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REP38-16 - Pavement Management Plan Overview 2016

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PAVEMENT MANAGEMENT

PLAN

CITY OF COLUMBIA

PUBLIC WORKS DEPARTMENT

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Executive Summary

Columbia's street infrastructure is critical to the operation of the City. The replacement cost of Columbia's 1360 lane miles of roadway pavement is estimated at more than $575 million. Over the years, traffic, weather, water, and aging of asphalt and concrete all contribute to street deterioration.

The City of Columbia Pavement Management Plan proactively combats street deterioration in the short-term, and improves the integrity and service life of Columbia streets over the long-term. The plan is grounded in the principle that preventative and rehabilitative street maintenance is more cost effective than reconstruction. The concept of preventive maintenance is the application of the right treatment on the right road at the right time to save or delay future expenditures.

Current funding levels are better than historic levels, but are still approximately $1.6 million/year below what is necessary to maintain a high quality driving surface for all streets. Due to the funding gap, decisions regarding where to spend money and on what streets should be made with good data, technical resources and with the knowledge that some streets will continue to deteriorate. By keeping as many roads as possible in good shape, the impact of deferring maintenance on some roads can be somewhat managed. Funding for the Columbia Street Maintenance Program should be at $4.8 million/year and is currently at $3.2 million/year.

Background

The basis for the pavement management plan has been developed and refined over the last four years. The plan focuses on prevention of deterioration once a road has been repaired to good or excellent condition.

Historically, funding for street repair work focused on a chip seal program and asphalt overlay (with milling or without) for major streets and some minor streets as funding allowed. Typically resources were low enough that very few streets were able to be maintained each year and many times a worst first selection method was used.

In 2012, the City began to increase funding for street maintenance and coupled that funding with a commitment to focus on a more active, methodical preservation program that can be better represented graphically to the public. We are beginning to see some positive results from those efforts.

Between 2012 and 2015 due to increased funding, several major streets were brought to good condition or better. For 2016, implementation of the preservation program has allowed us to continue to improve major streets, but also to begin to catch more local streets at a stage where a mill & overlay now will mitigate the need for a complete reconstruction in a few years (or lacking funds for that, the failure of the roadway).

To guide the process in a methodical manner, City of Columbia street maintenance staff updates the inventory and assessment of pavement conditions for City streets. Pavement condition is evaluated according to the Pavement Surface Evaluation and Rating (PASER) System. The PASER system is an industry standard, efficient way to rate street segments originally developed by the University of Wisconsin Transportation Information Center[1]. There are other rating systems that can provide more detailed analysis and might be candidates for use in the future, but with the City's current resources the PASER system provides reliable data for decision making. The PASER system utilizes a 10 point scale, with 10 being a newly constructed road surface and 1 being total failure.

[1] Pavement Surface Evaluation and Rating (PASER) Manuals, University of Wisconsin-Madison Transportation Information Center, various manuals and publication dates

Pavement Surface Evaluation and Rating

PASER Manual

Asphalt Roads

Transportation Information Center
University of Wisconsin–Madison

PASER Manual cover and example ratings

Rating system

Surface rating	*Visible distress**	*General condition/ treatment measures*
10 Excellent	None.	New construction.
9 Excellent	None.	Recent overlay. Like new.
8 Very Good	No longitudinal cracks except reflection of paving joints. Occasional transverse cracks, widely spaced (40' or greater). All cracks sealed or tight (open less than ¼").	Recent sealcoat or new cold mix. Little or no maintenance required.
7 Good	Very slight or no raveling, surface shows some traffic wear. Longitudinal cracks (open ¼") due to reflection or paving joints. Transverse cracks (open ¼") spaced 10' or more apart, little or slight crack raveling. No patching or very few patches in excellent condition.	First signs of aging. Maintain with routine crack filling.
6 Good	Slight raveling (loss of fines) and traffic wear. Longitudinal cracks (open ¼"– ½"), some spaced less than 10'. First sign of block cracking. Sight to moderate flushing or polishing. Occasional patching in good condition.	Shows signs of aging. Sound structural condition. Could extend life with sealcoat.
5 Fair	Moderate to severe raveling (loss of fine and coarse aggregate). Longitudinal and transverse cracks (open ½") show first signs of slight raveling and secondary cracks. First signs of longitudinal cracks near pavement edge. Block cracking up to 50% of surface. Extensive to severe flushing or polishing. Some patching or edge wedging in good condition.	Surface aging. Sound structural condition. Needs sealcoat or thin non-structural overlay (less than 2")
4 Fair	Severe surface raveling. Multiple longitudinal and transverse cracking with slight raveling. Longitudinal cracking in wheel path. Block cracking (over 50% of surface). Patching in fair condition. Slight rutting or distortions (½" deep or less).	Significant aging and first signs of need for strengthening. Would benefit from a structural overlay (2" or more).
3 Poor	Closely spaced longitudinal and transverse cracks often showing raveling and crack erosion. Severe block cracking. Some alligator cracking (less than 25% of surface). Patches in fair to poor condition. Moderate rutting or distortion (1" or 2" deep). Occasional potholes.	Needs patching and repair prior to major overlay. Milling and removal of deterioration extends the life of overlay.
2 Very Poor	Alligator cracking (over 25% of surface). Severe distortions (over 2" deep) Extensive patching in poor condition. Potholes.	Severe deterioration. Needs reconstruction with extensive base repair. Pulverization of old pavement is effective.
1 Failed	Severe distress with extensive loss of surface integrity.	Failed. Needs total reconstruction.

** Individual pavements will not have all of the types of distress listed for any particular rating. They may have only one or two types.*

Source: PASER Manual Asphalt Roads Transportation Information Center, University of Wisconsin-Madison

I. Need for a Pavement Management Plan

A. Purpose of the Plan

The purpose of the City's Pavement Management Plan is to lay forth a workable and affordable plan for improving the integrity and service life of City streets over the long term, while reducing the costs associated with deferred maintenance.

The key to effective pavement maintenance is applying the Right Treatment at the Right Time on the Right Roads.[2] Otherwise, the City and motorist will face lower quality streets and the maintenance techniques will be more costly. This plan leads to identifying when maintenance should be performed and what type of maintenance will give us the best benefit to cost ratio.

This plan focuses on the needs of our street network to ensure the long-term sustainability of the street infrastructure, such as seal coats, overlays, mill & overlays, and reconstruction. Day-to-Day maintenance activities are not addressed as part of this plan.

This plan is built on data gathered from street inspection reports performed by Public Works Street Division staff. A concentrated effort has been made to transition data gathering and decision making into a GIS centric approach to allow for better information sharing and transparency moving forward.

Not all aspects of data or the plan are complete and should be considered somewhat evolutionary. This is due to manpower limitations but also due to the fact that techniques and processes are constantly evolving in the pavement management industry.

B. Importance of Streets

The value of good streets and roads is often taken for granted by the general public. Public attention is usually focused on streets that are in poor condition or when there is a major failure. Residents and visitors depend heavily on Columbia's streets and our street network is vital to the local economy and attracting new businesses. For example, the delivery of public safety services would be seriously compromised without a dependable street network. Yet that network does not maintain itself, it requires regular preventative maintenance and repair to continue to the serve the community

[2] FHWA, Asset Management: The Right Road at the Right Time, May 2015

C. Magnitude of the Infrastructure

The City of Columbia includes a network of over 1360 lane miles of street. A lane mile is a 12 foot wide strip of pavement one mile long. Lane miles provide a better representation of the amount of maintenance than centerline miles. One mile of a five lane facility with bicycle lanes on each side is six lane miles, but one centerline mile.

The number of miles of streets continues to increase each year. Each new lane mile of roadway represents an added annual cost of maintenance for the life of the roadway. The estimated cost to build all 1360 lane miles today for the first time would cost over an estimated $1 billion. Since the cost of reconstruction is greater than first-time construction, to reconstruct all of the City owned roadways and associated drainage and other features would cost an estimated $1.3 billion. The asset replacement cost for the street portion only is at least $575 million.

The use of Columbia roadways is extensive and growing. According to 2010 census data, there were 108,500 people residing in the city, which represents a 50.7% increase in the last 20 years.[3] In addition to the City's population, many of the arterial roadways in the City carry residents from surrounding communities who come to Columbia for employment, business, travel, or shopping needs. Columbia remains a vibrant place for people to live, work and play. This means the total number of vehicles using Columbia's roadways is far greater than just the residents that reside within the City limit.

D. Cost of Foregoing Maintenance

Without a pavement management plan, preventative and/or minor maintenance needs are often pre-empted by major repairs or construction needs. Roads that need preventative maintenance are typically at minimal acceptable levels which is why they are considered of lower priority in some communities than new construction or reconstruction of failed streets. Unfortunately, in the long run, such an approach is much more expensive because it costs far more to rebuild a road after failure than it would have to rehabilitate the same road only a few years earlier.

Studies have shown that the costs of streets repair do not increase proportionately each year over the life of a street; rather, maintenance costs remain relatively low until the road's condition has deteriorated to below good condition. Once this minimum acceptable level has been reached the cost of repairs rises sharply and will only escalate as the pavement nears the end of its useful life. Take an asphalt street for example, if an asphalt rejuvenator product at a cost of $0.82 per square yard is not applied within the first year then a surface sealer can be applied at $1.25 per square yard on 2-3 year old pavement. Another option is a chip seal at cost $1.80 per square yard on a 3-4 year old pavement. If these preventative maintenance techniques are not applied then a mill and

[3] United States Census Bureau

overlay at a cost of $12 per square yard might be pursued on pavement typically 6 to 8 years old. Finally if nothing is done to the roadway the reconstruction cost would be $55 or more per square yard and need to be performed sometime around 10-15 years. Concrete streets can sometimes deteriorate more slowly earlier in their life cycle, but are more costly to maintain later on due to limited ways to preserve them.

The following graph illustrates how the quality of the road decreases rapidly after it deteriorates beyond the point of when preventative maintenance techniques can be used effectively. Depending on various factors including type of construction, quality and type of material used, traffic patterns and environmental factors, the life of a roadway may range from 15-30 years. For the first 50-75% of the roadway's life, the quality remains good and the costs of preventative maintenance are low. But once the condition of the pavement begins to drop, it drops rapidly and the cost to maintain it increases at an extremely fast rate.

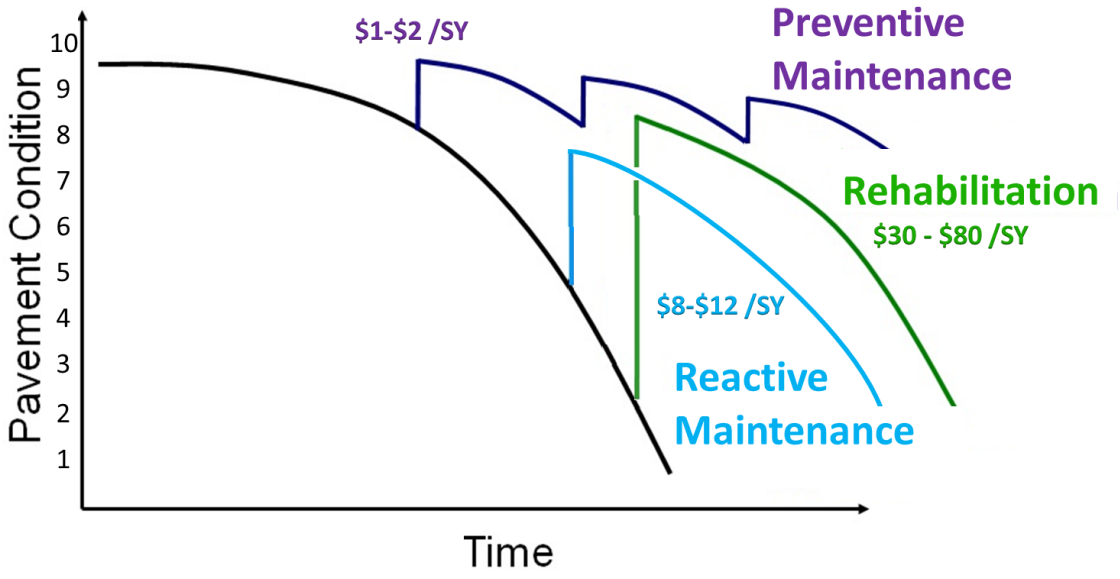


Figure 1: Pavement Maintenance options

The following comparison of two similar institutional locations shows the benefit of a pavement management plan over an ad-hoc system of repairing the worst roads. The U.S. Army Corps of Engineers compared the maintenance practices at two Army bases. One base used a pavement management system to help determine optimum timing and the most cost-effective strategies for periodic maintenance actions. The other base allocated its budget on the ad-hoc basis of which roads were in the worst condition. Both bases had nearly identical budgets, but an evaluation of the pavement network

conditions on both (on a scale of 0 to 100, with 100 being excellent) found the first base had an average condition rating of 75 compared with the second base's average of 41.[4]

Poorly maintained roads not only result in higher costs for the City; they also can result in higher automobile operating costs. Motorist might pay for poorly maintained pavements in damaged tires, more frequent front-end alignments, more frequent replacement of suspension systems components and more frequent traffic accidents, not to mention increased travel times. Studies have shown that driving on rough, broken pavement can cost more than five times the amount in automobile maintenance than driving on smooth, new pavement.[5]

Street maintenance costs are lowest at higher PASER ratings. As the PASER rating decreases, the cost of the recommended maintenance techniques to repair a street increases. For example, maintenance of a street in good condition (6 to 7) calls for relatively inexpensive preventative maintenance such as a seal coat. A street in fair to poor condition, however, often requires a rehabilitative maintenance effort such as a mill and overlay and might require dig out repair of failed sections of the road. This could cost the City 12 times the cost of preventative maintenance. A failed roadway in need of complete reconstruction can cost 30 to 50 times the cost of what a preventive maintenance solution would have cost.

Depending on various factors including type of construction, quality and type of material used, traffic patterns and environmental factors, the life of a roadway may range from 15-30 years. For the first 50-75% of the roadway's life, the quality remains good and the costs of preventative maintenance are low. But once the condition of the pavement begins to drop, it drops rapidly and the cost to maintain it increases at an extremely fast rate.

Decisions on which type of maintenance to pursue and on which roads or what to forego needs to take into account available funding.

Comparison of Potential Future Pavement Management Funding Scenarios

City staff used inspection data to generate a list of prioritized repair needs defined by the maintenance activities required, based on various scenarios. The following table compares the costs and outcomes of each of the funding scenarios. In Summary,

- **Scenario A (Comprehensive Plan)** would provide funding for all critical seal coat, overlay and reconstruction, at a cost of $8 million the first year and $6 million for maintenance per year after that. This scenario would result in an average PASER Rating of 8 (very

[4] American Public Works Association, The Hole Story, p. 11
[5] University of Minnesota, The Per-Mile Costs of Operating Automobiles and Trucks, Final Report

good) for major and minor routes by year 2026. Local streets could also be maintained at a high level with an overall average of 7 (good) or better.

- **Scenario B (Critical Breakpoint Plan)** would provide funding for all critical seal coat and overlay work and some reconstruction, at a cost of $4.8 million in FY2017 with an additional funding of $238,000 per year added after that. Would take a little longer than Scenario A to reach best results. Each street in the system would get some type of maintenance on average every 10 years with this scenario. This scenario results in an average PASER rating of 8 (Very Good) or better for most major routes and minor routes a rating of 7 (Good). Local residential streets would have an average rating of 7 (Good) by fiscal year 2026. This scenario allows the City to maintain the streets that are in good shape and bring streets in poorer condition to a rating of good over time.
- **Scenario C (Add moderate funding to current funding level)** would add $238,000 per year to the existing funding level of $3.2 million per year. This scenario would allow us to somewhat keep pace and also delay how fast the funding gap grows between what we should spend and what we are spending for preventive maintenance. This is the scenario essentially pursued over the last 3 years and what has been anticipated for the program moving forward. This scenario could delay deterioration of most roads, making them somewhat less costly to fix if additional funding becomes available by 2021 (essentially keeping most roads already in good shape in good shape longer). This scenario results in an average PASER Rating of 6.5 (Good) by the year 2021. Much of the outcome after that depends on potential advances in preservation techniques, additional maintenance responsibilities (added lane miles), additional funding and other factors. If no additional funding manifests, an average overall PASER Rating of 4.5 (Fair) by fiscal year 2026 is likely as deterioration is likely to outpace maintenance funds.
- **Scenario D (Current Funding Level)** would maintain the City's current funding level for pavement maintenance, at $3.2 million per year, allowing for some critical overlay, seal coat and a very limited amount of reconstruction of existing streets. This scenario would likely result in an average PASER Rating of 4.5 (Fair) for major routes and 3.5 (Poor) for minor routes by fiscal year 2026. Local routes would average a 3.5 (Poor). Essentially we would continue to fall behind on maintenance of roads and the pace that we fall behind will accelerate due to not being able to perform lower cost maintenance sooner. Roads that have been recently brought to good shape will not be able to be kept there and will begin to fail more rapidly in a few years unless less maintenance is performed on certain roads that are already failing and on local roads. Concrete streets beginning to now show signs of deterioration will accelerate towards very poor condition.
- **Scenario E (No Funding)** would defer essentially all preventative pavement maintenance for ten years, with no cost to the City. This scenario would result in the average PASER rating of 2.5 (Very Poor, at the risk of failure) by fiscal year 2026.

Table 1: Comparison of Funding Scenarios

	Comparison of Pavement Management Funding Scenarios				
	Scenario A	**Scenario B**	**Scenario C**	**Scenario D**	**Scenario E**
Plan	Comprehensive	Breakpoint Scenario – long term	Current Funding – moderate increase over time	Current Funding – no increase in funding	No Funding
Maintenance Activities	All seat coat, overlay, and reconstruction not adding capacity	All critical seal coat and overlay needs, most reconstruction needs met	Some overlay and seal coat, very little reconstruction	Some overlay and seal coat, very little reconstruction	None
Annual Cost	$8 million initially $6 million / year thereafter	$4.8 million initially, adding $238,000 per year thereafter	$3.2 million initially, adding $238,000 per year thereafter	$3.2 million / year, no future increase in funding	$0
Annual Number of Lane Miles Treated*	10% of the system	136	83 – increase incrementally over time initially, then decrease	83 initially decreasing thereafter	None
Average PASER Rating (Condition) by Fiscal Year 2026	Majors: 8 (Very Good) Minors: 8 (Very Good) Locals: 7 (Good)	Majors: 8 (Very Good) Minors: 7 (Good) Locals: 7 (Good)	Majors: 5 (Fair) Minors: 3.5 (Poor) – Locals: 4.5 (Fair) delays brunt of deterioration to 2021 with an average PASER of 6.5 at that time.	Majors: 4.5 (Fair) Minors: 3.5 (Poor) Locals: 3.5 (Poor)	Major: 2.5 (Very Poor) Minor: 2 (Very Poor) Locals: 3 (Poor)

*Includes only: Chip Seal, Overlay, Mill & Overlay, microsurface, rejuvenators, and surface seals. Crack sealing, a vital part of the maintenance program, would be tracked separately.

All of these pavement management funding scenarios are flexible and could be modified as new funding or priorities are presented. The types of preservation pursued and the streets that are selected depends on the level of funding available. A choice of any one of the funded plans represents the absolute best use of funding for pavement management within the constraints of the available funding.

If the program continues on the current pace but without additional funding, by 2018 we will need to transition back to more preservation activity almost exclusively on those roads brought to good condition in the 2012 to 2015 time frame with less focus on local streets. We'll also be faced with tough choices for those streets that have base failure issues and concrete streets that begin to deteriorate. Clinically, it would be better to let most of those failing roads continue to deteriorate and spend money more wisely on preserving more roads that are in better shape. That, however, is difficult from a public perception perspective.

Street rating data collection, programming street maintenance and providing data

In order to program improvements, major arterials and collectors are inspected and rated every two years, while residential streets have historically been on a seven year inspection cycle due to limited funding to perform maintenance. Residential streets are being transitioned to a 3 year cycle due to recent increases in street maintenance funding and the possibility of programming more timely maintenance.

Street data information has historically (20+ years) been maintained in a Hansen Software database. That system provided cutting edge information when implemented and still is a reliable source for internal operations personnel. However, it is not well suited to providing visual data for the public. In 2011, Public Works began transitioning street information to a GIS based system that allows for better visual information sharing with the public. Several underlying modifications in information sharing between Boone County and the City were needed prior to incorporating the information into the plan. Public Works worked with County and City GIS personnel to make the changes and are now in the process of converting the Hansen database set to GIS. Utilizing GIS data allows for better coordination with potential utility and capital projects, reducing conflicts and minimizing street work being done prior to utility work.

Ratings for all arterials and collectors are now in the City's GIS Pavement Management Database. A total of 49.8% of the total street segments within the City are represented in the GIS system. The current average PASER rating for streets within the GIS system is 7.45. Higher PASER ratings are over-represented in this number due to ratings on most streets being entered as we perform maintenance. This cuts down on data entry time, but doesn't exactly reflect the overall rating of the street network. The total street PASER rating average is anticipated to currently be approximately 6.5 (Good). The remaining GIS data will be built over the next year and a half.

The current GIS map showing those rated segments and their ratings is attached.

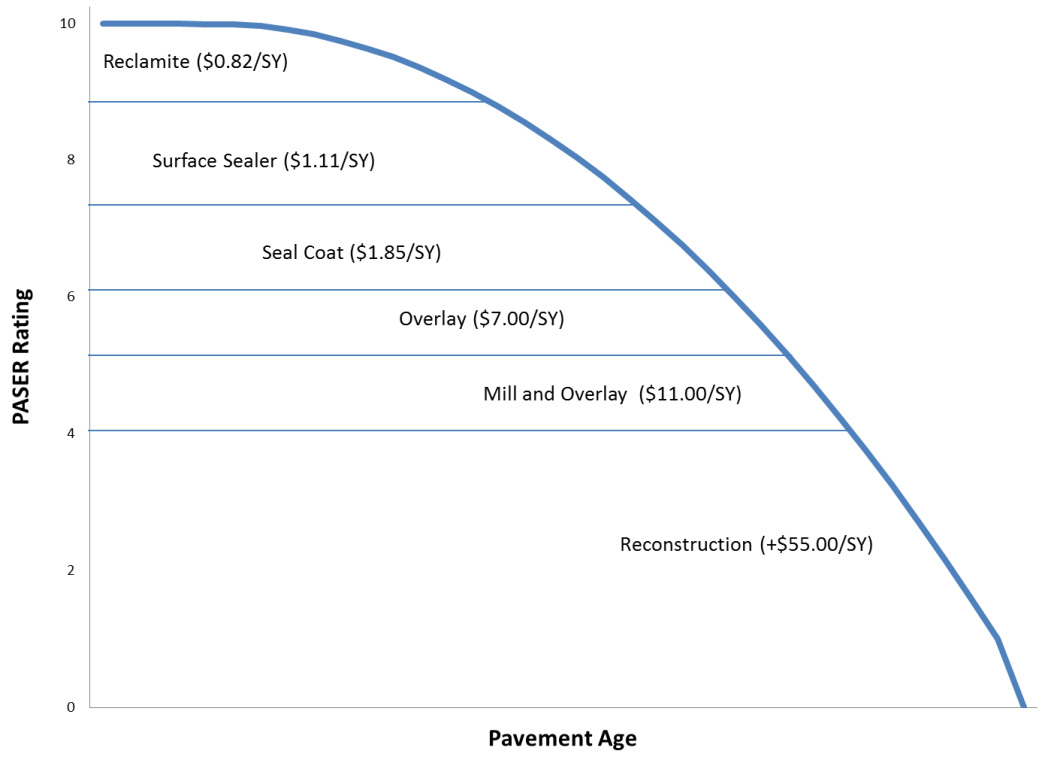
There are other pavement management rating systems. The bones of the PASER analysis relies on trained personnel's experience coupled with reference material. Training for rating is relatively straightforward and ratings can be performed field personnel. This enhances buy-in from maintenance crews as they can continue to develop a better understanding of roadway conditions and how their maintenance work makes an impact long term.

Other systems, such as Pavement Condition Index (PCI) scoring have some advantages and might be a good fit for the City long term. PCI also relies on training and experience, but incorporates more detailed analytics of stresses and failure types. If

funding and manpower allows, the PCI system can produce an extra degree of efficiency. However, the initial level of manpower required to complete the rating is higher than PASER ratings. Due to limited staffing, at this time the PASER rating offers a good balance between time up front and value of information for our situation.

II. Example Street Resurfacing and Maintenance Techniques

A number of different maintenance techniques can be used on a roadway depending on condition and PASER rating. As a general rule, the following graph illustrates the types of maintenance activities correlated to the different PASER ratings for an asphalt street.



The graph shows the type and the average cost of the maintenance activity to the City of Columbia. Streets with a PASER rating of 9 or higher are candidates for Reclamite or other rejuvenator type products which help seal up surface cracks and prevent water and UV rays for damaging the street surface of the roadway. Once an asphalt roadway has dropped to a PASER rating of 7.5-8 the City uses a surface sealing product to help seals up the roadway and blocks UV rays from further damaging the surface. This is used if the street has deteriorated past the point of a Reclamite treatment, but the overall condition of the road is still in good shape. This product is slightly more expensive than the Reclamite.

Seal coating, also known as chip sealing, is done in-house by City of Columbia crews, and is performed when the condition rating of the street has dropped to a PASER rating of 6 or 7. This maintenance activity is currently one of the City's best values for extending the life of our asphalt streets. Since chip sealing is done in-house, we are able to treat many more miles of streets than if we contracted this maintenance activity out. A chip seal can extend the life of an asphalt pavement by seven to ten years if the roadway has no structural issues.

Once a pavement has reached a PASER rating of 5-6, an overlay is likely required. Like chip seal, City crews do most overlaying in-house to save money, and also allows us to fix problem areas that arise more quickly. Overlaying is much more expensive than any of the previous options but is much less expensive than a reconstruction. An overlay can bring the condition of a street back up to a rating of 8-9, which allows us to apply one of the previous treatment options to extend the life of a street, by reducing the water than penetrates into the roadway.

Once a roadway reaches a rating of 4-5, an asphalt mill and overlay is the principle method of rehabilitating the roadway. Depending on the thickness of the overlay, it may extend the life of the roadway from 6 to 20 years.[6] This requires a contractor to mill the top 1.5-2 inches of asphalt or concrete and place a new layer of asphalt on top of the existing roadway. Sometimes deeper mills are required. This maintenance technique will bring the overall rating back up to a 8.5-9 if all structural issues with the pavement have been addressed prior to the contractor milling the street. These repairs, called "dig out", are performed weeks or even months in advance of the contractor beginning his work. Dig our repairs fix structural issues with the pavement, but are expensive and very time consuming.

Reconstruction is the final option if a street deteriorates below a 4 rating. Reconstruction is very expensive and time consuming while causing even more traffic problems for commuters than any of the previous treatments, because the streets or parts of the street will have to be closed for days at a time during the reconstruction.

Staff continues to explore options for maintenance including micro-surfacing and concrete rehabilitation. Many industry changes have occurred over the last 10 years and are continuing to be developed. Staff's approach for implementing new techniques is to explore a relatively low dollar project (less than $75,000), and evaluate the results, both in how disruptive the process was for traffic and how well the product worked.

Another critical maintenance option is crack sealing, which is probably the best pay-off of any maintenance technique, if performed by City crews. Crack sealing on both concrete and asphalt, can reduce pavement deterioration, when there is a pavement seam or crack, by restricting water penetration into underlying base and sub layers. However, this option is very time consuming and weather (hot or wet conditions) dependent on when this method can be used. Because of this it is typically expensive if contracted out. The City currently has two crack seal machines, and City crews pursue crack filling approximately 40% of the year.

[6] U.S. Dept. of Transporation, National Transportation Library, Pavement Management – A Manual for Communities, p 42