6	Fair to Good	Non-structural preservation treatment	
3 and 4	Poor to Fair	Structural repair (e.g., overlay)	$130,000 to $500,000
1 and 2	Failed	Reconstruction	
Concrete Roads			
9 and 10	Excellent	No maintenance required	$0
7 and 8	Very Good	Routine maintenance	$1,000 to $100,000
5 and 6	Fair to Good	Preventive maintenance	
3 and 4	Poor to Fair	Rehabilitation	$130,000 to $500,000
1 and 2	Failed	Reconstruction	

8 Michigan Asset Management Council. (2011) Asset Management Plan for Pavements: A Template for End Users https://www.ctt.mtu.edu/sites/default/files/resources/PASER/localamplantemp.pdf

9 Indiana LTAP PASER Training Manuals

Keys to a Successful PASER Rating

Getting the most out of your PASER ratings requires that each rater makes a commitment to the success factors listed below.

- Raters should consider inspection sites to be a work zones so all agency rules for being in the right-of-way (ROW) should be followed. This usually means having a working warning light bar or strobe lights on the inspection vehicle, a sign indicating it is a slow moving vehicle or a vehicle that can make sudden stops, and class 2 or 3 safety vests. If you are working in an area with high traffic speeds or high traffic volumes, you may also be required to have a shadow vehicle equipped with an arrow board or a sign following the inspection vehicle. Working during off-peak hours can be helpful for reducing the interaction of the inspection crews with traffic.

- Each inspection team should consist of at least three raters, with one individual responsible for driving and the other two individuals responsible for conducting the ratings. All individuals should be aware of traffic and avoid any unsafe conditions. When conducting the survey, it's a good idea to drive over the entire segment at a low speed, looking at the types of distress that are present in the surface. The rating assigned to the section should represent the average condition of the segment, not the condition of small areas with more severe distress. It is a good idea to note on the rating form whether these isolated areas exist in a segment so your crews can be instructed to patch these areas.
- There may be a tendency for some raters to assign lower ratings to their roads in the hope that the road will be fixed sooner. To ensure the consistency of the ratings on a statewide basis, it is important that all raters resist this temptation and rate the roads in accordance with the PASER Rating Manual. One way to help ensure this kind of thing doesn't happen is to have inspectors from a neighboring agency conduct your ratings while your raters inspect their roads. This type of cooperation is a good way to improve objectivity of each agency's inspections.
- Roads should be divided into individual segments with similar construction and condition. On rural roads, the segments may be ½ mile to 1 mile in length. In urban areas, the segments will likely be 1 to 4 blocks in length. The length of each segment should be about the length of a typical rehabilitation project. Because of that, it doesn't make sense to set up individual segments that are too short. In general, changes in surface type or number of lanes are the types of factors that might prompt you start a new section. Try to avoid dividing sections based on isolated conditions, school zones, or traffic counts.
- Be sure raters know how to handle divided roads, turn lanes, or small medians so they are handled consistently.
- Other recommendations that might be helpful to your crews:
  - The PASER rating method focuses on surface distress rather than on the road's smoothness, or ride. For that reason, inspectors should also focus more on the types of distress they see than the overall ride.

- Rate the worst lane.
- If you have a pavement segment with more than one pavement type, rate the pavement type as individual segments or split the segments.
- Ignore road ownership or importance when rating road conditions. These factors will influence the priority for fixing the road, but not the condition of the road.
- If you have to rate a segment that is being constructed, rate it when the construction is finished. If a chip seal has been applied to a segment, the highest score it can receive is an "8" since it is not the same as a new pavement.
- Lighting and shade can make it difficult to see surface distress. When the sun is at your back, it lights up the cracks and hides the contrast. When you're driving into the sun, there's usually more contrast so you can see more severe cracks.
- Rate only the main lane (edge line to edge line) and not the shoulder of the road.

MONITORING THE CONDITION OF BRIDGES

The NBI has established standards for inspecting and evaluating highway bridges and each state DOT is required to conduct bridge inspections, at least every other year, in accordance with these standards. These standards are referred to as National Bridge Inspection Standards, or NBIS. In Indiana, the DOT ensures that bridge inspections are conducted on all of the bridges in the state, even those that are the responsibility of a local agency. The current and historical ratings are stored in the BIAS database that is accessible by local agencies.

Overview of NBIS Inspections

When inspecting a bridge, inspectors evaluate the entire structure and assign a numerical rating to each bridge component (e.g., deck, superstructure, and substructure) that represents the existing condition compared to its original as-built condition. The ratings range from 0 to 9, as shown in table 4-3.

RATING	DESCRIPTION
N	Not Applicable
9	Excellent Condition
8	Very Good Condition
7	Good Condition – some minor problems.
6	Satisfactory Condition – structural elements show some minor deterioration
5	Fair Condition – all primary structural elements are sound but may have minor section loss, cracking, spalling, or scour.
4	Poor Condition – advanced section loss, deterioration, spalling, or scour.
3	Serious Condition – loss of section, deterioration, spalling, or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present,
2	Critical Condition – advanced deterioration of primary structural elements. Fatigue cracks in steel or sheer cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored, closing the bridge may be necessary until corrective action is taken.
1	"Imminent" Failure Condition – major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic but corrective action may put back in light service.
0	Failed Condition – out of service or beyond corrective action.

The same ratings are used for channels, channel protection, and culverts (with a span length of 20 ft or more). Since culverts do not have components, only a single culvert rating of 0 to 9 is assigned.

In addition to the NBI ratings, inspectors determine whether a bridge is "structurally deficient" and/or "functionally obsolete." A bridge is considered to be "structurally deficient" if significant load-carrying elements are found to be in *Poor* condition or the adequacy of the waterway opening is determined to be insufficient. A bridge that receives a NBI rating of 4 or less on any of its components is defined as "structurally deficient." A bridge is considered to be "functionally obsolete" when the geometry, load carrying capacity, clearance or approach no longer meets current design criteria or standards.

Bridge inspections are conducted by trained inspectors under Indiana's State Bridge Inspection Program, which operates under the directives of the FHWA and INDOT. The inspections are typically conducted from the deck or the ground, but they may also be conducted from water-level or from permanent work platforms and walkways, if they exist.

Frequency of Bridge Inspections

INDOT generally requires routine bridge inspections on a 2-year cycle, since that is the maximum frequency required under the NBIS for publicly-owned bridges. However, bridges with ratings of 4 or less for the deck, superstructure, substructure, or culvert rating are inspected every year. Other bridges may be inspected more frequently than every 2 years if extensive deterioration or special conditions exist.

10 INDOT Asset Management for Local Public Agency Bridges, December 2015.

Consultant Reports on Bridge Conditions

The information provided to local agencies typically includes the following from the NBI database:

- Bridge number.
- NBI number.
- Inventory information, such as the year the bridge was built and whether or not it is an historic structure.
- Ratings for each bridge component, channel, and culvert.
- An indication of whether the bridge is determined to be structurally deficient or functionally obsolete.
- A list of bridges recommended for Replacement, Rehabilitation, Widening, Repair, and Elimination.

This information is then used to assign work types and estimate project costs, as discussed in the next section. An example of the bridge condition information provided to Fulton County to prepare its bridge asset management plan is shown in figure 4-5.

Fulton County

Bridge Info			NBI: Condition Ratings				
Asset Name	NBI Structure Number	Year Constructed	NBI 058: Deck	NBI 058.01 Wearing Surface Rating [National Bridge Inventory]	NBI 059: Superstructure	NBI 060: Substructure	NBI 061: Channe and Channel Protection
25-00002	2500001	2005	7	7	8	7	7
25-00006	2500002	1970	7	6	7	7	7
25-00007	2500003	1984	6	5	7	7	6
25-00021	2500011	1979	7	5	7	7	6

Figure 4-5. Excerpt from the Fulton County Bridge Management Plan showing bridge ratings.

Links Between NBI Ratings and Levels of Repair

The NBI rating for any component can be used to identify the needed category of repair, as shown in table 4-4. Depending on the rating of each component, bridges are typically scheduled for preventive maintenance, rehabilitation, or reconstruction work to address the deficiency.

INDOT provides funding for bridges in each category according to criteria established for the Local Public Agency (LPA) Bridge Program[11]. A sufficiency rating, which combines structural adequacy (55 percent), serviceability and functional obsolescence (30 percent), and essentiality for public use (15 percent), is used to determine eligibility for federal funding. A score of 100 represents a completely sufficient structure to remain in service and a 0 represents a completely insufficient structure. Bridges with a sufficiency rating below 80 qualify for rehabilitation funding. A sufficiency rating below 50 qualifies a bridge for replacement funds. ■

Table 4-4. Levels of bridge repair by NBI rating[12].

NBI RATING	CONDITION	STRUCTURAL ADEQUACY	LEVEL OF REPAIR SUGGESTED
N	Not Applicable		No maintenance required
9	Excellent		Scheduled preventive maintenance
8	Very Good		
7	Good		
6	Satisfactory		Preventive maintenance or repair
5	Fair		
4	Poor	Structurally Deficient	Rehabilitation or Reconstruction
3	Serious		
2	Critical		
1	"Imminent" Failure Condition		
0	Failed		

11 LPA Bridge Program information can be found here: http://www.in.gov/indot/2390.htm.

12 INDOT Asset Management for Local Public Agency Bridges, December 2015.

CHAPTER 5

Setting Targeted Levels of Service

Once you have your inventory established and know the condition of your pavements and bridges, you can set targets for the level of service you would like to provide. There are several steps to this process. First, you have to estimate the level of funding you think will be available for pavement and bridge repairs and improvements. Second, you have to identify any legislated requirements that will have to be addressed before anything else. The final step in the process is establishing your targeted level of service. Each of these steps is discussed in more detail in this chapter.

ESTIMATING FUNDING LEVELS

Available Funding

The first step in setting a targeted level of service is to estimate the amount of money you expect to be able to put towards the maintenance and rehabilitation of your roads and bridges.

Funding Sources

Local agencies typically fund their programs through a combination of federal, state, and local funds. The Federal Aid portion of the program is dictated by federal statute and regulations. When federal funds are used, the public is provided an opportunity to provide comments on the projects that are selected. A local agency with federally-funded projects that fall within a Metropolitan Planning Organization (MPO) must work with the MPO to include the project in region's Transportation Improvement Program (TIP). Federally-funded projects that do not fall within an MPO are included on the Statewide Transportation Improvement Program (STIP) developed by INDOT.

INDOT administers the State's Local Road and Bridge Matching Grant Fund, known as Community Crossings, which provides funds through an application process. A local agency must have an approved asset management plan to receive funds through this program.

Additional funding is provided from various state and local sources, including the local portion of the tax on gasoline, wheel tax and excise surtax, cumulative bridge

funds, bond sales, and general funds. Each of these funding sources may have limitations on how the money can be used that has to be taken into consideration.

Estimating the Amount of Available Funding

To help prepare your estimate of available funding, think about the following types of questions.

- How much money has been available for road and bridge improvements over the last several years? Has that amount varied each year or has it been relatively constant?
- Are there any new sources of funding that might be available? If you are preparing an asset management plan for your pavements and bridges, you may be eligible for funds under Indiana's Local Road and Bridge Matching Grant Fund that provides a match to your local dollars for eligible projects.
- Are there any factors that might decrease the level of funding available? For instance, has revenue from the local gas tax dropped in recent years?

The answers to these questions will help you prepare an estimate of the level of funding you expect over the next few years. For your roads, the pavement asset management plan asks you to identify projects for the next 5 years, so you need to estimate at least that far in advance. For bridges, the asset management plan asks for a 10-year plan, so you will need to forecast the funding available for bridges for at least that long.

NEEDED FUNDING

In addition to estimating the amount of funding available for your asset management plan, it's also a good idea to estimate how much funding it would take if you wanted to address all of your needs. No agency expects to be able to get enough funding to address all of its needs at one time, but the difference between the funding level that's available and the funding level you need is an important number to share with your agency leadership and elected officials. It represents the "backlog" in work that is needed but isn't funded. If your backlog is growing over time, it means that you are not putting enough money into the network and the value of your assets is probably dropping. This is similar to a vehicle owner who doesn't do the necessary maintenance on a car or truck. After several years of neglected maintenance, the vehicle can be expected to have a growing number of problems and the value you would receive if you tried to sell the vehicle would be much less than if the vehicle had been maintained.

You can estimate the funding you need by multiplying the number of miles in each PASER or NBI rating category with the average cost of repairs for the type of work needed at that condition level. An example for a small road network is shown in table 5-1. In this example, the agency has a total of $24,525,000 in needs on its road network. If we assume that the agency receives $2M in funding each year, there is a $22,525,000 backlog of unfunded needs, showing that the agency is funding less than 10 percent of its needs each year. Unless something significant changes in terms of available funding, this agency can expect to see its backlog continue to grow over time. Indiana LTAP provides a Road Treatment Summary template that can be used to estimate pavement needs. The spreadsheet can be found on the LTAP website (http://wpvecnltap01.itap.purdue.edu/ltap/main.php).

Table 5-1. Example showing how to estimate needed funding.

PASER RATING	CONDITION	LEVEL OF REPAIR SUGGESTED	TYPICAL REPAIR COSTS (PER MILE)	NUMBER OF MILES IN THIS CONDITION	TOTAL AMOUNT NEEDED
9 and 10	Excellent	No maintenance required	$0	20	$0
8	Very Good	Little to no maintenance	$1,000	25	$25,000
7	Good	Crack sealing and minor patching	$10,000	50	$500,000
5 and 6	Fair to Good	Non-structural preservation treatment	$100,000	100	$10,000,000
3 and 4	Poor to Fair	Structural repair (e.g., overlay)	$130,000	100	$13,000,000
1 and 2	Failed	Reconstruction	$500,000	20	$1,000,000
Totals				315	$24,525,000

CHALLENGES WITH FORECASTING AVAILABLE FUNDING

There is always some uncertainty in trying to forecast funding for one year, let alone 5 or 10 years. Even so, the exercise is helpful for anticipating how funding trends might impact your road and bridge conditions. If funding has been fairly constant for a number of years, you probably have a pretty good idea of the change in conditions that you might expect to see each year. Estimating the amount of funding that is expected also allows you to talk to your elected officials and the public about your asset needs and how quickly those needs are being addressed.

One of the factors that makes it so hard to estimate the amount of funding that will be available for road and bridge repairs is the level of uncertainty that every transportation agency has to deal with. For example, one or more years with a severe winter can completely consume a maintenance budget and the amount of work that was planned. The cost of work can vary significantly, too, if material costs fluctuate significantly or if work that was expected to be done using agency forces has to be done by contract. All transportation agencies have to deal with these kinds of uncertainties at some point in time, so it's best to have a clear

understanding of how to take them into account when putting together your asset management plan. One approach is to build in a contingency of about 10 percent of your budget for unexpected events. That way, you have money available should the need arise. If it doesn't, you can use the money to get ahead on reducing your backlog.

IDENTIFYING OTHER FACTORS THAT IMPACT THE PROGRAM

In addition to having an estimate of how much funding will be available over the next 5 to 10 years, you also have to identify any legislated or other requirements that have to be funded before anything else. For example, recent federal legislation (i.e., Moving Ahead for Progress in the 21st Century [MAP-21] or the Fixing America's Surface Transportation [FAST] Acts) included requirements that no more than 5 percent of Interstates and 10 percent of bridge decks on the National Highway System can be in *Poor* condition. Although state DOTs are tasked with making sure these minimum conditions aren't exceeded, they illustrate the way legislation can impact your program. At the local level, requirements such as the federal mandate for sign retro-reflectivity, the expected requirements for pavement markings, and existing requirements for addressing American Disability Act (ADA) requirements, are all factors that have to be considered when putting together an improvement plan.

There may also be agency priorities that have to be considered when putting together your program. For instance, if your community made commitments to a local business as part of an economic development program, a portion of your budget may have to be used to fund that project. Or, if your agency is working on a program to address deteriorated culverts in a flood zone, it's possible that some money that would have gone toward road or bridge repairs is diverted for a couple of years while that initiative is in place. When putting together your asset management plan, do the best job you can of finding out whether or not there are any of these kinds of requirements in place that will have to be addressed during the plan period.

USING THE INFORMATION TO SET TARGETED LEVELS OF SERVICE

Armed with your estimates of available funding and your knowledge of any requirements that have to be addressed, you are ready to estimate the level of service you expect to be able to provide.

Setting a performance target allows you to establish a goal for the level of service you expect to achieve when your asset management plan is implemented. It is useful for communicating with agency leadership, elected officials, and the public so they know what to expect in the coming years. It is also a good way to establish accountability within your organization. It shows that you are a good steward of the assets you manage and that there is a strategic, thought-out process in place.

The process of developing a targeted level of service requires a balance between the amount of funding you expect to receive, the treatments you intend to fund, and the conditions you hope to achieve. This balance is reflected in figure 5-1. As you might expect, if you set too high a target, you will need more money than you have available. If you set too low a target, your community may express their unhappiness

through their elected officials. The challenge is to be realistic without setting expectations that are too high.

Figure 5-1. Balance required to set a level of service target. © 2017 Applied Pavement Technology, Inc.

What Should We Use As a Target?

There are many different types of performance measures that can be used to set a target and each has advantages and disadvantages. The most commonly used performance measures used in asset management are related to the method used to rate asset conditions. However, sometimes those measures are simplified so that elected officials and the public understand their message. For example, most people wouldn't understand the difference between an NBI rating of 6 versus 7 as a target. Similarly, most people wouldn't know whether a PASER rating of 6 is okay to use as a level of service target for the network. These ratings don't often work because they aren't commonly understood outside the transportation community.

Even so, many agencies choose to use an average rating or a weighted[13] average rating as their target. A weighted average is considered to be a better representation of conditions than a straight average since it takes into account the amount of area at each rating. Think about a network with one really large bridge with a bridge deck in *Poor* condition (NBI rating of 4) and one small bridge with its bride deck in *Very Good* condition (NBI rating of 8). The average NBI rating for bridge decks is 6, which could be used as the target. However, if a weighted average was used, the target would be 5 (assuming the large bridge deck area is 100,000 sq.ft. and the small bridge deck area is 40,000 sq.ft.).

To address the concern that people don't understand PASER or NBI ratings, many agencies choose to set a target related to the percent of the pavements or bridges in *Good* or *Fair* condition. This may be supplemented with an additional target for the maximum on the percent of the network in *Poor* condition. Even though you use your PASER or NBI ratings to determine the percentage of the network at these condition levels, it's easier for elected officials and the public to understand terms such as *Good*, *Fair*, or *Poor*. Using this approach, an agency may set a level of service target so that 70 percent of its pavement network is in *Good* or *Fair* condition and no more than 5 percent can be in *Poor* condition.

Some examples of performance targets are listed below:

- Weighted average network PASER rating > 70.
- At least 70 percent of the network area with a *Good* or *Fair* rating.
- Reduce the percentage of roads in *Poor* condition from 40% to 25% within 5 years.

13 A weighted average is calculated by summing up the product of the rating for each section times its area. The sum is then divided by the total area of the network to determine the weighted average.

- Average weighted Pavement Condition Index (PCI) > 70 (out of 100).
- All streets with PASER rating ≥ 5.
- Weighted average PASER rating of 8 on arterial roads within 5 years.

A good target should include both the condition you want to achieve as well as the timeframe for achieving it. If you are developing a 5-year pavement asset management plan or a 10-year bridge asset management plan, it makes sense that your targets will be tied to the dates covered in your plans.

Setting One or More Targeted Levels of Service

One of the easiest ways to set a targeted level of service is to look at past trends in the level of service that has been provided. Assuming that funding levels have been relatively constant, and material cost increases have been fairly constant each year, you can expect that future trends will be fairly similar to those from the past.

For example, figure 5-2 shows two different scenarios. On the left side is an example in which asset conditions have remained relatively constant over time, so the targeted level of service is set at that level (PASER rating of 7). The example on the right shows a network that is deteriorating a little each year. Expecting the same amount of deterioration over the next several years, the level of service target for this network is set at a PASER rating of 6.

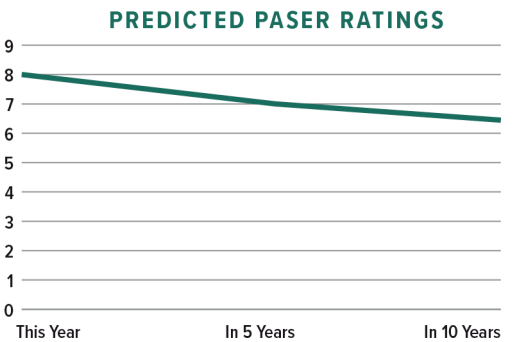


Figure 5-3. Example of predicted conditions in 5 years.

If you have a pavement or bridge management system with models that predict conditions over time, you can use the software to help you set a reasonable target. An example of the type of output you might get from a pavement management system is shown in figure 5-3. In this example, a 5-year target might be set

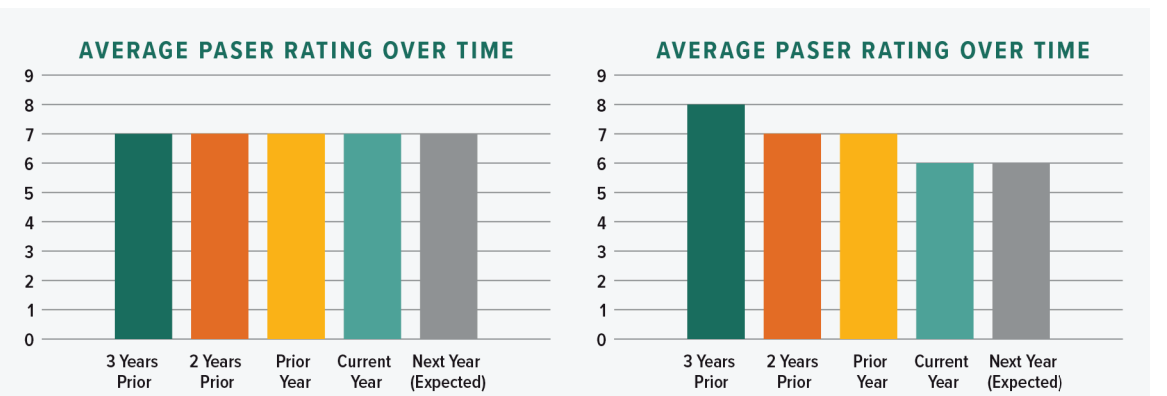


Figure 5-2. Examples showing how historical data can be used to set performance targets.

at an average PASER rating of 7, but a 10-year target would have to be set at a lower condition. The predicted conditions allow you to quickly examine the way asset conditions will change. You can use these types of tools to compare conditions with different levels of funding or different projects and treatments.

Rather than set just one performance target, an agency may choose to set different targets for different parts of their network. For instance, different targets could be set for each bridge component or for each road functional classification. This allows you to place a higher priority on certain parts of your network so it is easier to prioritize the projects that are funded. These priorities are usually linked to the number of people who are using that asset. For instance, an agency might set the targeted condition for its arterial roads at a PASER rating of 8, but set the target for the collectors and residential roads at a PASER rating of 6.

You should review your targets annually to see whether you are making progress towards meeting your objectives. If there are major changes to the funding that's available, or there are other factors that impact your ability to reach your targets, you should adjust the targets appropriately and inform your elected officials of the changes.

Realistic and Aspirational Targets

When a target is matched to the level of funding, it is referred to as a "realistic" or "constrained" target because it represents the conditions you expect to achieve. However, in most agencies the realistic target does not represent the level of service they think they should be providing. For that reason, some agencies set an "aspirational" target that represents the level of service they think they should be providing in addition to the realistic target. When an aspirational target is used, it is most commonly used as a way of showing elected officials that funding levels are not sufficient to provide the level of service that the community is expecting. ■

CHAPTER 6

Developing a Program With a Mix of Fixes

The next step in the TAM process is to develop a multi-year program that lists the projects and treatments that should be funded over a 5-year window for pavements and a 10-year window for bridges. Candidate projects should be selected to help you meet your targeted levels of service.

There are many different approaches that an agency can take to develop its program and some lead to better conditions than others. One of the objectives of a TAM approach is to help you find the combination of treatments and strategies that makes the best use of the available funding and leads to the best possible performance. For that reason, this Guide promotes a "mix of fixes" that puts some funding towards pavements and bridges in need of major rehabilitation or reconstruction, but also puts money towards roads and bridges in *Good* and *Fair* condition to slow down their rate of deterioration and keep them in operational condition as long as possible. A "mix of fixes" will always be a more cost-effective use of funding than the more traditional worst-first strategy that doesn't address assets until they are in *Poor* condition.

This chapter will help you use your condition data to decide what treatments are needed and to develop a multi-year program that is made up of a "mix of fixes." It also shows you how one local agency has gotten more out of each dollar that it puts into its road system by following this strategy.

USING CONDITION DATA TO DETERMINE REPAIR NEEDS

In chapter 3 we introduced two tables showing how PASER and NBI ratings can be used to determine the level of repair that is needed for your pavements and assets. Those tables are reproduced here for your convenience as tables 6-1 for roads and 6-2 for bridges. In addition, we have expanded the tables in Appendix A to include more information on the types of treatments that might be used in each category and the expected life if the treatment is applied at the right time. If you have pavement or bridge management software, you can incorporate the treatments from these tables into your software program so it can generate the treatment recommendations automatically.

Each of these levels of repair is intended to address different types of asset deterioration. The PASER and

NBI scores help you decide which of the treatments is right for a specific road or bridge. General guidance on each category of repair is provided below.

- ***Preventive maintenance*** These treatments are applied to pavements and bridges that are in relatively good condition. They are usually low-cost treatments that are applied to slow the rate of deterioration or restore certain properties, such as a road's skid-resistance properties. Preventive maintenance treatments can be applied regularly as part of a scheduled program (such as bridge washing) or the treatments can be triggered based on an asset condition rating. The value of preventive maintenance treatments lies in their ability to preserve asset conditions and avoid further deterioration for a very low cost.

Preventive maintenance and non-structural preservation treatments represent "the best bang for the buck."

There are times that agencies use these types of treatments on roads that are not good candidates as a way to keep the asset operational before funding is available for rehabilitation or reconstruction. These applications should not be classified as a preventive maintenance treatment and the life expectancy under these types of conditions will be much shorter than those shown in Appendix A.

- ***Non-structural preservation treatment*** Preservation is a broad category of treatments that can include preventive maintenance activities as well as minor rehabilitation activities, such as thin overlays or micro-surfacing. Non-structural preservation treatments are usually less than 2 inches in depth and are designed to address age-related problems (such as block cracking) or distress caused by exposure to the elements (such as transverse cracking). When these treatments are applied to assets without much structural deterioration, they can be very cost-effective. Preventive maintenance and non-structural preservation treatments often represent "the best bang for the buck" in a transportation agency.
- ***Rehabilitation or structural repairs*** When assets have deteriorated significantly, more substantial repairs are necessary. Rehabilitation treatments include structural enhancements that extend the service life and improve the ability to carry traffic loads.
- ***Reconstruction or replacement*** When assets are considered to have failed, they are candidates for reconstruction or replacement. For a road, reconstruction usually requires the complete removal and replacement of the existing pavement structure using either new or recycled materials. For bridges, various components of the bridge may be replaced when they are in failed condition and considered to be structurally and/or functionally obsolete.

Table 6-1. Levels of repair for asphalt and concrete roads by PASER rating[14,15].

PASER RATING	CONDITION	LEVEL OF REPAIR SUGGESTED	TYPICAL REPAIR COSTS (PER MILE)
Asphalt Roads			
9 and 10	Excellent	No maintenance required	$0 to $3,000
8	Very Good	Little to no maintenance	
7	Good	Preventive maintenance	$5,000 to $100,000
5 and 6	Fair to Good	Non-structural preservation treatment	
3 and 4	Poor to Fair	Structural repair (e.g., overlay)	$130,000 to $500,000
1 and 2	Failed	Reconstruction	
Concrete Roads			
9 and 10	Excellent	No maintenance required	$0
7 and 8	Very Good	Routine maintenance	$1,000 to $100,000
5 and 6	Fair to Good	Preventive maintenance	
3 and 4	Poor to Fair	Rehabilitation	$130,000 to $500,000
1 and 2	Failed	Reconstruction	

Table 6-2. Levels of repair by NBI rating[16].

NBI RATING	CONDITION	STRUCTURAL ADEQUACY	LEVEL OF REPAIR SUGGESTED
N	Not Applicable		No maintenance required
9	Excellent		Scheduled preventive maintenance
8	Very Good		
7	Good		
6	Satisfactory		Preventive maintenance or repair
5	Fair		
4	Poor	Structurally deficient	Rehabilitation or reconstruction
3	Serious		
2	Critical		
1	"Imminent Failure Condition"		
0	Failed		

14 Michigan Asset Management Council. (2011) Asset Management Plan for Pavement: A Template for End Users https://www.ctt.mtu.edu/sites/default/files/resources/PASER/localamlantemp.pdf

15 Indiana LTAP PASER Training Materials

16 INDOT Asset Management for Local Public Agency Bridges, December 2015

As you can tell from the treatment descriptions, knowing the type of deterioration that is present is as important as the overall rating to determine the most appropriate repair. That is one of the strongest reasons for emphasizing the importance of regular training for all inspectors so they can correctly distinguish between the different types of distress that may be present. In the case of bridges, the NBI rating is used to calculate a sufficiency rating that determines eligibility for federal funding. As discussed in chapter 4, a bridge with a sufficiency rating below 80 qualifies for federal rehabilitation funding and a rating below 50 qualifies a bridge for federal replacement funds.

PUTTING TOGETHER A MULTI-YEAR PROGRAM

Once you've identified your candidate projects and treatments, you can use this information to develop a multi-year program. The pavement asset management plan requires a minimum of a 5-year plan while the bridge asset management plan covers a 10-year period. Since conditions change and uncertainties will occur over the period covered in your plans, you will have to update your plans every year to make sure they include the amount and type of work that you expect to construct.

Prioritizing Projects

The biggest challenge with putting together a multi-year program is figuring out which candidate projects should be funded, since you likely have many more projects than you can pay for. If you have pavement or bridge management software, this activity is a little easier because these tools have models that predict future conditions and recommend projects based on optimizing your return on your investment. Agencies that don't have pavement or bridge management systems have to decide which projects can be postponed and which ones need to be addressed right away. Looking at trends in your condition data from several surveys is one way to determine which assets are deteriorating faster than others. From a cost-effectiveness standpoint, try to program as many projects as possible when they're at the point that preventive maintenance or non-structural preservation treatments are recommended. This is often referred to as "the window of opportunity" because you can make the best use of your money here. The "window of opportunity" is shown in figure 6-1.

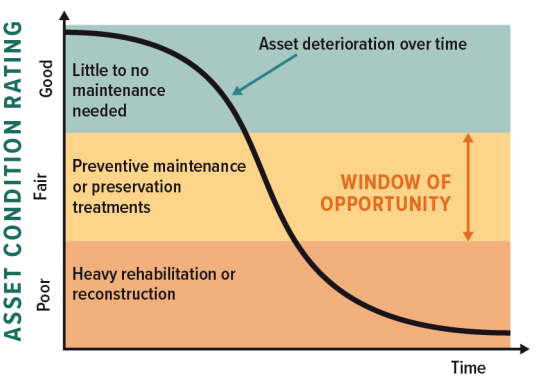


Figure 6-1. Graphic showing the "Window of Opportunity."

If you aren't able to catch your roads or bridges at that point, the cost of the repair can be 5 to 6 times more expensive because major rehabilitation or reconstruction will be needed. If you miss the window of opportunity and try to use the same low-cost treatment, you'll probably get less than half of the expected life out of the treatment. Either way, you will have missed the opportunity to take advantage of the benefits that preservation treatments provide.

In addition to prioritizing projects that are within the "window of opportunity," there are other factors

to consider when putting together your multi-year program, as listed below.

- The condition of the asset or the rate of deterioration.
- The urgency of a project from a safety perspective.
- The amount of traffic using the road or bridge.
- The opportunity to piggy-back with another project.
- Coordination with utilities or other work in an area.
- Opportunities to generate economic growth in an area.

Using a Systematic Process for Developing Your Program

If you want to be systematic about ranking your projects, you can develop a fairly simple method of scoring projects to develop your prioritized list. An example is shown in table 6-3. In this example, each project is scored based on criteria established for important factors to the agency. In this case, asset condition, safety, and traffic are used to set priorities. A high score is assigned 5 points, a medium score is assigned 3 points, and a low score is assigned 1 point. The total score can be used to set the priority, or each of the criteria can be weighted if one is considered more important than another. In the example below, each of the three factors was considered to be equal.

Because of the importance of catching projects within the "window of opportunity" you might first establish a budget for projects in that category and prioritize those projects separately from rehabilitation and reconstruction projects. That way, you can be sure that you end up with a "mix of fixes" in your program. It also helps ensure that preventive and preservation treatments are being used on projects that are still in relatively good condition. For instance, the first few years of the pavement asset management plan should fund projects on sections with PASER ratings of 5 or 6. The later years should fund projects on sections with PASER ratings of 7 or 8, since they will likely have a rating of 5 or 6 by the time the projects are actually funded.

Once your priorities are established, projects are assigned to each year in the program based on the amount of funding you have available using the steps outlined below. However, be sure to take into account any treatment needs that may change if a project is postponed into a later year of the program or any changes that might need to be done to coordinate with other projects in the area.

Table 6-3. Example showing how projects can be prioritized.

PROJECT IDENTIFIER	URGENCY BASED ON ASSET CONDITION	URGENCY BASED ON SAFETY	URGENCY BASED ON TRAFFIC LEVEL	TOTAL SCORE	FINAL RANKING
MainSt01	High	High	Medium	13	1
GreenSt05	Low	Medium	Medium	7	4
GreenSt10	Medium	High	Low	9	3
NevadaSt04	Medium	Low	Low	5	5
LincolnAve06	Medium	Medium	High	11	2

- Step 1: Subtract the cost of the highest ranking project from your budget.
- Step 2: If there is money left over, select the next highest ranking project and subtract the project cost from your budget. Repeat this process until you have exhausted your budget for the year.
- Step 3: Using the remaining projects, begin the process again for the next year's budget. Choose the highest ranking project from the remaining list of candidate projects and subtract its cost from your budget. Continue this process until the second year's budget is exhausted.
- Step 4: Repeat the process for each year in your program.

This process is illustrated using the same network presented in table 6-3. In table 6-4, the projects have been sorted by the final ranking and costs for each treatment have been added. An agency with a budget of $2,750,000 would fund the top 3 ranking projects and the remaining projects would be considered again in the next years' program.

Table 6-3. Example of the prioritized project selection process.

PROJECT IDENTIFIER	FINAL RANKING	PROJECT COST	FUNDED?
MainSt01	1	$800,000	Yes
LincolnAve06	2	$1,200,000	Yes
GreenSt10	3	$750,000	Yes
GreenSt05	4	$1,500,000	No
NevadaSt04	5	$900,000	No

The objective of the prioritization process is to develop a reasonable and defensible multi-year program that allows you to explain to elected officials or the public why one project was selected over another. Having a systematic approach to prioritizing your projects enables you to defend your program against outside pressures to fund certain projects over others.

GETTING THE MOST OUT OF YOUR PROGRAM

The National Center for Pavement Preservation published a method of evaluating your program to see whether you are investing in the right mix of fixes. The FHWA publication documenting this process is called *A Quick Check of Your Highway Network Health*[17]. Very simply, the document explains how you can compare the number of miles you are funding in your program to the amount of deterioration that is taking place to see whether you are getting as much life as possible from your planned projects and treatments.

Taking some liberty to simplify the process, imagine a network with 500 lane miles. Assuming that each year a lane mile loses one year of life, it can be assumed that in any given year, at least 500 lane mile years need to be replaced.

Continuing the simplified process, assume that you have three choices for repairing your network:

- Preservation work: Each project costs $20,000 per lane mile and gives you 5 years of life.
- Rehabilitation work: Each project costs $100,000 per lane mile and gives you 10 years of life.

17 https://www.fhwa.dot.gov/pavement/preservation/if07006.pdf

- Reconstruction: Each project costs $500,000 per lane mile and gives you 20 years of life.

In the traditional program that focuses on rehabilitation and reconstruction work, an agency with a budget of $3,000,000 might put together a program that includes the work shown in table 6-4. This program puts 240 lane mile years back into the system. This is much less than the 500 lane miles lost each year, so it can be assumed that network conditions are deteriorating.

Having heard about the benefits of TAM, you decide to see if you can improve the cost-effectiveness of your program by including a "mix of fixes." Under this scenario, you invest a significant portion of your budget on preservation projects to keep them from deteriorating to the point that rehabilitation is needed. But, you also have to invest some money on projects that are in a deteriorated condition. The resulting program is reflected in table 6-5. Under this scenario, your program puts 420 lane mile years back into the system, which is significantly more than the traditional program but still slightly less than the system is losing each year. Of course, this scenario assumes that you have 50 lane miles of good candidates for preservation treatments to work. Over time, an ongoing commitment to a "mix of fixes" will have a significant impact on your network conditions, with a growing percentage of your assets in the *Good* and *Fair* categories. Agencies that currently have a large percentage of their assets in *Poor* condition will have to put more of their budget into rehabilitation and reconstruction projects each year, but the only way to improve system conditions is to begin investing a portion of the budget in preservation programs to keep your newly-improved roads in good condition as long as possible.

Table 6-4. Traditional program containing only rehabilitation and reconstruction.

COLUMN A	COLUMN B	COLUMN C	COLUMN D	COLUMN E	COLUMN F
Treatment	Cost Per Mile	Years of Life Provided	Number of Lane Miles in the Program	Total Cost	Total Number of Lane Mile Years Gained *(Column C times Column D)*
Preservation	$20,000	5	50	$1,000,000	250
Rehabilitation	$100,000	10	15	$1,500,000	150
Reconstruction	$500,000	20	1	$500,000	20
Totals			22	$3,000,000	420

Table 6-5. Program that includes a mix of fixes.

COLUMN A	COLUMN B	COLUMN C	COLUMN D	COLUMN E	COLUMN F
Treatment	Cost Per Mile	Years of Life Provided	Number of Lane Miles in the Program	Total Cost	Total Number of Lane Mile Years Gained *(Column C times Column D)*
Preservation	$20,000	5	0	$0	0
Rehabilitation	$100,000	10	20	$2,000,000	200
Reconstruction	$500,000	20	2	$1,000,000	40
Totals			**22**	**$3,000,000**	**240**

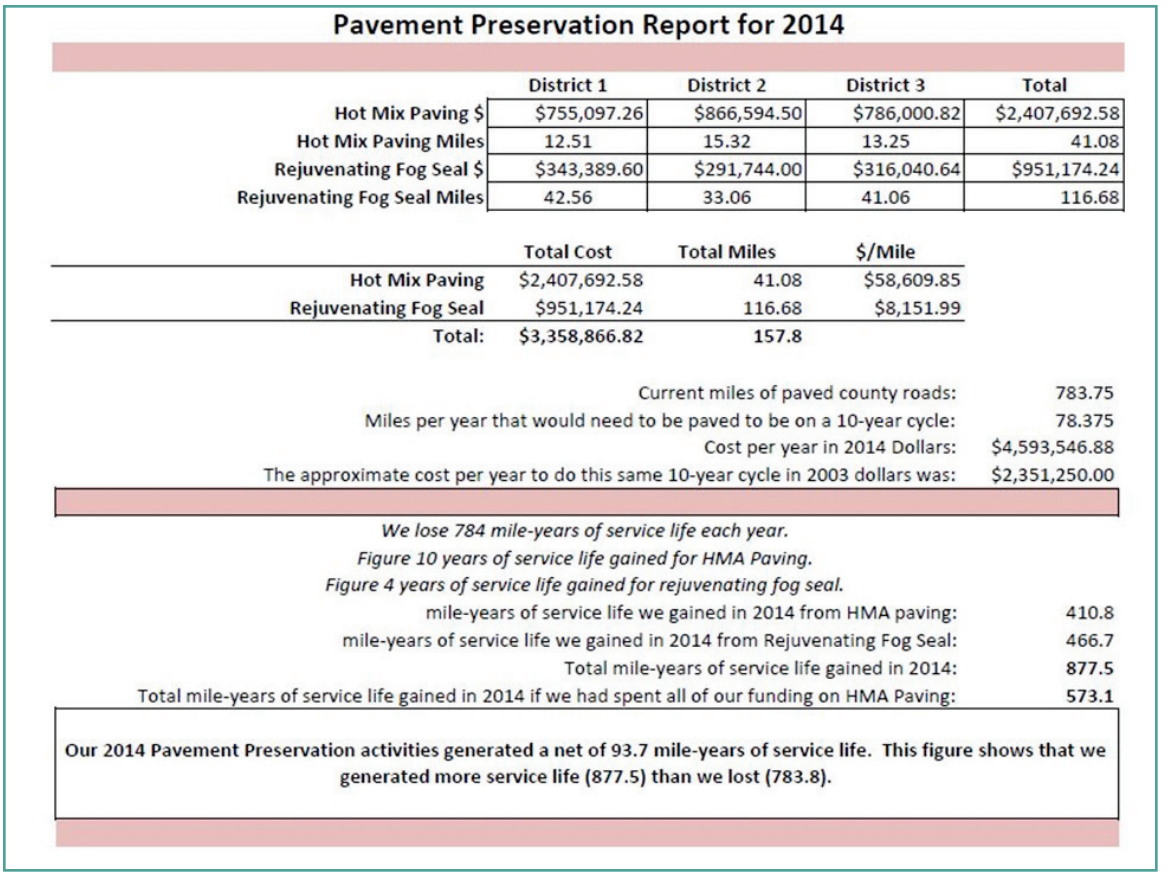
This "seat of the pants" approach provides an opportunity for you to test your program to see if you're "buying" as many lane mile years as possible each year. Harrison County used this approach to check its 2014 preservation program, as shown in figure 6-2. Their emphasis on preservation shows that they were able to add back 877.5 lane mile years into a system that was losing 783.8 lane mile years annually. If they had only used hot-mix paving on their network, their budget allowed them to add back only 573.1 lane mile years—significantly less than they needed to put back in the system. These results are highlighted with stars added to the figure.

MOVING TOWARDS THE ABILITY TO PREDICT FUTURE CONDITIONS

The development of a multi-year program is strengthened when you have the ability to predict how asset conditions will change over time. For example, if you have two roads with a PASER rating of 7, but one is only 2 years old and the other is 8 years old, you know more about what's happening than if you had just looked at the two PASER ratings alone. The same is true of bridges. Knowing the rate at which an asset is deteriorating can help make your asset management plan more effective.

Basic Techniques for Estimating Rates of Deterioration

Without a pavement or bridge management system in place, there are several relatively simple approaches that you can use to estimate the rate at which your assets are deteriorating. Using pavements as an example, two approaches are illustrated. One approach uses pavement age to estimate rates of deterioration and the other uses a statistical analysis.



Pavement Preservation Report for 2014

	District 1	District 2	District 3	Total
Hot Mix Paving $	$755,097.26	$866,594.50	$786,000.82	$2,407,692.58
Hot Mix Paving Miles	12.51	15.32	13.25	41.08
Rejuvenating Fog Seal $	$343,389.60	$291,744.00	$316,040.64	$951,174.24
Rejuvenating Fog Seal Miles	42.56	33.06	41.06	116.68

	Total Cost	Total Miles	$/Mile
Hot Mix Paving	$2,407,692.58	41.08	$58,609.85
Rejuvenating Fog Seal	$951,174.24	116.68	$8,151.99
Total:	$3,358,866.82	157.8	

Current miles of paved county roads:	783.75
Miles per year that would need to be paved to be on a 10-year cycle:	78.375
Cost per year in 2014 Dollars:	$4,593,546.88
The approximate cost per year to do this same 10-year cycle in 2003 dollars was:	$2,351,250.00

We lose 784 mile-years of service life each year.
Figure 10 years of service life gained for HMA Paving.
Figure 4 years of service life gained for rejuvenating fog seal.

mile-years of service life we gained in 2014 from HMA paving:	410.8
mile-years of service life we gained in 2014 from Rejuvenating Fog Seal:	466.7
Total mile-years of service life gained in 2014:	877.5
Total mile-years of service life gained in 2014 if we had spent all of our funding on HMA Paving:	573.1

Our 2014 Pavement Preservation activities generated a net of 93.7 mile-years of service life. This figure shows that we generated more service life (877.5) than we lost (783.8).

Figure 6-2. Results from Harrison County's quick check of network health.

OPTION 1: USE PAVEMENT AGE

This approach allows you to use pavement age to determine average rates of deterioration. This is the approach that is often used by agencies when they are first setting up a pavement management system because they often don't have historical data available for modeling. It can be done using your engineers' and technicians' expertise and/or using historical data.

The easiest approach is to assume a constant rate of deterioration over the life of a pavement using the following steps.

- ***Step 1*** If pavements are designed for 20 years, it is probably a reasonable assumption that a new pavement will go from a PASER rating of 10 to 1 during that period of time. Dividing the 10 PASER points by the 20 year life establishes an average rate of deterioration of ½ point per year.
- ***Step 2*** If you want to be more specific, you can look at the different rates of deterioration for different types of treatments. For instance, overlays typically don't last as long as a new pavement, so they have a faster rate of deterioration. Assuming an overlay is designed for 10 years before another overlay may be needed (at a PASER

rating of 4) results in an average deterioration rate of 0.6 points per year ((10-4)/10). Similar calculations can be generated for each type of treatments used by your agency based on estimated design lives.

In reality, pavements don't typically deteriorate at a constant rate over their life. They usually start out with a slow rate of deterioration that increases as cracks and other distress start to appear. If you want to set different rates of deterioration for different stages of a pavement's life, you can use the approach described below, which is illustrated in figure 6-3.

- ***Step 1*** Determine how many years you would expect it to take for a road to get to a PASER rating of 7, representing the point when preventive maintenance (such as crack sealing and minor patching) is needed. If you have PASER data available, use the last date an overlay was applied, or the year the road was constructed, as the starting date for calculating the age of the pavement. Using the average age, estimate how many PASER points are lost each year at the beginning of a pavement's life. For example, if the average age of a pavement at a PASER rating of 7 is 9 years, your pavements are deteriorating at a rate of 0.33 points per year ((10-7)/9). This represents the rate of deterioration for a road in the *Very Good* to *Excellent* condition categories.
- ***Step 2*** Repeat step 1, but look at pavements that are at a PASER rating of 4. This represents the point in time when structural repairs are needed. Assuming it takes 6 years for a pavement to go from a PASER rating of 7 to a PASER rating of 4, the pavement is now deteriorating at a rate of 0.5 points per year ((7-4)/6). This represents the rate of deterioration for a road in the *Fair* to *Good* categories.
- ***Step 3*** The final step is to estimate how long it would take for a pavement to go from a PASER rating of 4 to a failed condition (a PASER rating of 0). This is often harder to estimate because agencies rarely let a road actually get to a rating of 0 without performing some type of maintenance to keep the road operational. To estimate the rate of deterioration, you have to assume that no work is being done to the road. If we assume that it takes 6 years for a road to get to a failed condition, then the new rate of deterioration is now 0.67 points per year ((4-0)/6). This represents the rate of deterioration for a road in the *Poor* to Failed categories.

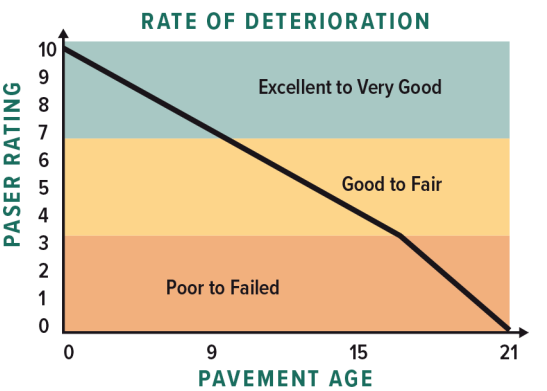


Figure 6-3. Example of different rates of deterioration based on condition.

It is easier to use only one rate of deterioration over the life of an asset, but it may be helpful to know whether there are differences in how your pavements are deteriorating at different stages of its service life.

OPTION 2: USE STATISTICS

You can also use statistical programs, such as the features available in Excel or in proprietary statistical

software packages, to develop performance models. Within these programs, first assemble assets into groups (sometimes called a family) with similar characteristics (such as arterial roads with an asphalt surface). For each group, run a statistical regression analysis on the age and condition data to generate an equation that describes the rate of deterioration. This approach is actually more complicated than it sounds and may require someone with some statistical expertise to develop reliable models. For that reason, it is not a common approach for developing performance models at the local level.

Advanced Techniques for Predicting Future Asset Conditions

If pavement or bridge management systems are in place, they will enable you to predict future pavement and bridge conditions using computerized models. Most management systems have tools for developing rates of deterioration built into them, using either default deterioration rates that are the same for all users, or your own historical data. Different rates of deterioration are usually developed for different "families" of assets, which are groups of assets with similar characteristics that would enable them to deteriorate at similar rates. An example of the type of performance models that is generated from a pavement management system is shown in figure 6-4. In this example, the blue dots represent individual pavement sections. Their pavement condition and age are plotted and a statistical regression analysis is conducted to fit the best line through the data. The equation for the line is then used to predict future conditions. These types of models need to be developed for each "family" of assets and for each type of treatment that might be applied to the system. Figure 6-5 shows an actual deterioration model developed by the City of Flat Rock, Michigan.

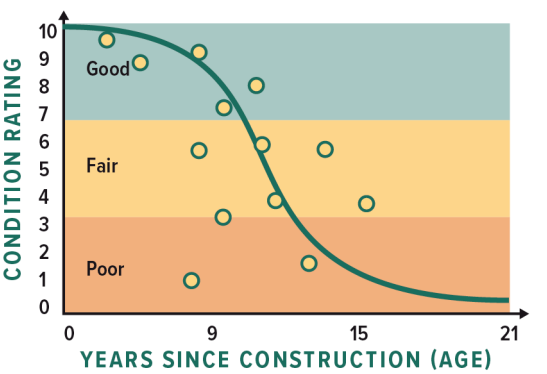


Figure 6-4. Example performance model.

Although the process of developing deterioration models can be challenging, they make pavement and bridge management systems extremely helpful for developing a multi-year work plan and communicating your funding needs.

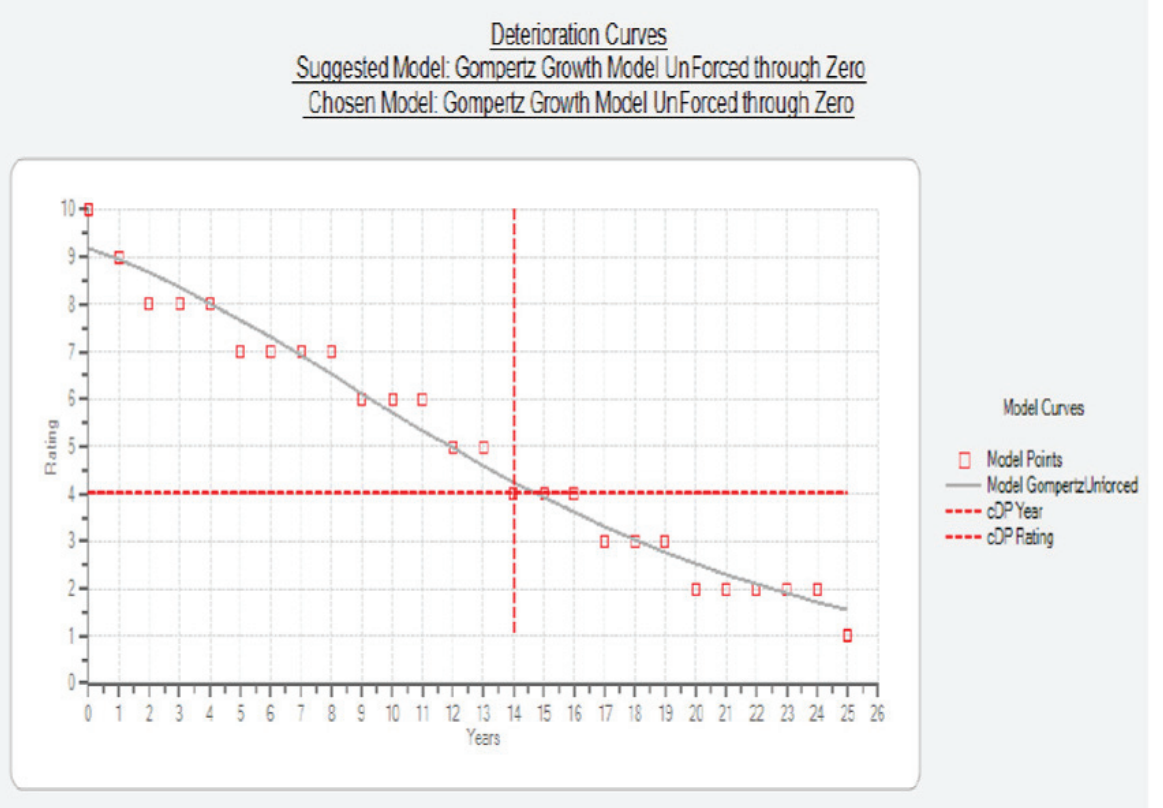


Figure 6-5. City of Flat Rock, MI asphalt deterioration curve[18].

Using Predicted Conditions

The ability to predict asset conditions enables you to do a number of key tasks, including:

- Estimating the funding levels that will be needed in the future to maintain conditions.
- Communicating the impact of funding levels on network conditions. For example, you can estimate the drop in asset conditions that will occur over the next 5 years if your budget is cut.
- Comparing the impact that different treatment strategies and funding levels will have on the future condition of your network.

An example of how predicted conditions can be used to accomplish these tasks is provided in figure 6-6. In this example, the amount of money needed to achieve certain performance targets was estimated in 2015. Five different funding levels are included, ranging from the current funding level of $2 million per year all the way up to $6.8 million dollars per year.

18 C.E. Raines Company. 2014. Pavement Surface Evaluation and Rating Study — (PASER) For the City of Flat Rock http://www.flatrockmi.org/uploads/Library/Files/Site-HomePageNews/PASER%20over%2017%2014.pdf

The 5-year analysis found that at least $2.5 million per year was needed to maintain conditions and funding in the amount of $3 million or $4 million per year would improve conditions. If the agency wanted to address all of its needs within the 5-year analysis period, they would have to invest at a level of $6.8 million each year over the 5-year period. These details can be useful when you are trying to communicate your funding needs or explain what you will accomplish with the amount of funding you are provided. ■

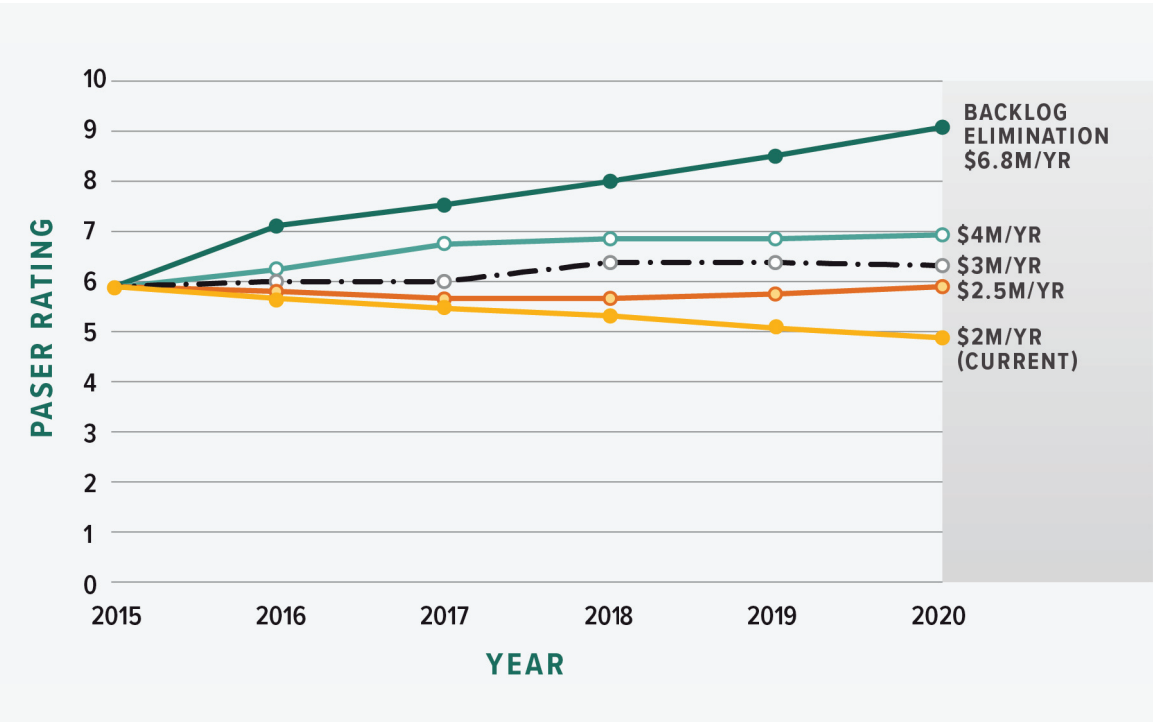
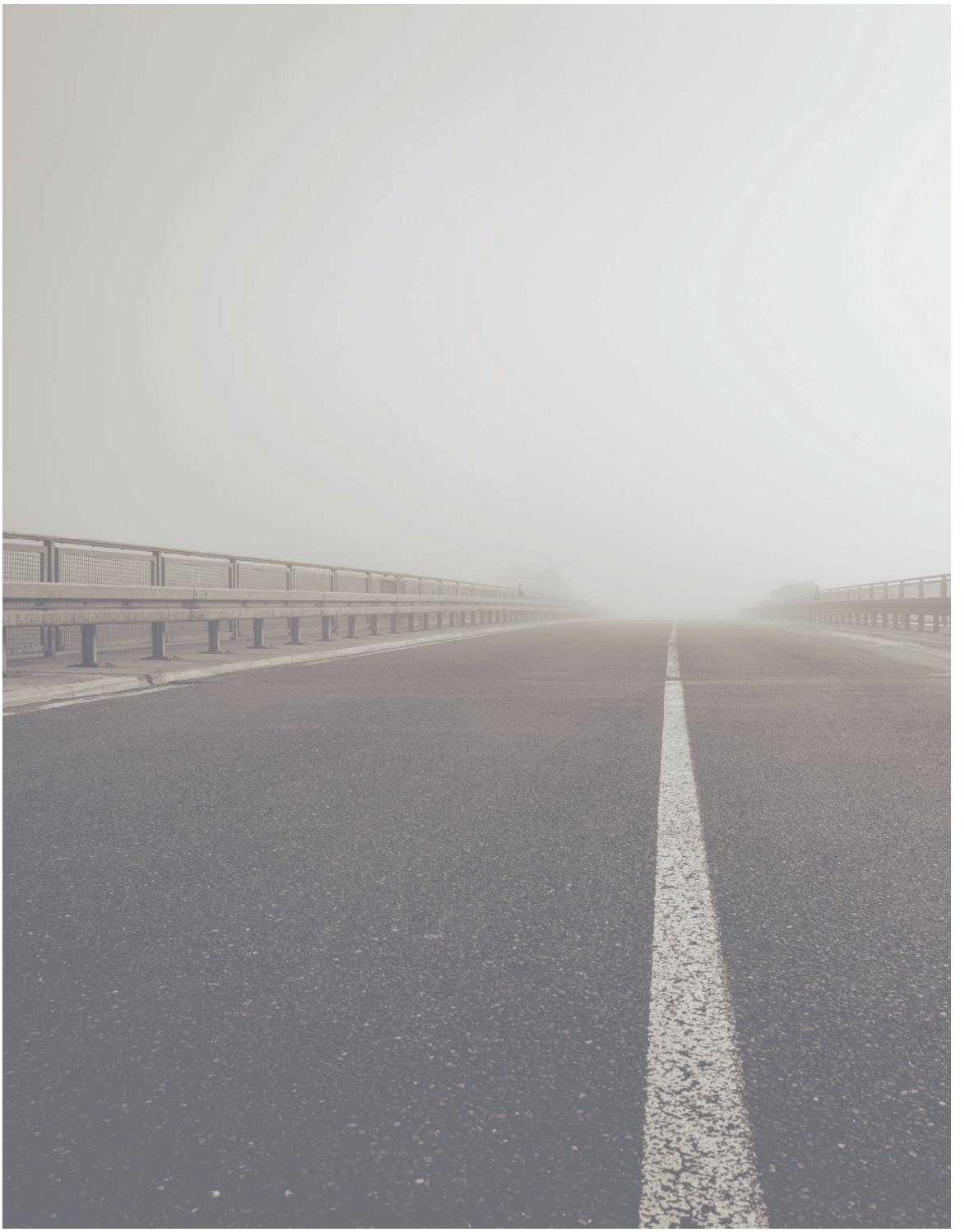


Figure 6-6. An example of how predicted conditions can be used. © 2017 Applied Pavement Technology, Inc.



CHAPTER 7

Reporting Results and Developing the Plan

THE LAST STEP in the TAM process is sharing your results with others through the development of an asset management plan. This chapter introduces the pavement and bridge asset management plans that are required of local agencies in Indiana for eligibility under the Local Road and Bridge Matching Grant Fund (known as Community Crossing). In addition to satisfying eligibility requirements for the CC grant program, these asset management plans are also useful for planning work activities and for reporting conditions to elected officials and other interested parties. In addition to providing information on these asset management plans, the chapter also includes examples of different types of reports that have been used by local agencies in Indiana to present the results of their asset management efforts.

ASSET MANAGEMENT PLAN OBJECTIVES

The State of Indiana recognizes that funding for local roads and bridges has not been sufficient to address all of the local needs. During the 2016 legislative session, the State Legislature passed legislation to address these funding needs. However, to help ensure that the funding was being used cost-effectively, the legislation required that planned investments in pavements and bridges are detailed in an asset management plan that is approved by INDOT. The Indiana LTAP center at Purdue University was charged with assisting local governments with the development of these plans through training, the development of this Guide, and other initiatives. The LTAP Advisory Board also worked with INDOT to develop the pavement asset management plan template that is provided in appendix B. INDOT developed the bridge asset management plan template that is provided in appendix C.

There were several key objectives considered in developing the minimum plan requirements, including those listed below.

- The plan development should not be so difficult that it places a large burden on local agencies.
- The plan should summarize information about the size and condition of the pavement and bridge inventory and the planned treatments over a multi-year period.

- The plan should encourage local agencies to apply TAM principles so available funding is used as cost-effectively as possible.
- The plan should indicate the agency's performance goals and the expected level of service that will be attained at the end of the reporting period.

Those objectives turned into minimum requirements that are included in the asset management plan templates and explained later in this chapter.

DEVELOPING A PAVEMENT ASSET MANAGEMENT PLAN

Information Required For the Plan

The material contained in the pavement asset management plan is divided into three sections, as described below.

Pavement Asset Inventory

This section of the plan includes an inventory of pavements in the network. This information can be presented in a table format (as shown in the template) or in a different format if that is more convenient. The inventory should include information that identifies each road, its length and width, functional classification, and the type of pavement surface. In addition, the inventory should include the most recent PASER rating and the year in which the rating was conducted.

This information may be obtained from paper records, a spreadsheet, or a database.

Road Treatment Summary

The second section of the pavement asset management plan includes a summary of the road repairs that are planned for the next 5 years. The plan does NOT have to list every road section that is planned for repair. Instead, agencies should summarize, by year, how many miles of each type of treatment will be addressed, the estimated cost per mile, and the total cost for the work. The average PASER rating for the roads receiving each type of repair should also be provided.

The total amount spent on road repairs each year should not exceed the funding levels available for these types of repairs. As you prepare the summary, keep in mind that the PASER ratings provide a good idea of the level of repair that's needed (as discussed in chapters 4 and 5). Since most agencies have more road needs than they do funding, it's important to prioritize which projects should be funded first. One cost-effective strategy is to avoid putting your entire budget towards roads that are in *Poor* condition, even if it's tempting to do so. It's much better to invest in a "mix of fixes" that addresses some of the roads in *Poor* condition, but also addresses some roads in *Fair* condition that don't have too much deterioration present. You can keep the road in *Fair* condition from dropping to *Poor* condition by applying some low-cost treatments like seal coats or chip seals. In the long run, the mix of fixes will lead to better road conditions over time than a strategy that just focuses on roads in *Poor* condition.

Performance Objectives and Measures

The last section of the pavement asset management plan asks the agency to set level of service goals (or targets) for the road network and to describe the processes used to develop the work plan and monitor the work plan over time. It also asks each agency to describe the drainage and right-of-way (ROW) conditions for the road network. Guidance for rating drainage and ROW conditions is provided in the next part of this chapter.

Your current PASER ratings can be used to set a level of service target for your road network, but if you have historical trends showing how the conditions are changing over time, it will be even easier. Methods of developing a level of service target are discussed in chapter 5. One way to set a level of service target is to calculate a weighted average condition for your road network. The number calculated could be used as the target if you think you can maintain that condition over time. If road conditions are getting better with time, you might set a higher target and if they are getting worse, you may set a lower target. You might also consider reporting your target in terms of the number of miles that will be in *Good* or *Fair* condition, since PASER ratings might not be well understood by the decision makers.

Some agencies set level of service targets that are higher than what their budget will allow them to achieve. These types of targets are called aspirational targets. These targets are used to show elected officials the amount of money that is needed to bring roads up to the desired condition. For example, if an agency set a target so that all of its roads are in *Good* condition, you could calculate the estimated cost to reach that condition using the results of your PASER survey and average cost information for the types of treatments you use on your network. The costs shown earlier in figure 2-3 give you a range of typical treatment costs that can be used for roads at different condition levels.

Addressing Drainage and Right-of-Way Conditions

Good drainage is an important part of pavement performance. Without it, roads can flood or potholes can result. For that reason, it is important to assess the condition of existing drainage systems so the information can be used to help estimate maintenance and rehabilitation strategies. Typical signs that drainage work is needed include clogged ditches, vegetation and brush obstructing water flow, sediment in culverts, or ponding behind curbs in urban areas.

A good drainage system prevents water from standing on the road or saturating the base layers. There are many different types of drainage systems including shoulders, ditches and culverts, curb and gutter systems, and storm sewers. An evaluation of drainage conditions should include the following checks:

- ***Crown*** the center of the road should be higher than the shoulders so water will run off the road onto the shoulders. The crown is especially important with gravel roads since they are more susceptible to rain damage.
- ***Shoulders*** the shoulders should help direct the water flow to the ditches, so they should have enough of a slope to keep rain from getting trapped against the pavement. A common distress on rural road in Indiana is edge distress, primarily caused by poor drainage at the edge of the pavement and traffic loads cause edge failure. Edge distress is identified as a PASER 3 rating.
- ***Ditches*** the ditches help carry water away from the road so they should be properly shaped and clear of vegetation or growth.
- ***Culverts*** culverts help control water flow by carrying water under the road to the ditch. The culvert has to have a thick enough wall and enough reinforcement to be able to carry the weight of the road and traffic. Culverts should have enough cover to protect the culvert, it should be sized adequately to carry the typical flow capacity, should have an end treatment, and should be clear of debris.

- ***Curb and gutter*** curbs and gutters are often used in urban areas where there is not enough room for ditches. The gutters should not be filled with overlays, there should be no evidence of settlement and the gutters should be free of debris.
- ***Storm sewers and inlets*** these drainage devices collect water from the streets and carry it to streams or other bodies of water. These typically require a more sophisticated visual inspection, which may include cameras that can be snaked through the pipes.

The Transportation Information Center at the University of Wisconsin-Madison has developed the *Local Road Assessment and Improvement Drainage Manual* (http://epdfiles.engr.wisc.edu/pdf_web_files/tic/other/Drainagecontent.pdf) that includes a simple method of assessing drainage conditions while conducting a PASER survey, as shown in table 7-1.

Table 7-1. Drainage assessment ratings[19].

RATING	DESCRIPTION	IMPROVEMENT NEEDED
Excellent	With adequate ditches or like-new curb, gutter, and storm sewer system. All culverts clean and sound	No improvement necessary.
Good	Overall, pavement and shoulder have adequate crown, ditching, or storm sewer on the majority of the section. May need localized cleaning of ditches, storm sewers and culverts; minor repairs to curbs, inlets, and culverts. No drainage-related pavement damage.	Minor or localized repairs.
Fair	Minimal crown on pavement. Some areas need shoulder slope improvement. Ditching improvement or cleaning needed on up to 50% of ditches. Pavement distress from localized flooding or ponding indicates improvements are needed in some storm sewer, inlets, or ditching. Some culverts need cleaning or minor repairs.	Several improvements necessary.
Poor	No pavement crown. Shoulders create secondary ditch. Frequent ponding. Significant ditching improvements needed on more than 50% of roadway. Frequent localized flooding or erosion with pavement distress or failure. Significant improvement in storm sewer, curb or inlets, and/or major culvert replacement or improvement needed.	Major improvement in drainage required.

19 Walker, D., L. Entine, S. Kummer. 2000. Local Road Assessment and Improvement Drainage Manual. University of Wisconsin-Madison Transportation Information Center. (http://epdfiles.engr.wisc.edu/pdf_web_files/tic/other/Drainageconent.pdf).

It is also important to check the ROW during the survey to ensure that there are no obstructions or other issues that could lead to safety issues along the road.

EXAMPLES FROM LOCAL AGENCY PAVEMENT ASSET MANAGEMENT PLANS

Inventories and Process Documentation

As discussed in chapter 4, many local agencies in Indiana are building their pavement inventory and collecting PASER ratings using agency staff, although some have hired consultants to collect the data. If pavement management software is not available, the information is put into a spreadsheet or an Access database for use in developing the pavement asset management plan. An example of a report showing a portion of the asset inventory from Noble County is provided in figure 7-1. This is the type of report that can be included in a pavement asset management plan.

The results of the pavement condition surveys are used with other information that is available (such as traffic levels, emergency routes, other construction projects, and local community needs) to develop a 5-year program that reflects good use of available funding. The process that was used to develop the program should be documented in the pavement asset management plan, along with a summary of how the pavement conditions will be monitored and the plan will be kept current. Examples of how this information was presented by Brown County in its pavement asset management plan is presented on the next page.

NOBLE COUNTY HIGHWAY — PAVEMENT ASSET INVENTORY — 2016

Roadway	From Road	To Road	Length	Width	Surface Type	Rating	Year Rated	Functional Classification
Butler Ln.	Kathryns Ct.	Patty Ln.	0.04	35	Asphalt	7	2016	Local—Residential
Candy Ln.	Meadow Ln.	Patty Ln.	0.06	22	Chip Seal	5	2016	Local—Residential
Carnoustie Cir.	Claridge Ct.	End	0.06	27	Asphalt	8	2016	Local—Residential
Carnoustie Cir.	Ballenshire Ln.	Claridge Ct.	0.09	28	Asphalt	8	2016	Local—Residential
Circle Dr.	W. Split	N 900 E	0.09	23	Chip Seal	5	2016	Local—Residential
Circle Dr.	E. Split	E. Split	0.48	18	Chip Seal	5	2016	Local—Residential
Claridge Ct.	End	Carnoustie Cir.	0.03	28	Asphalt	8	2016	Local—Residential
Cobblestone Ln.	Sawgrass Cir.	Laurelwood Ln.	0.18	27	Asphalt	8	2016	Local—Residential
Cobblestone Ln.	Laurelwood Ln.	Merritt Dr.	0.23	27	Asphalt	8	2016	Local—Residential
Country Homes Dr.	End	Diamond Lake Rd.	0.24	23	Chip Seal	5	2016	Local—Residential
Diamond Lake Rd.	Rochester Rd.	Country Homes Dr.	0.66	20	Chip Seal	6	2016	Rural
Diamond Lake Rd.	Country Homes Dr.	Lincolnway S.	0.33	21	Chip Seal	6	2016	Rural

Figure 7-1. A portion of the pavement asset inventory and PASER ratings from Noble County.

Excerpts from the Brown County Pavement Asset Management Plan:

DESCRIBE THE PROCESS USED TO DEVELOP A WORK PLAN:

We develop the work plan (paving plan) based on Paser condition ratings, traffic volumes, emergency routes, community needs, and our local knowledge of history of existing pavement. We select roads that will provide a good long term life-cycle service. We also evaluate the other construction activity planned in the area - such as closure of State Roads which force extra traffic onto local county roads. We will wait until after their construction is completed, if possible, and then do our roadway improvements in order to increase the service life of the new county roadway pavement.

DESCRIBE THE MONITORING PROGRAM AND PLAN FOR MAKING UPDATES AND ADJUSTMENTS:

We believe the Asset Management Plan is a "living" document to be updated and improved as often as necessary to incorporate changes in the roadway system. Changes will occur due to natural aging of the system, flood and storm damages, freeze/thaw damage, vandalism, etc. Positive changes will occur with new construction, reconstruction, and maintenance of the roadway system.

As a Standard Operating Procedure, we will review and modify the program each spring as the major damages normally appear after the winter season. Any revisions to the condition ratings and road improvement priorities will be incorporated into the Annual Plan at such time. The Brown County Highway is currently setting paving priorities based on the Roadway Improvement Plan 2015-2017 prepared by Superintendent Magner. This Plan identified 138.7 miles of roads in need of paving within the three year window. Due to lack of funding to accomplish this paving, it will take at least seven years to complete this work. Our goal with the new 2016 GRANT Funding is to improve as many miles of roadway as possible and be able to use the additional funding to help close the funding gap and save the roadways from falling into the distress category and requiring full reconstruction at a much higher cost.

Roadways in Brown County are monitored on a daily basis by the Highway Management, Highway crews, Sheriff Department, and the general public - who are happy to call to inform us of road conditions in their area, township, or just where they may happen to be driving. People are quick to call about a pothole, dusty road, muddy road, or weeds that need mowed.

Summaries of Pavement Conditions

The graphic shown in figure 7-2 was provided by Ripley County. Note that in addition to showing the number of miles at each PASER rating, the color coding provides a way of illustrating which PASER ratings correspond to *Good, Fair, and Poor conditions.*

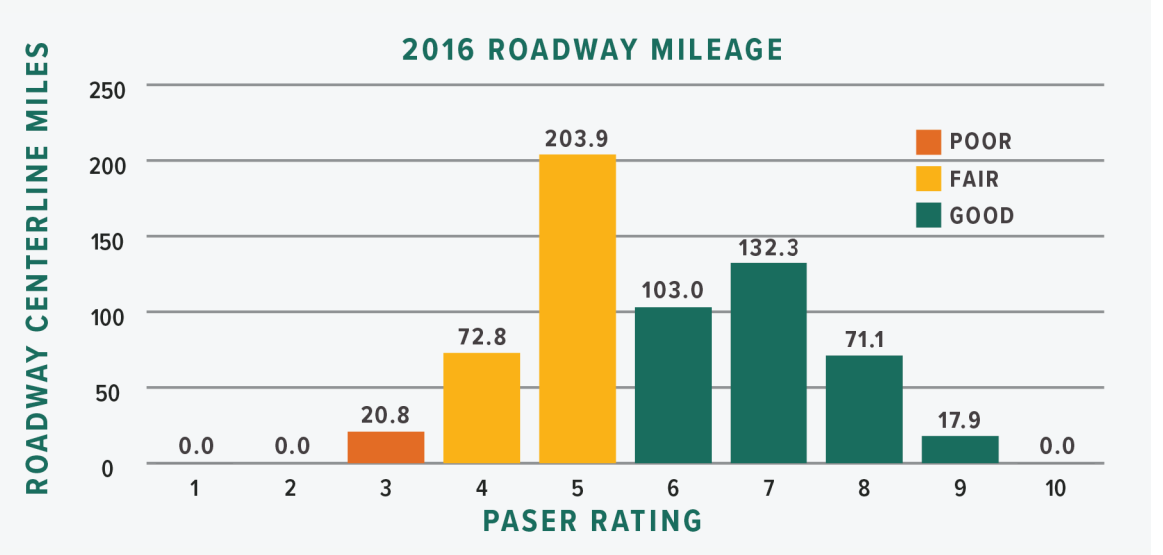


Figure 7-2. Ripley County summary of road conditions.

Some of the local agencies in Indiana indicated they have linked their pavement inventory and condition information to their Geographic Information Systems so they can produce maps showing road conditions, as shown in figure 7-3 from Noble County. Noble County also produces graphs that summarize conditions by Township, as shown in figure 7-4.

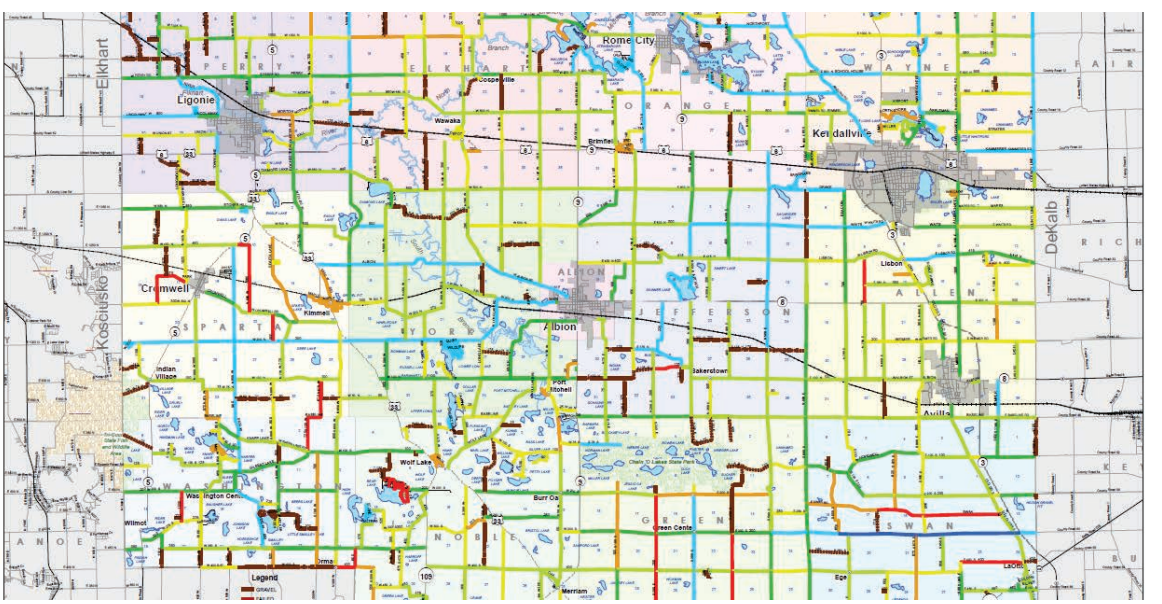
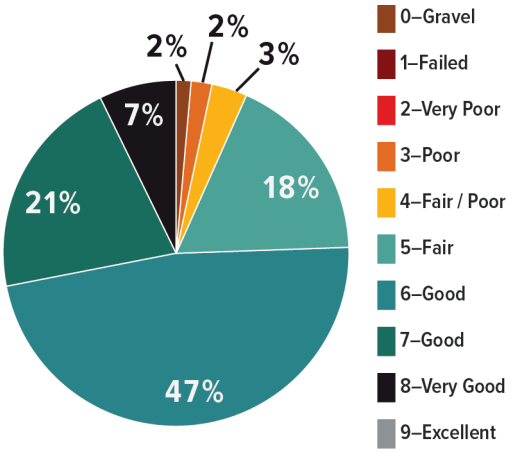


Figure 7-3. Noble County road condition map.



ALLEN TOWNSHIP			
Rating	Mileage	Percentage	Weight Rating
9—Excellent	0.00	0.0%	0.00
8–Very Good	4.50	7.1%	0.58
7–Good	13.14	20.8%	1.48
6–Good	29.90	47.4%	2.89
5–Fair	11.23	17.8%	0.90
4–Fair / Poor	2.15	3.4%	0.14
3–Poor	1.20	1.9%	0.06
2–Very Poor	0.00	0.0%	0.00
1–Failed	0.00	0.0%	0.00
0–Gravel	1.01	1.6%	N/A
Total:	63.13	100.0%	6.05

Figure 7-4. Noble County road conditions by township.

The last example presented as figure 7-5 shows how Ripley County summarized pavement conditions by roadway classification. Since roadway classifications are usually closely linked to traffic levels, this format allows the County to show the roads with the most traffic are in *Good* condition, but the local roads are more deteriorated.

ROADWAY CLASSIFICATION SURVEY		
Classification	Mileage	Avg. PASER Rating
Local Road	590.6	*5.6
Minor Collector	1.0	7.0
Major Collector	1.8	7.0
Rural Minor Collector	60.2	7.1
Rural Major Collector	60.7	6.8

*Local Roads include Stone, not all Stone roads were rated, this average is only for the asphalt roads.

Figure 7-5. Ripley County average condition rating by functional classification.

Presenting Road Needs

Local agencies use several different methods of presenting their road needs in the pavement asset management plans. The plans are not required to include a detailed list of all of the projects that will be funded, but many plans include that information in the document or in an appendix.

2016 — ROADWAY ASSET MANAGEMENT — 5 YEAR PROJECTION							
Road name	Start Point	End Point	Miles	Work performed	Cost	Year	Cumulative Cost
Angling Rd.	Kendallville	800N	1	1.5" HMA Surface	$55,746	2016	$55,746
600S	SR9	Bridge 82	2.45	1.5 HMA Surface	$136,578	2016	$192, 324
Appleman Rd.	1000E	Riley Rd.	1.25	Crack Seal	$6,875	2016	$199,199
900N	1050W	SR.5	2.5	Crack Seal	$13,750	2016	$212,949
550S	1100E	Old SR.3	1	Crack Seal	$5,500	2016	$218,449
900N	125W	100E	2.25	Crack Seal	$12,375	2016	$230,824
400N	150E	415N	1	Crack Seal	$5,500	2016	$236,324
415N	400N	500E	2.5	Crack Seal	$13,750	2016	$250,074

Figure 7-6. A portion of the Noble County list of planned projects

The two figures from Noble County, shown in figures 7-6 and 7-7, show a portion of the detail table listing all of the projects as well as the summary table that lists the amount of work that will be done by treatment type (shown for 2 years only).

Another example of a treatment summary from Fulton County is provided in figure 7-8. This example shows the work that will be done in 1 of the 5 years covered in the plan.

NOBLE COUNTY HIGHWAY — PAVEMENT TREATMENT SUMMARY

Year	Rating	Treatment	Estimated cost per mile	Estimated miles	Estimated cost
2016	7–10	Crack Seal	$5,500	33.6	$184,800
	6–7	Rejuvenator	$11,733	4.2	$49,749
	6	Single Micro Seal	$35,200	0.3	$10,912
	6	Single Chip Seal	$10,939	13.3	$144,944
	5	Double Chip Seal	$21,036	32.2	$676,314
	5	Double Micro Seal	$46,933	5.8	$275,111
	4–5	1.5" HMA Surface	$55,746	3.5	$192,324
	4–5	Wedge	$5,000	15.7	$78,250
	1–3	Reconstruction	$56.624	9.0	$509,616
				2016 Total	$2,122,020
2017	8–10	Asphalt Sealant	$12,085	9.9	$119,282
	7–10	Crack Seal	$5,665	46.4	$262,969
	6	Single Chip Seal	$11,267.38	30.8	$346,472
	6	Micro Seal	$36,256.00	1.0	$37,344
	5	Double Chip Seal	$21,667.29	24.8	$536,265
	5	Double Miro Seal	$48,341.33	5.8	$279,353
	4–5	1.5" HMA Surface	$57,418.38	0.6	$35,025
	4–5	2" HMA Binder	$73,601.33	7.0	$513,737
	4–5	Wedge	$5,150.00	7.0	$36,050
	1–3	Reconstruction	$58,322.72	8.5	$495,743
				2017 Total	$2,662,241

Figure 7-7. Summary of treatments for 2 of the 5 years in the Noble County Pavement Asset Management Plan.

MAINTENANCE COST SUMMARY USING ONLY PROJECTED MVH, LRS FUNDS, AND WHEEL TAX REVENUE

Year	Rating	Treatment Used	Estimated cost per mile	Estimated miles	Estimated cost
2017	8–10	Durra Patch	$1,000	20	$20,000
	7	Durra Patch	$3,000	10	$30,000
	6	Chip Seal	$9,665	40	$386,600
	5	Repairs and Chip Seal	$10,915	40	$436,600
	4	Repairs and Overlays	$29,552	10	$295,520
	3	Some Reconstruction	$77,000	2	$154,000
	2	Large Reconstruction	$154,000	1	$154,000
	1	Total Reconstruction	$254,000	1	$254,000
				Total	$1,730,720

Figure 7-8. Fulton County work summary for 1 year of the plan.

Floyd County's Pavement Asset Management Plan includes a summary of all the work that will be conducted over the 5-year period covered in the Plan, as shown in figure 7-9.

Ripley County's Pavement Asset Management Plan includes a summary of what it would cost to address all of the current road network improvement needs. Its plan lists about $6.5M in project for the 5 years in the plan, showing that they will be addressing most of their needs within the 5-year window. The table is presented in figure 7-10.

RATING	TREATMENT USED	ESTIMATED COST PER MILE	ESTIMATED MILES	ESTIMATED COST
9–10	Crack Sealant	$5,000	53	$265,000
7–8	Crack Sealant	$5,000	64	$320,000
6	Crack Sealant	$5,000	93	$465,000
6	1" Overlay	$50,000	30	$1,500,000
4–5	2" Overlay	$70,000	33	$2,310,000
1–3	Reconstruction	$115,000	11	$1,265,000
			Total	$6,125,000

Figure 7-9. Floyd County summary of work to be conducted over the 5-year period.

PASER RATING	PAVEMENT TREATMENT	LANE MILES (11' LANES)	ESTIMATED COST PER LANE MILE	ESTIMATED COST TO IMPROVE
1	Reconstruction	0.00	$352,029.33	$0.00
2	Reconstruction	0.00	$352,029.33	$0.00
3	Resurface, 10% Full Depth Patch	31.07	$92,702.13	$2,880,423.83
4	Chip Seal	102.08	$7,000.00	$714,589.21
5	Chip Seal	301.64	$7,000.00	$2,111,501.72
6	Crack Seal	157.96	$2,000.00	$315,918.90
7	Crack Seal	211.34	$2,000.00	$422,681.37
8	None	103.04	$0.00	$0.00
9	None	27.45	$0.00	$0.00
10	None	0.00	$0.00	$0.00
	Totals	934.59		$6,445,115.04

Figure 7-10. Total estimate of all paved road needs (based on 11 ft width) in the Ripley County Pavement Asset Management Plan.

Performance Goals

Local agencies in Indiana have also used various methods of presenting their pavement goals as illustrated in the following excerpts. The first one is taken from the Ripley County Pavement Asset Management Plan. It explains that its road network will be maintained above a PASER rating of 4.0.

> ***The expected level of service (LOS) rating for the roads maintained by Ripley County is based upon the functional classification. The County desires the Local Roads be maintained to a LOS rating of 4 or higher Rural Minor and Rural Major Collectors will be maintained to a LOS rating of 4 or higher. Minor and Major Collectors will also be maintained to a LOS rating of 4 or higher. A PASER rating of 4 is the lowest rating for a road to be consider in fair condition. With Ripley County's current ability to chip seal up to 150 miles of roadway each year they are able to stay ahead of the roadway's sever deterioration.***

The second example from the Floyd County Pavement Asset Management Plan[20] shows that different performance measures are used based on the roadway classification.

BENCHMARK PERFORMANCE GOALS

1. All Minor Arterial Roads will have a benchmark rating of 8 within 2 years.
2. All Major Collector Roads with a rating of 4–5 will be slated for resurfacing within the next 3 years.
3. All Major Collector Roads with a rating of 6–9 will be slated for preventive maintenance within 1 year.
4. All Minor Collector roads with a rating of 4–5 will be slated for resurfacing within the next 3 years.
5. All Minor Collector roads with a rating of 6–9 will be slated for preventive maintenance within 1 year.
6. All local roads with a rating of 0–3 or less will be slated for resurfacing within the next five years.
7. All local roads with a rating of 6–9 will be slated for preventive maintenance within the next five years.
8. A quarter of the roads with a rating of 5 will be slated for preventive maintenance and selected resurfacing.

20 Floyd County. 2016. *Pavement Asset Management Plan.*

DEVELOPING A BRIDGE ASSET MANAGEMENT PLAN

The minimum requirements for the bridge asset management plan are presented in Appendix C, along with an example of the format that may be used for presenting the information. The biggest difference between the development of the bridge asset management plan and the pavement asset management plan is that the inventory and condition information that is included in the plan comes from the INDOT bridge database. INDOT also provides guidance to local agencies in developing work plans in a document, *Asset Management for Local Public Agency Bridges,* published by the INDOT Local Public Agency Program in April 2016.

In 2017, a new template for the Bridge Asset Management Plan was developed. It is described in Appendix C.

EXAMPLES FROM LOCAL AGENCY BRIDGE ASSET MANAGEMENT PLANS

The information extracted from the INDOT database is used to produce the summary of bridge inventory, condition assessment results, and treatment needs. Several examples of different formats that are used for presenting the information, from local agencies in Indiana, are provided below. The first example provided in figure 7-11 is from Henry County.

Fulton County produces a report that uses color coding to provide a visual representation of bridge conditions in addition to the NBI ratings. The example provided in figure 7-12 is an extract from the full table that is provided in the Plan. It was modified to better fit within the pages of this document. A second example from Fulton County, presented as figure 7-13, expands on the information in the first table, showing the sufficiency rating, work needs, and treatment costs for each bridge shown in figure 7-12.

HENRY COUNTY — BRIDGE ASSET MANAGEMENT PLAN — 2016

Bridge Number	NBI #	Deck Rating 058	Superstructure Rating-059	Gen. Paint Condition-59.01	Substructure Rating-060	Channel Rating-061	Culvert Rating-062	Sufficiency Rating	Structurally Deficient	Functionally Obsolete	Work Type	Planned Repair Year	Estimated Cost
33-00003	3300002	3	4	0	5	5	N	15.0	≤		Replacement	2017	$1,291,000
33-00004	3300187	N	N	N	N	6	5	59.7		≤	Replacement	2024	$487,500
33-00005	3300004	7	7	N	7	7	N	95.1					
33-00006	3300005	7	7	N	7	8	N	89.0					
33-00007	3300006	6	6	N	6	5	N	91.5			Preventive Maintenance	2021	$7,000

Figure 7-11. A portion of the summary table included in the Henry County Bridge Asset Management Plan.

Fulton County

Bridge Info			NBI: Condition Ratings				
Asset Name	NBI Structure Number	Year Constructed	NBI 058: Deck	NBI 058.01 Wearing Surface Rating [National Bridge Inventory]	NBI 059: Superstructure	NBI 060: Substructure	NBI 061: Channel and Channel Protection
25-00002	2500001	2005	7	7	8	7	7
25-00006	2500002	1970	7	6	7	7	7
25-00007	2500003	1984	6	5	7	7	6
25-00021	2500011	1979	7	5	7	7	6
25-00023	2500012	1981	7	5	7	7	7
25-00024	2500013	1975	N	6	N	N	5
25-00027	2500014	1969	6	7	6	6	6
25-00032	2500015	1975	5	6	6	6	7

Figure 7-12. A portion of the NBI condition rating summary from the Fulton County Bridge Asset Management Plan.

Sufficiency Rating		Cost Estimate			
Unofficial Sufficiency Rating	Status [National Bridge Inventory]	Total Estimated Cost (5-Year Plan)	Year Work is Needed	Inspector's Estimated Cost	Additional Maitenance Cost
99.9		$0		$ -	3,000.00
97.0		$0		$ -	0.00
91.5		$0		$ -	10,000.00
86.9		$0		$ -	35,000.00
91.5		$0		$ -	30,000.00
96.0		$0		$ -	10,000.00
92.9		$0		$ -	0.00
88.3		$1,175,000	2021	$ 750,000	0.00

Figure 7-13. Sufficiency ratings and work plan activities included in the Fulton County Bridge Asset Management Plan for the bridges shown in figure 7-12.

A portion of a table showing the planned projects Noble County included in its asset management plan is included as figure 7-14, illustrating both funding sources and planned treatment years.

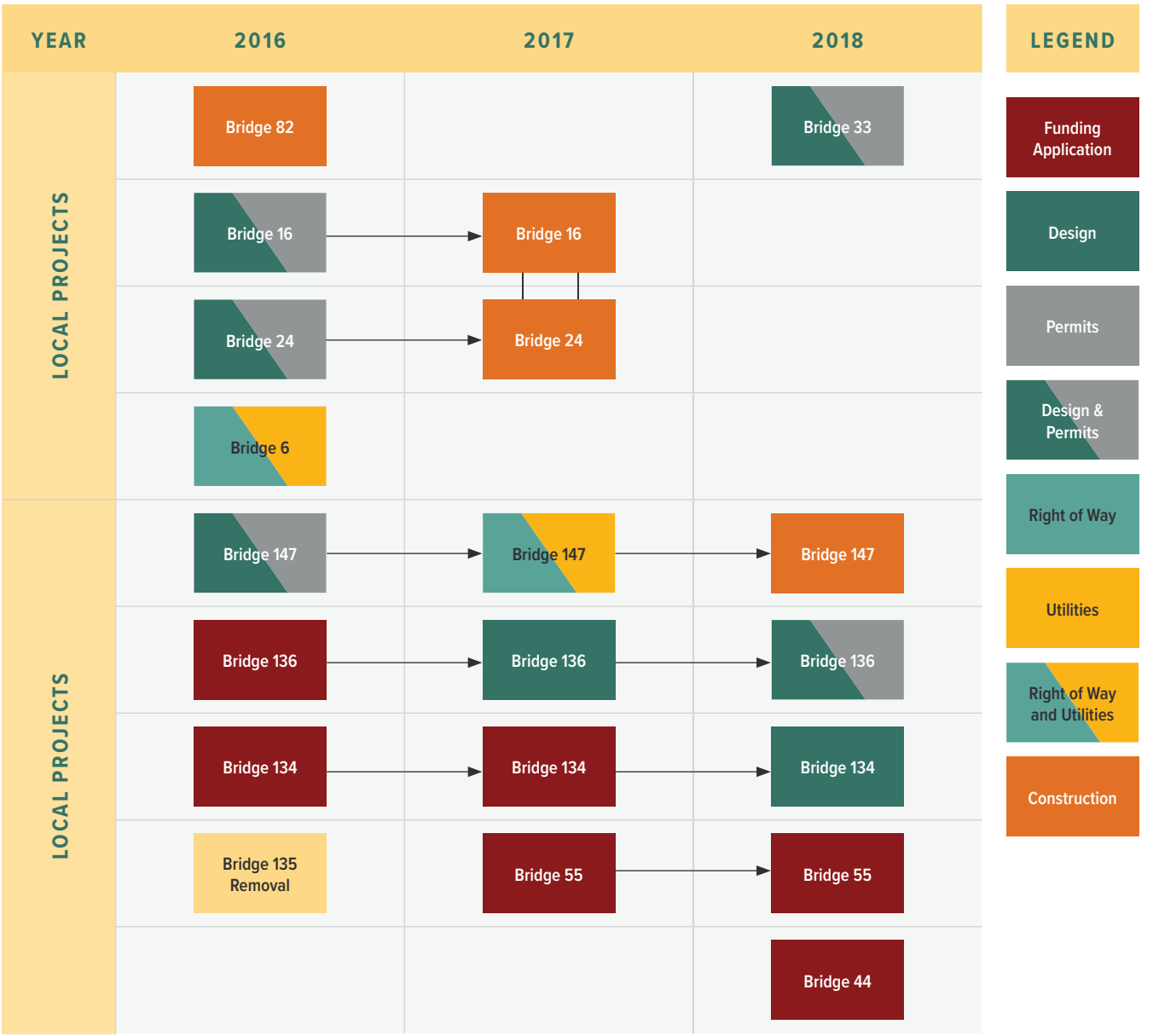


Figure 7-14. A portion of the Noble County bridge replacement plan.

The bridge asset management plan template is included in Appendix C.

OTHER INFORMATION PRESENTED IN ASSET MANAGEMENT PLANS

In its Pavement Asset Management Plan, Fulton County describes the importance of early and systematic interventions to get the most benefit out of investments in the road network. They include figure 7-15 in their plan to illustrate this concept. It shows that a $2 investment in a road still in *Good* condition will cost $6 to $8 if the work does not get done until the road is in *Fair* or *Poor* condition.

TIPS AND TRICKS FROM LOCAL AGENCY EXPERIENCES IN INDIANA

As a follow-up to the survey of local agencies in Indiana that was conducted during the development of this Guide, several agencies were asked to provide feedback on the amount of time required to build their inventory and conduct the PASER surveys, the biggest challenges they faced in developing their plans, and any benefits they have realized from the process. These individuals were also asked to describe any lessons they've learned from their experiences that might benefit other local agencies. Their responses to each of the questions are provided below.

Time Required to Build the Inventory and Conduct PASER Ratings

When asked to describe the amount of time required to build the road inventory and conduct PASER ratings, the following comments were offered by local agencies in the state:

- One city was able to use its street centerline maps from its GIS in a tablet interface for collecting PASER ratings. Their process was considered to be very efficient, with three teams able to collect the road ratings for 34 centerline miles over a 4-day period.

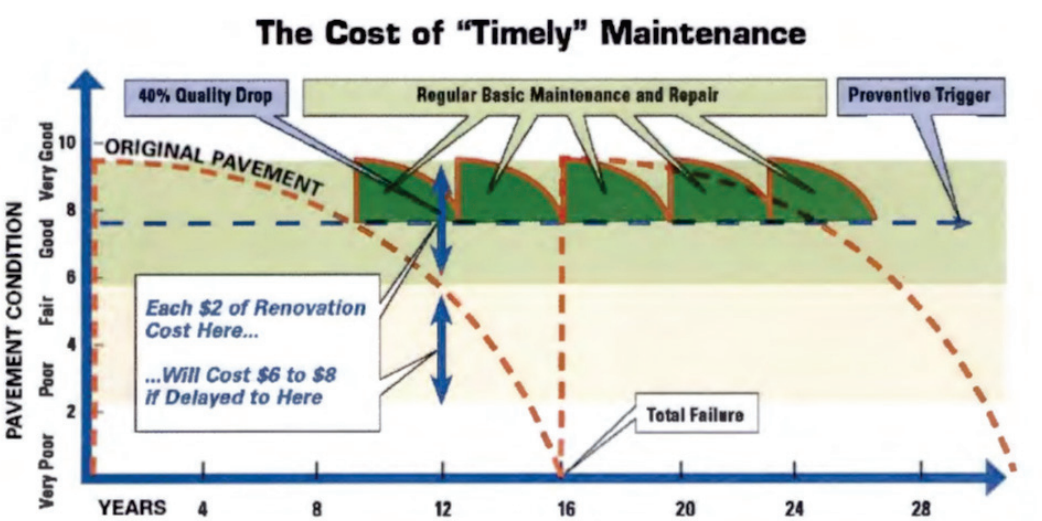


Figure 7-15. Fulton County illustration showing the cost-effectiveness of early intervention

- A city with just over 100 miles in its network was able to collect the data at a rate of about 2 to 3 miles per hour in the field.
- One county with approximately 780 centerline miles was able to collect PASER ratings for all roads, except the subdivision roads, in about 2 to 3 weeks. The subdivision roads usually take approximately 2 more weeks to complete. All of the data is loaded into a spreadsheet in one morning and it takes about one day to put together the priorities.

Biggest Challenges in Developing Pavement and Bridge Asset Management Plans

Asset management relies on good, quality data for managing the pavement and bridge networks. For many agencies, this represents a change in the way work plans had been developed in the past. Several local agencies were asked to identify the challenges they realized in developing their plans. Their responses identified the challenges listed below.

- Coordinating the training, people, and equipment for this effort.
- Building consistency among raters. It involved getting everything set up and going through the training.
- Maintaining consistency in ratings from one year to the next.
- Assigning costs to maintenance activities because of the variability in costs from one year to the next.
- Starting with nothing and having to build all the data sets needed to create the inventory and the plan.

Benefits Realized From Collecting Inventory and Condition Data or Putting Together a Plan

Although there were challenges in putting together the plans, all of the agencies questioned recognized that they had already realized some important benefits from the availability of the data. The benefits these agencies identified are listed below.

- In the past, county records were incomplete or did not exist. This process allowed the agency to improve their records. They now have a better understanding of road conditions, which is helping them set priorities and develop work plans.
- The process was considered a good first step in asset management and it motivated one city to begin a citywide asset management plan.
- Comparisons of road conditions from one year to the next have been helpful for monitoring deterioration.
- One city has used its asset management plan to identify the projects for the past 2 years.
- The results allowed one agency to describe actual needs to maintain operability at prescribed levels.
- One streets department was very happy to have the road ratings to justify their paving program.
- The information helped one agency identify its backlog so resources could be allocated to address this unfunded need.
- It was a lot of work, but one county was able to get $1M in funding for 2 years because of the data.

Lessons Learned

Representatives from these agencies were also asked to list any lessons learned from the experience that might help other local agencies in Indiana. Their suggestions are listed below.

Don't be afraid to jump right in and get started. You'll find that the process goes quickly once you take the first steps.

Maintain a system that is simple, manageable, and not too data intensive or the quality of the information will be lost.

Work on the accuracy of the ratings and build consistency from one year to the next.

Don't worry about being perfect. Get a plan together so your municipality can start using it as a planning tool. ■

APPENDIX A

Typical Pavement and Bridge Preservation Treatments

TYPICAL PAVEMENT IMPROVEMENTS

The following table lists the types of improvements that are appropriate at different PASER ratings. It also provides general cost information for these treatments and life extensions that can be expected. Please note that the life extension provided in this table assume that the PASER ratings reflect the definitions in the PASER Manual. This helps ensure that preservation treatments, especially those being conducted on roads in good and fair condition are good candidates for the type of treatments recommended. If your pavement section shows significant amounts of structural deterioration (such as alligator cracking or rutting), it is probably a better candidate for a structural improvement than a non-structural preservation treatment.

PASER RATING	CONDITION	LEVEL OF REPAIR AND TREATMENTS SUGGESTED	TYPICAL REPAIR COSTS (PER MILE)	TYPICAL LIFE EXTENSION (IN YEARS)
Asphalt Roads				
9 and 10	Excellent	No maintenance required	$0 to $3,000	N/A
8	Very Good	Little to no maintenance - Treatments might include crack sealing or a fog seal		1 -2
7	Good	Preventive maintenance - Treatments might include more extensive crack sealing, minor patching, and fog seals	$5,000 to $100,000	1-3
5 and 6	Fair to Good	Non-structural preservation treatment - Treatments might include a thin overlay, microsurfacing, seal coat, or a chip seal		4-9
3 and 4	Poor to Fair	Structural repair - Treatments might include mill and overlay or patch and overlay	$130,000 to $500,000	8-15
1 and 2	Failed	Reconstruction		20
Concrete Roads				
9 and 10	Excellent	No maintenance required	$0	N/A
7 and 8	Very Good	Routine maintenance - Treatments might include joint resealing or minor patching	$1,000 to $100,000	1-2
5 and 6	Fair to Good	Preventive maintenance - Treatments might include surface repairs, sealing, and partial-depth patching		2-7
3 and 4	Poor to Fair	Rehabilitation - Treatments might include extensive slab or joint rehabilitation (full-depth repairs), grinding, dowel bar retrofit, and hot-mix asphalt overlays	$130,000 to $500,000	6-15
1 and 2	Failed	Reconstruction		20

TYPICAL BRIDGE IMPROVEMENTS

The following table lists the types of improvements that are appropriate at different NBI ratings. It also provides general cost information for these treatments and life extensions that can be expected. Note that repair costs are not provided for bridge improvements because they vary significantly depending on the type of bridges being repaired.

NBI RATING	CONDITION	STRUCTURAL ADEQUACY	LEVEL OF REPAIR SUGGESTED	TYPICAL LIFE EXTENSION (IN YEARS)
N	Not Applicable		No maintenance required	N/A
9	Excellent		Scheduled preventive maintenance – Treatments might include bridge washing, debris and vegetation removal, drainage clean-out, joint and crack sealing	1-5
8	Very Good			
7	Good			
6	Satisfactory		Preventive maintenance or repair – Treatments might include zone painting, deck patching, repair/replace steel bearing	3-10
5	Fair			
4	Poor	Structurally Deficient	Rehabilitation – Treatments might include complete painting, concrete deck overlays (deep, shallow and hot-mix asphalt with membrane)	8-25
3	Serious			
2	Critical			
1	"Imminent" Failure Condition		Replacement – Treatments might include deck replacement, superstructure replacement, substructure replacement (full or partial), total replacement	40-70
0	Failed			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APPENDIX B

Pavement Asset Management Plan Template

PAVEMENT ASSET MANAGEMENT PLAN

This Pavement Asset Management Plan satisfies State Funding Requirements. This plan must include the complete pavement inventory of the local agency.

Agency Name: _____

Contact Name: _____

Address: _____

Email: _____

Phone: _____

(If applicable)

Consultant Agency: _____

Consultant Contact Name: _____

Consultant Address: _____

Consultant Email: _____

Consultant Phone: _____

Pavement Asset Inventory

Provide the information below for the complete road inventory.

- Designation
- Roadway – Name and suffix (such as Street or Avenue)
- From – Name and suffix
- To – Name and suffix
- Length – Miles
- Width – Feet
- Number of Lanes
- Surface Type – Asphalt (no other substitutions), concrete, chip seal, gravel, brick, unimproved (e.g., dirt).
- Rating
- Year Rated
- Functional Classification

An example table is included on the next page.

Develop a list of proposed treatments by ratings by year for the next 5 years. Provide the information listed below.

- Rating
- Treatment Used
- Estimated Cost per Mile
- Estimated Miles
- Estimated Cost

An example table is included on the next page.

Objectives and Measures

- Define the agency performance goals and expected level of service for pavements.
- Define the rating system used (PASER or PCI or another).
- Describe the process used to develop a work plan.
- Describe the monitoring program and plan for making updates and adjustments.
- Describe drainage and ROW conditions.

SAMPLE TABLES

Sample Road Asset Inventory Table

DESIGNATION	ROADWAY		FROM		TO		LENGTH	WIDTH	NUMBER OF LANES	SURFACE TYPE*	RATING	RATING TYPE (PASER, ETC)	YEAR RATED	FUNCTIONAL CLASSIFICATION
	Name	Suffix	Name	Suffix	Name	Suffix								

* Surface Type Options - asphalt (no other substitutions), concrete, gravel, brick, chip seal, unimproved

Sample Road Treatment Summary Table For the Next 5 Years

YEAR	RATING	TREATMENT USED	ESTIMATED COST PER MILE	ESTIMATED MILES	ESTIMATED COST

APPENDIX C

Bridge Asset Management Plan Template

The submitted Bridge Asset Management Plan should at a minimum contain the "Priority Schedule for Bridges" that is located near the beginning of the bridge inspection reports. This table includes 5 categories: 1) Replacement, 2) Rehabilitation, 3) Widening, 4) Repair, 5) Elimination.

This table can be copied from the bridge inspection report or it can be modified based on your current schedule of priorities. If the table is modified, this should be coordinated with your bridge inspector so they can update the table during the next round of bridge inspections.

Examples of the inventory and condition table, as well as the Priority Schedule for Bridges, are provided on the next two pages in tables C-1 and C-2, respectively.

Table C-1. Sample inventory and rating table.

Bridge Number	NBI #	Deck Rating	Superstructure Rating	Paint System Rating	Substructure Rating	Channel Rating	Culvert Rating	Sufficiency Rating	Structurally Deficient	Functionally Obsolete
BR 1	140	7	7	8	8	7	N	90.2		
BR 2	26005	6	6	N	6	6	N	90.1		
BR 3	24260	4	6	6	6	7	N	71.2	X	
BR 4	7798	N	N	N	N	N	N	96.7		
BR 5	11120	4	4	N	6	5	N	65.1	X	
BR 6	7780	4	4	6	6	4	3	83.1		
BR 7	980	6	6	6	6	6	3	99.3		
BR 8	990	5	5	6	4	7	3	35.1	X	
BR 9	1070	6	6	5	5	6	3	80.9		
BR 10	1080	6	6	5	5	6	3	78.9		
BR 11	1110	7	7	8	8	7	N	90.2		
BR 12	1120	6	6	N	6	6	N	90.3		
BR 13	1170	4	6	6	6	7	N	71.2	X	
BR 14	1180	7	7	6	6	7	6	96.3		
BR 15	1000	7	7	5	5	7	5	67.5		
BR 16	1010	7	7	8	8	7	6	99.3		
BR 17	1020	4	4	N	6	5	N	65.1	X	
BR 18	1030	7	7	6	6	7	4	98.1		
BR 19	1040	7	7	6	6	7	4	98.1		
BR 20	1090	5	4	5	5	7	4	22.1	X	
BR 21	1100	6	6	5	5	6	4	96.0		
BR 22	1130	7	7	8	8	7	N	90.2		
BR 23	1140	6	6	N	6	6	N	90.2		
BR 24	1150	4	6	6	6	7	N	71.2		
BR 25	1160	6	6	5	5	6	4	93.6		
BR 26	1050	5	5	N	N	5	3	85.3		
BR 27	1060	6	6	N	N	6	3	86.3		
BR 28	24130	4	4	N	6	5	N	65.1	X	

Table C-2. Sample priority table for bridges.

PRIORITY SCHEDULE FOR BRIDGE (1) REPLACEMENT (2) REHABILITATION (3) WIDENING (4) REPAIR (5) ELIMINATION								
Bridge Number	Year of Work	Type of Work	Inventory Rating	Unofficial Sufficiency Rating	Estimated Bridge Cost (x$1000)	Estimated Total Cost (x$1000)	Estimated Maintenance Cost (x$1000)	Local Maintenance Year Needed
Category 1								
00284	2017	31	9	12.2	650	1100	000044	2017
00162	2018	31	12	25.5	200	380	000020	2017
00118	2018	31	13	44.8	360	540	000034	2017
00153	2019	31	18	35.6	425	775	000027	2017
00017	2020	31	15	38.9	350	650	000050	2017
00065	2021	31	14	48.9	250	425	000075	2017
00112	2021	31	20	50.6	815	1250	000012	2017
Total Bridges for Category 1: 7								
Category 2								
00105	2017	35	32	67.6	170	220	000047	2017
00187	2018	35	24	57.1	75	120	000044	2017
00282	2018	35	21	60.7	100	190	000030	2017
0095	2019	35	24	68.6	220	270	000052	2017
00155	2020	35	18	40.9	155	255	000054	2017
00142	2020	37	25	59.2	225	300	000035	2017
00010	2021	36	36	66.3	110	165	000040	2017
Total Bridges for Category 2: 7								
Category 3								
00105	2017	34	36	80.1	100	150	000042	2017
00187	2018	34	36	75.2	110	160	00036	2017
00282	2020	34	36	77.6	90	140	000025	2017
Total Bridges for Category 3: 3								
Category 4								
00072	2017	38	36	90.1	50	60	000040	2017
00111	2019	38	36	81.1	65	80	000032	2017
00210	2021	38	36	83.2	44	60	000025	2017
Total Bridges for Category 4: 3								
Category 5								
00105	2017	N/A	0	5.2	50	65	000000	N/A
Total Bridges for Category 5: 1								

NOTES

Our Journey Starts Here

The mission of the Indiana Local Technical Assistance Program is to foster a safe, efficient and environmentally sound transportation system by improving the skills and knowledge of local transportation providers through innovative training, technical assistance and technology transfer.

Contact

INDIANA LTAP
3000 Kent Ave Ste. C2-118
West Lafayette, IN 47906

765-494-2164 or 800-428-7639 (Toll Free)
inltap@purdue.edu
purdue.edu/inltap

@ltapindiana

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