

Considerations in Managing Pavements and Bridges in *Fair Condition*

April 2023



Source: Applied Pavement Technology, Inc.

FHWA-HIF-23-012



U.S. Department
of Transportation
**Federal Highway
Administration**

Federal Highway Administration

**Office of Stewardship, Oversight and Management
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Washington, DC 20590**

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1. Report No. FHWA-HIF-23-012	2. Government Accession No. None.	3. Recipient's Catalog No. None.	
4. Title and Subtitle Considerations in Managing Pavements and Bridges in <i>Fair</i> Condition		5. Report Date April 2023	
		6. Performing Organization Code None.	
		8. Performing Organization Report No. None.	
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9. Performing Organization Name and Address Applied Pavement Technology, Inc. 115 W. Main Street, Suite 400 Urbana, IL 61801		11. Contract or Grant No. Contract No. 693JJ319D000023/ Order No. 693JJ320F000210	
		13. Type of Report and Period Covered White Paper, September 2021 to May 2022	
		14. Sponsoring Agency Code None.	
12. Sponsoring Agency Name and Address Federal Highway Administration 1200 New Jersey Ave SE Washington, DC 20590		15. Supplementary Notes Laura Lawndy (COR), Tashia Clemons (Technical Lead)	
16. Abstract The percentage of pavements and bridges in <i>Fair</i> condition represents a significant portion of the nation's inventory. This document summarizes points raised during virtual meetings conducted by the FHWA's Transportation Asset Management Expert Task Group (TAM ETG) during calendar year 2021. These discussions addressed the importance of managing pavement and bridge assets in <i>Fair</i> condition as a cost-effective strategy for system preservation. This summary highlights several examples provided by the TAM ETG to illustrate the importance of managing assets in <i>Fair</i> condition and suggests the consideration of performance to preserve or extend asset life in accordance with sound lifecycle planning practices to mitigate risk. The discussions that took place on this topic were independent of the approach used to define <i>Fair</i> condition.			
17. Key Words Transportation Asset Management, Pavement Condition, Bridge Condition, Transportation Performance Management		18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161	
19. Security Classify. (of this report) None.	20. Security Classify. (of this page) None.	21. No of Pages 10	22. Price None.

Background

When the Moving Ahead for Progress in the 21st Century (MAP-21) Act¹ was enacted in 2012 it included a requirement for asset management plans to be developed for National Highway System (NHS) pavements and bridges². These plans placed the country's State transportation departments (State DOTs), and by extension the many local agencies they partially fund and support, on a path toward the broad use of transportation asset management (TAM). There are many benefits to this. For instance, transportation agencies can use TAM principles to develop and implement cost-effective investment strategies to address highway infrastructure needs. TAM also provides a rational framework for a performance-based approach to managing transportation assets that considers long-term needs and risks in the face of common financial and operational constraints.

The Bipartisan Infrastructure Law (BIL), enacted as the Infrastructure Investment and Jobs Act (IIJA) (Pub. L. No. 117-58) on November 15, 2021, includes program funding for asset management as well as other provisions related to asset management, including those listed below:

- The Bridge Investment Program and Bridge Formula Program provide billions of dollars to address bridge needs. Fact sheets are available on the *FHWA Bipartisan Infrastructure Law webpage*: https://www.fhwa.dot.gov/bipartisan-infrastructure-law/fact_sheets.cfm
- Transportation asset management plans are now required³ to consider extreme weather and resilience. Guidance is available in the *FHWA Memo on State Asset Management Plan Under BIL*: <https://www.fhwa.dot.gov/asset/guidance/may2022memo.pdf>

Considering the interest in asset management the Federal Highway Administration (FHWA) formed a Transportation Asset Management Expert Task Group (TAM ETG) to identify outreach activities and other initiatives that further the awareness and use of asset management. The TAM ETG was formed in March 2012 and its members have been on the leading edge of discussions concerning existing and emerging issues to advance the state-of-practice.

During TAM ETG meetings conducted in calendar year 2021, several members acknowledged that they were experiencing increases in the percent of their pavement and bridge networks that were falling into *Fair* condition, regardless of whether the Federally-required performance measures⁴ or the State's own measures were being used. The TAM ETG members recognized factors contributing to this situation and initiated discussions stressing the importance of managing this growing percentage of their networks using TAM principles. The results of those discussions serve as the foundation for this document that:

¹ <https://www.fhwa.dot.gov/map21/>

² [23 U.S.C. 119\(e\)\(1\)](#)

³ [23 U.S.C. 119\(e\)\(4\)](#)

⁴ [23 CFR 490.105](#)

- Helps State and local transportation agencies understand why focusing investments on assets in *Fair* condition is more effective than heavily investing in those in *Poor* condition.
- Promotes the more aggressive use of lifecycle planning in investment decisions.

The Growing Percentage of Pavements and Bridges in *Fair* Condition

Agencies often define strategic performance objectives to guide investment priorities. To determine whether an agency is making progress towards those objectives, agencies monitor performance and adjust priorities or programs as needed. On the Federal level, target setting and performance monitoring are part of the Transportation Performance Management (TPM) requirements under 23 U.S.C. 150(c)(d)⁵.

The FHWA established TPM rules on pavement performance measures in 23 CFR Part 490.309⁶. State DOTs and metropolitan planning organizations (MPOs) established targets for those measures. State DOTs began reporting on their targets and, beginning in 2018, including their targets in the Transportation Asset Management Plans (TAMPs) required under 23 U.S.C. 119(e)⁷ and 23 CFR Part 515.7⁸.

The national performance metrics established by FHWA in 23 CFR Part 490 are the percent of an agency’s NHS pavement network in *Good*, *Fair*, and *Poor* condition. *Good*, *Fair*, and *Poor* in turn are defined by different condition thresholds for different subsets of the network (23 CFR 490.305)⁹. As an example, the pavement conditions applied to a State’s asphalt and concrete-surfaced pavements on the NHS are the International Roughness Index (IRI), rutting or faulting, and cracking. The threshold values for these conditions are shown in table 1.

Table 1. Federal *Good*, *Fair*, *Poor* pavement classifications on the NHS (23 CFR 490.305).

<i>Distress</i>	<i>Good</i>	<i>Fair</i>	<i>Poor</i>
IRI, inches/mi	< 95	95 to 170	> 170
Rutting, inches	< 0.20	0.20 to 0.40	> 0.40
Faulting, inches	< 0.10	0.10 to 0.15	> 0.15
Cracking, %	< 5	5 to 20 (asphalt) 5 to 15 (Jointed Concrete Pavement (JCP)) 5 to 10 Continuously Reinforced Concrete Pavement (CRCP)	> 20 (asphalt) > 15 (JCP) > 10 (CRCP)

For Federal reporting purposes, a pavement’s overall rating is determined by the number of lane miles in *Good* and *Poor* condition (23 CFR 490.313)¹⁰: if all three (IRI, rutting, and cracking for

⁵ <https://www.govinfo.gov/content/pkg/USCODE-2015-title23/html/USCODE-2015-title23-chap1-sec150.htm>

⁶ <https://www.ecfr.gov/current/title-23/chapter-I/subchapter-E/part-490>

⁷ <https://www.govinfo.gov/content/pkg/USCODE-2015-title23/html/USCODE-2015-title23-chap1-sec119.htm>

⁸ <https://www.ecfr.gov/current/title-23/chapter-I/subchapter-F/part-515>

⁹ <https://www.ecfr.gov/current/title-23/chapter-I/subchapter-E/part-490/subpart-C/section-490.305>

¹⁰ <https://www.ecfr.gov/current/title-23/chapter-I/subchapter-E/part-490/subpart-C/section-490.313>

asphalt pavements; IRI, faulting, and cracking for jointed concrete pavements) are *Good*, the overall rating is *Good* and if at least two of the measures are *Poor* then the overall rating is *Poor*. All other combinations generate a rating of *Fair*.

Bridges are also rated on a *Good, Fair, and Poor* scale based on the 10-point National Bridge Inventory (NBI) ratings for the deck, superstructure, substructure, and culverts as established by FHWA in 23 CFR Part 490 Subpart D¹¹. A NBI value of 7, 8, or 9 is *Good*, 5 and 6 are *Fair*, and below 5 is *Poor*. Bridge conditions for Federal reporting purposes are defined in 23 CFR 490.409¹². A bridge is considered in *Good* condition when the lowest rating of all 3 NBI items for a bridge (deck, superstructure, and substructure) or the culvert rating is a 7, 8, or 9. When the lowest of the 3 NBI items for a bridge or the NBI rating for a culvert is a 4, 3, 2, 1, or 0, the bridge or culvert are classified in *Poor* condition. When the lowest of the 3 bridge NBI items or the culvert rating is a 5 or 6 the assets are classified as being in *Fair* condition.

The Federal performance measure reporting requirements are relatively new. Reported conditions for each State are available from FHWA’s TPM website at <https://www.fhwa.dot.gov/tpm/reporting/state/>. The TPM website displays several years of pavement and bridge data by State. Using the information available for 2019, average condition distributions for pavements and bridges on the NHS were prepared. As the graphs presented in figure 1 show, a significant percentage of NHS pavements and bridges are in *Fair* condition. Since a consistent method of reporting conditions on Non-NHS pavements and bridges is not available nationally, the authors assumed that the condition of pavement and bridge assets on the Non-NHS are similar to those on the NHS.

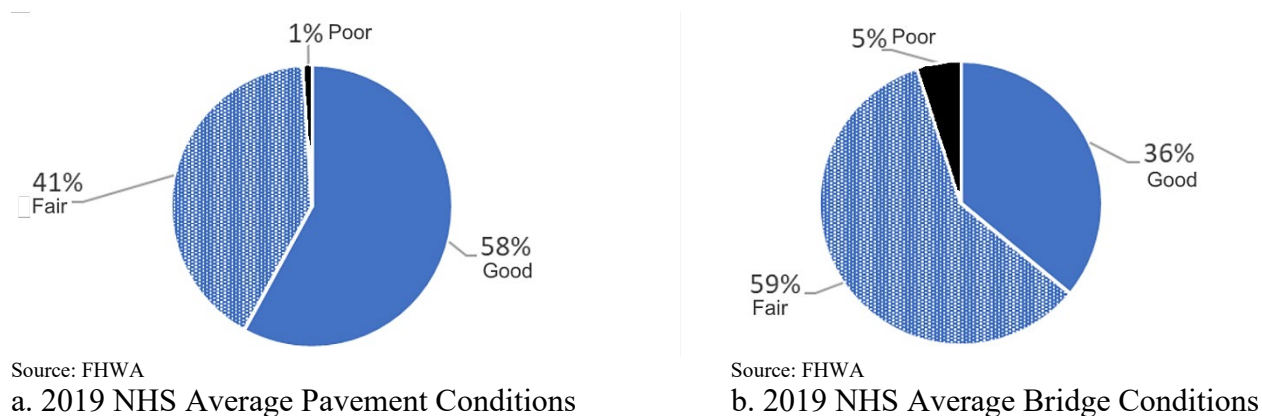


Figure 1. 2019 average condition of NHS pavements and bridges (<https://www.fhwa.dot.gov/tpm/reporting/state/>).

Prior to the establishment of Federal TPM reporting requirements for pavement and bridge conditions, many transportation agencies had developed their own legacy definitions for summarizing pavement and bridge conditions into *Good, Fair, and Poor* categories. For bridges, these categories generally match the Federal definitions. However, the legacy approaches used to determine pavement conditions at the State and local level vary from the Federal definitions in

¹¹ <https://www.ecfr.gov/current/title-23/part-490/subpart-D>

¹² <https://www.ecfr.gov/current/title-23/chapter-I/subchapter-E/part-490/subpart-D/section-490.409>

terms of the type of distress collected and the definitions for *Good*, *Fair*, and *Poor*. Further complicating the issue is that nearly all agencies' definitions vary from one another, making it difficult to report conditions on a national basis prior to 23 CFR Part 490. Today, many State agencies continue to report pavement conditions using their legacy approaches in addition to reporting the Federal TPM data for the NHS. Except for locally-owned NHS pavements that must adhere to Federal reporting requirements (23 CFR 490)¹³, local agencies can use either the Federal performance measures or a different approach to analyze and report pavement conditions.

Regardless of the way bridges and pavements in *Good*, *Fair*, and *Poor* condition are defined, there is benefit in recognizing the importance of managing these assets using asset management principles that promote long-term, cost-effective strategies such as those developed through lifecycle planning. Good lifecycle planning techniques consider the preservation of assets that are in *Fair* condition to slow the rate at which they fall into *Poor* condition and defer the need for most costly repairs. This type of strategy helps to reduce the long-term cost of managing a transportation network.

Challenges with Focusing on Good and Poor Asset Conditions

The growing number of pavement and bridge assets in *Fair* condition is a valid cause for concern. In simple terms, when a pavement or bridge has a *Good* rating, it is doing well based on all performance metrics, while if it has a *Poor* rating, it is in *Poor* condition on most or even all performance metrics. In one sense those represent simple conditions to manage:

- Keep *Good* assets in *Good* condition.
- Restore (by rehabilitation or reconstruction) assets in *Poor* condition.

Keeping *Good* conditions *Good* could be as simple as doing nothing or performing occasional minor maintenance, while addressing *Poor* conditions will likely require capital improvements which are costly and usually require years of planning. Appropriate approaches for both conditions are well understood by most highway agencies.

The challenge arises with the national TPM focus on managing the reported performance metrics of percent *Good* and percent *Poor* because a significant portion of the nation's assets are likely to be classified in *Fair* condition. Agencies tend to manage the performance that is measured and reported, so in the absence of a TPM target for assets in *Fair* or *Fair and Better* condition, agencies' attention may shift to managing *Good* and *Poor* assets. If this effort causes an agency to shift its investment priorities to demonstrate success in reducing the percent of the network in *Poor* condition, this could lead to practices that resemble a "worst-first" approach to managing assets. In a worst-first approach, agencies refrain from applying maintenance and preservation activities, which can extend service life very cost-effectively, until an asset is in *Poor* condition where substantial and costly rehabilitation and reconstruction activities are usually applied. A more cost-effective asset management strategy may consist of a "mix-of-fixes" that address the full range of asset conditions with maintenance, preservation, rehabilitation, and reconstruction options that provide a long-term, lifecycle approach to managing transportation assets. The latter

¹³<https://www.ecfr.gov/current/title-23/chapter-I/subchapter-E/part-490>

approach is reflective of sound TAM practices that are promoted in the current Federal definition for asset management, which stresses a “strategic and systematic process” that will “achieve and sustain a desired state of good repair over the lifecycle of the assets at minimum practicable cost.” (23 CFR 515.5).

Certainly, having a large percentage of a network’s assets in *Good* condition and a small percentage in *Poor* condition is a positive goal. However, if this is accomplished by focusing on assets in *Poor* condition there is a risk that too much of an agency’s available funding will be allocated to correcting a small portion of the network while the remainder of the network continues to deteriorate. This situation could occur because of the substantial cost associated with the types of rehabilitation and reconstruction work typically needed on a bridge or pavement in *Poor* condition. It also encourages a “worst first” approach to managing the network, which contradicts the more cost-effective lifecycle strategies considered in State DOT TAMPs.

The solution to this challenge lies in a continued commitment to an asset management strategy that includes a blended approach to system preservation. As noted earlier, agencies generally understand how to manage assets in *Good* or *Poor* condition, but TAM adds efforts to also manage assets in *Fair* condition concurrently. These asset management strategies include the use of low-cost preservation techniques that slow the rate of asset deterioration, cost-effectively keeping the assets in better condition and extending their service lives. Over time, this type of blended strategy can reduce the annual cost of system preservation and lead to improved system conditions.

Another challenge in focusing on percent *Good* and *Poor* performance measures is that the *Fair* category potentially represents a very broad range of conditions. Using pavements as an example, recall that a *Fair* rating is assigned when there is at least one performance metric (IRI, rutting, or cracking) that is not *Good*, but no more than one that is *Poor*. This covers a very broad range of conditions in which, for example, there may be a *Poor* ride but no deficiencies in cracking or rutting, or there may be some rutting, but a *Good* ride and minimal cracking. For bridges, one of the three components could be in *Poor* condition, but the other two could be in *Good* or *Fair* condition and the bridge would still be classified in *Fair* condition.

Unlike *Good* and *Poor*, the *Fair* rating does not clearly lead to a single set of actions because of the range of conditions in this category. Potential variations in conditions leading to a *Fair* rating could be linked to a need for minor maintenance, preservation (such as preventive maintenance

Pavements and Bridges are in *Fair* Condition For Much of Their Service Lives

Typical definitions for defining *Good*, *Fair*, and *Poor* conditions can resemble a bell curve, with a small percentage of the network in *Good* or *Poor* condition and the majority in *Fair* condition. In fact, pavements and bridges can spend much of their service life in *Fair* condition, with some experts estimating a bridge is in *Good* condition for 12 years but may be in *Fair* condition for 40 to 100 years, depending on how well it is maintained.

The type and extent of deterioration in assets rated *Fair* can vary significantly, suggesting that different types of treatments may be needed. Careful attention to managing assets in *Fair* condition can significantly improve network conditions maintaining service life for an extended period.

techniques), minor rehabilitation, or more substantial rehabilitation. This suggests that assets in *Fair* condition need to be managed diligently so that timely, appropriate, and cost-effective strategies are used. Assets in this condition category could benefit from additional evaluation to determine the type and extent of deterioration present. For bridges, this type of information may be available from an NBI inspection or may require more in-depth testing, evaluation, or analysis. For pavements, it may necessitate the need for more detailed distress information or additional testing, such as coring or non-destructive testing, to better understand the mechanisms behind the deterioration and better match strategies to those mechanisms.

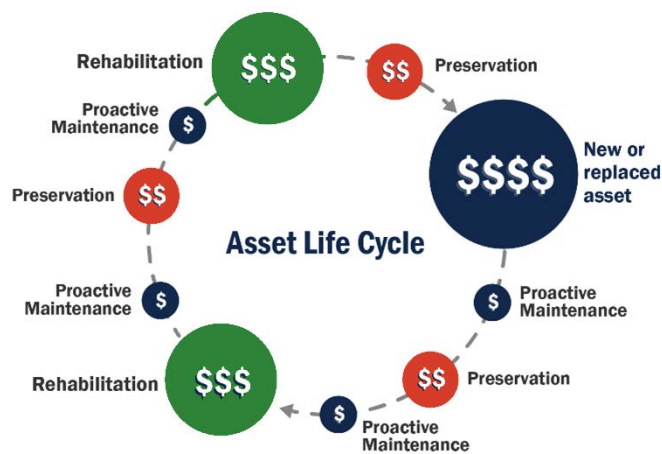
It is generally understood in the industry that the application of low-cost treatments on assets in *Fair* condition extends asset service life very economically by correcting minor defects and/or slowing the rate of asset deterioration. An unintended consequence to managing assets in *Fair* condition is that some of the techniques used to manage the assets may improve service life or slow the rate of deterioration, but they may not make a significant change in the State DOT's progress towards its target for the performance measure being used. For instance, a technique that seals pavement cracks, preventing moisture infiltration and extending service life by several years, will not change the *Fair* classification, so the benefits to that treatment are not obvious using the *Good, Fair, Poor* measures. If instead the performance measures looked at the percent of the network in *Good and Fair* condition together, the contribution of the crack sealing would be evident because the asset would remain in the *Fair* condition category longer. Therefore, not only do agencies managing their assets in *Fair* condition need to consider the range of treatments needed, but they also need to determine whether they have performance measures that provide a means of determining the benefit to their application.

Suggestions for Managing Assets in Fair Condition

Addressing the challenges of managing assets in *Fair* condition needs a focused effort that addresses the challenges introduced earlier. Key strategies for addressing these challenges are highlighted.

Incorporating a "Mix of Fixes" into the Program

A promising approach to manage assets in *Fair* condition is to ensure that an agency's program includes targets and planned investments in the range of treatments that may be appropriate over the life of an asset. With an appropriate combination of maintenance, preservation, rehabilitation, and reconstruction treatments many transportation assets can provide an acceptable level of service for years beyond their original design lives. Omitting any of the treatment categories from



Source: Applied Pavement Technology, Inc.

consideration, or only addressing assets in *Poor* condition, disrupts the asset lifecycle and could lead to more expensive fixes in the long run. Some agencies compare this approach to the maintenance schedule required to keep a vehicle in *Good* working order. Ignoring the need for routine maintenance such as oil changes or tire rotations increases the risk that more expensive repairs will be needed sooner than would have been expected.

Adopting a Strategy that Focuses on Keeping Assets in Fair Condition from Dropping to Poor

Under this approach, an agency may dedicate a portion of its available funding to the preservation of assets in *Fair* condition to prevent them from dropping into the *Poor* category, which usually entails more costly repairs. This approach has the benefit of minimizing the number of assets deteriorating into *Poor* condition each year, which enables an agency to keep the percent *Poor* from growing. This reduction in the rate at which assets are deteriorating to *Poor* condition reduces the long-term cost of ownership and results in less disruption to system users because construction periods for preservation treatments are generally shorter than those associated with major rehabilitation or reconstruction. One agency adopted this strategy after seeing a considerable increase in its percent of *Poor* bridges, from 14 *Poor* NHS bridges in one year to 34 in the next reporting cycle. The focus on keeping assets in *Fair* condition may also address social equity considerations by ensuring that all communities, including underrepresented communities, have access to serviceable pavements and bridges.

Quantifying the Benefits of Preservation Treatments

A key to effectively managing the portion of a transportation network in *Fair* condition is being able to quantify the benefits of the treatments applied to assets in that condition category. As discussed in the section Challenges With Focusing on Good and Poor Asset Conditions, not all treatments make the same contributions to asset performance. This creates a challenge with the use of some preservation treatments that may not positively influence the measures being used to report asset conditions. For example, crack sealing a pavement does not remove the presence of cracking, so it may have no impact on moving an asset from *Fair* condition. As a result, it may be hard to convince decisionmakers of the benefits to these types of treatments unless other ways of quantifying benefits can be used.

One State DOT analyzed the cost-effectiveness of its preservation treatments and found that by applying targeted “strategic” maintenance, they could defer the need for major rehabilitation by two to three years. The strategy saved the agency an average of \$25 to \$30 million annually with no corresponding decrease in overall system conditions¹⁴. To institutionalize the use of these strategic applications, the agency established a one-touch maintenance policy that involves the use of strategic maintenance before funding for more substantial repairs is provided. The policy has had the positive impact of prioritizing the extension of pavement life before a more substantial treatment is selected.

¹⁴ Li, J., D. R. Luhr, M. Russell, T. Rydholm, J. S. Uhlmeier. 2017. “Cost-Effective Performance Management for Washington State Pavement Assets.” *Transportation Research Record 2639*. Transportation Research Board, Washington, DC.

Many agencies rely on pavement and bridge management systems to identify and prioritize treatment options under constrained funding. These analysis tools consider the benefits and costs associated with various treatment options to determine projects and treatments that maximize performance for the expected level of funding. For low-cost preservation treatments to be prioritized in these types of analysis tools, it is imperative that treatment benefits are described in a manner that can be analyzed by the tool. Agencies practicing sound preservation practices will typically have models with slower deterioration rates that demonstrate the funding saved by reducing the flow of assets into *Poor* condition. Whether benefits are defined in monetary terms or in terms of added performance, it is important to configure these benefits into management systems to evaluate the long-term impact of preservation treatments on network conditions.

Identifying Meaningful Performance Measures and Targets

Agencies use a variety of different performance measures to manage their highway systems to address strategic areas of priority. At the highest levels in an organization, performance measures are used to monitor progress towards these strategic priorities in a way that is easy for both internal and external stakeholders to understand.

Since performance measures are intended to drive decisions, agencies may find it beneficial to adopt performance measures that go beyond those required by the Federal government. These additional measures may be used to provide additional detail that is useful for determining the specific type of treatment needed (e.g., thin overlay or bridge deck repairs), and not just the category of repair (e.g., preservation or rehabilitation).

The use of different, but related, performance measures may be useful in transportation agencies to support decisions at different organizational levels. For instance, at the strategic level, reporting the percent of the network in *Good* and *Poor* condition may be appropriate for communicating with stakeholders. At the operational level, the agency may be tracking and reporting different, but related measures that can be rolled up for reporting at the strategic level. For instance, an agency may use condition indices based on structural and non-structural deterioration for recommending repair types. These operational indices may be used to track District or Region performance but would have to be consolidated in some way for reporting network conditions at the strategic level. This alignment of performance measures at all levels within an organization is important to ensure that the agency's strategic objectives are achieved.

Within that framework, especially at the operational level, it is also important that the performance measures drive the desired performance. For instance, a performance measure that rewards on-time delivery may incentivize people to submit incomplete or erroneous materials since only the delivery date is being monitored. This is the heart of the concern with using just percent *Good* and percent *Poor* as performance measures in an organization. If an agency focuses primarily on reducing the percent of assets in *Poor* condition, it may encourage investments that conflict with the long-term, whole-life strategies promoted in asset management. To prevent this conflict, agencies may consider monitoring the combined percentage of their network in *Good* and *Fair* condition to promote strategies that keep the network in serviceable condition for as long as possible.

In addition to Federal TPM target setting requirements, agencies may find it beneficial to set internal performance targets to ensure that their investment decisions support their asset management objectives. For example, a target focused on pavements and bridges in *Good* or *Fair* condition combined could be meaningful in supporting investments that support the use of preservation treatments to extend service life very economically. At least one State DOT has divided its *Fair* condition into two categories based on the type of improvement needed: *Fair* “Protective” and *Fair* “Corrective.” Encouraging higher targets for the percentage of assets in the *Fair* Protective category than those in *Fair* Corrective would further emphasize investments that focus on the cost-effectiveness of preservation treatments.

Communicating for Success

A plan for managing assets in *Fair* condition can only be effective if it persuades stakeholders to make investment decisions that reflect the plan’s intent and long-term benefits. This is complicated by the fact that it is easier to justify “putting out fires” than investing in assets that still have a significant amount of service life remaining.

The development of effective communication materials that convey the financial and performance benefits to the strategy can be an important component in turning the plan into action. As with any successful communication approach, it is important to:

- Have a specific message to convey.
- Align the message with the agency’s strategic priorities.
- Keep the message simple so it can be understood in seconds rather than minutes.
- Use talking points that matter to the audience rather than to the technical experts.
- Present the message in several ways since different people process information differently.
- Follow up with more detailed information if it is requested.

The Ohio DOT hired a contractor specializing in communication to develop a communication plan that included materials to promote the agency’s asset management philosophy both internally and externally. The products included a short video illustrative of the benefits to preservation treatments¹⁵. This video is publicly available so it can be used to promote Ohio DOT’s asset management philosophy with a variety of stakeholders.

Summary

The condition of the nation’s transportation system is influenced by traffic volumes, vehicle loading, unexpected climate effects, and a myriad of other factors. With insufficient funding to address all system needs, agencies can expect to see a growing percent of the network being classified in *Fair* condition. This challenges transportation agencies to be deliberate in developing strategies to prevent these assets from deteriorating to *Poor* condition. These strategies may include shifting from an exclusive focus on investing in assets in *Poor* condition

¹⁵ Ohio DOT. n.d. [*ODOT: Taking Care of What We Have*](#). Ohio Department of Transportation, Columbus, OH.

to help ensure that cost-effective long-term preservation strategies applied to assets in *Fair* condition are prioritized.

Several strategies are suggested in this paper. These include:

- Using a mix of fixes to address asset needs over their service life.
- Preventing assets in *Fair* condition from deteriorating further.
- Quantifying the benefits of preservation strategies.
- Developing an approach to address the variation in treatments needed on assets in *Fair* condition. This might involve creating new, internal performance measures beyond those that are Federally required such as combining the *Good* and *Fair* categories or using criteria such as *Fair* “Corrective” and *Fair* “Protective” to better guide internal, operational decisions.
- Establishing internal, operational performance measures that promote the cost-effective use of preservation for maintaining asset in *Fair* condition and align with both the Federal measures and any agency-specific strategic performance measures.

Adopting any of the suggested strategies can help agencies avoid the challenges associated with the expected increase in pavements and bridges in *Fair* condition. These strategies support the principles of asset management and encourage agencies to base investment decisions on meaningful data that consider asset needs over their lifecycle and encourage strategies that reduce risk and improve performance.