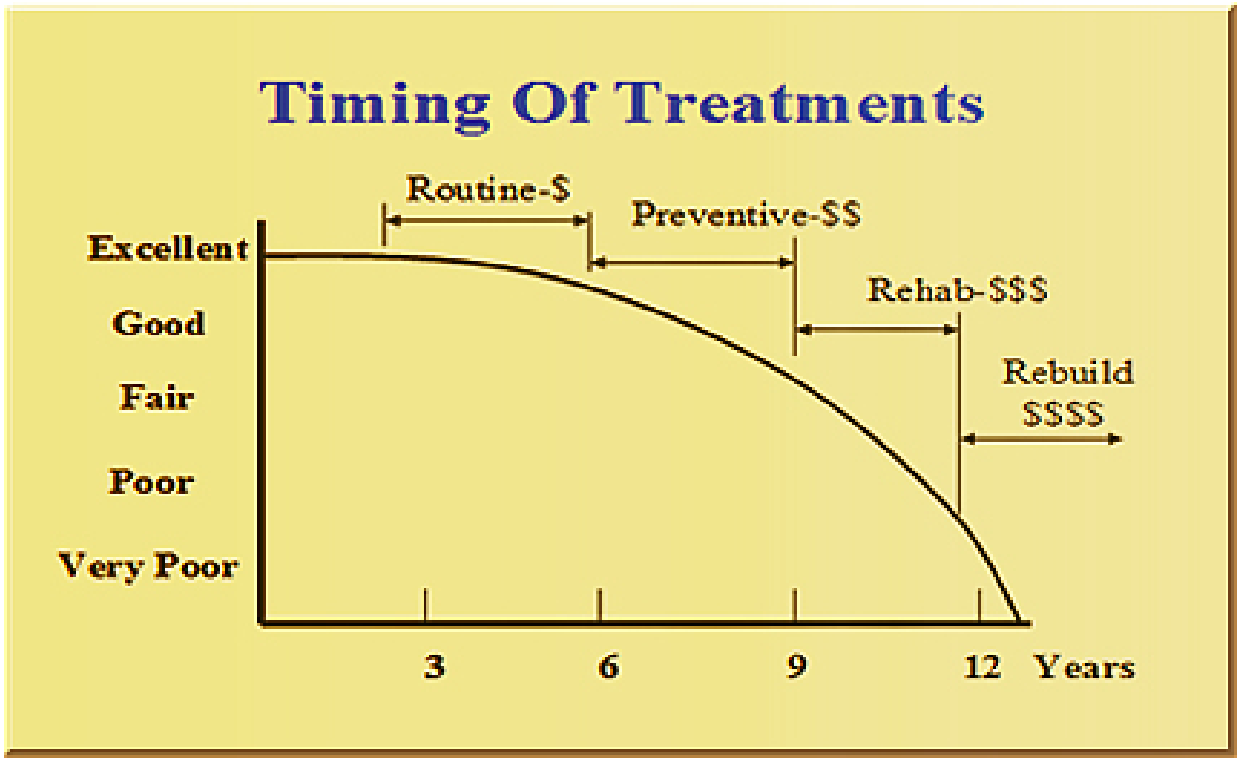
PAVEMENT MAINTENANCE STRATEGY

BACKGROUND

Asphalt pavements deteriorate due to a variety of load impacts and environmental effects. Generally the most significant impacts are caused by repetitive heavy truck loads and water infiltration of pavement sections. The combined effect of these factors results in a deterioration curve that accelerates over time without the introduction of maintenance treatments to reverse or retard the decline. Timely maintenance will be the most cost effective use of maintenance funds as shown on the following graph.



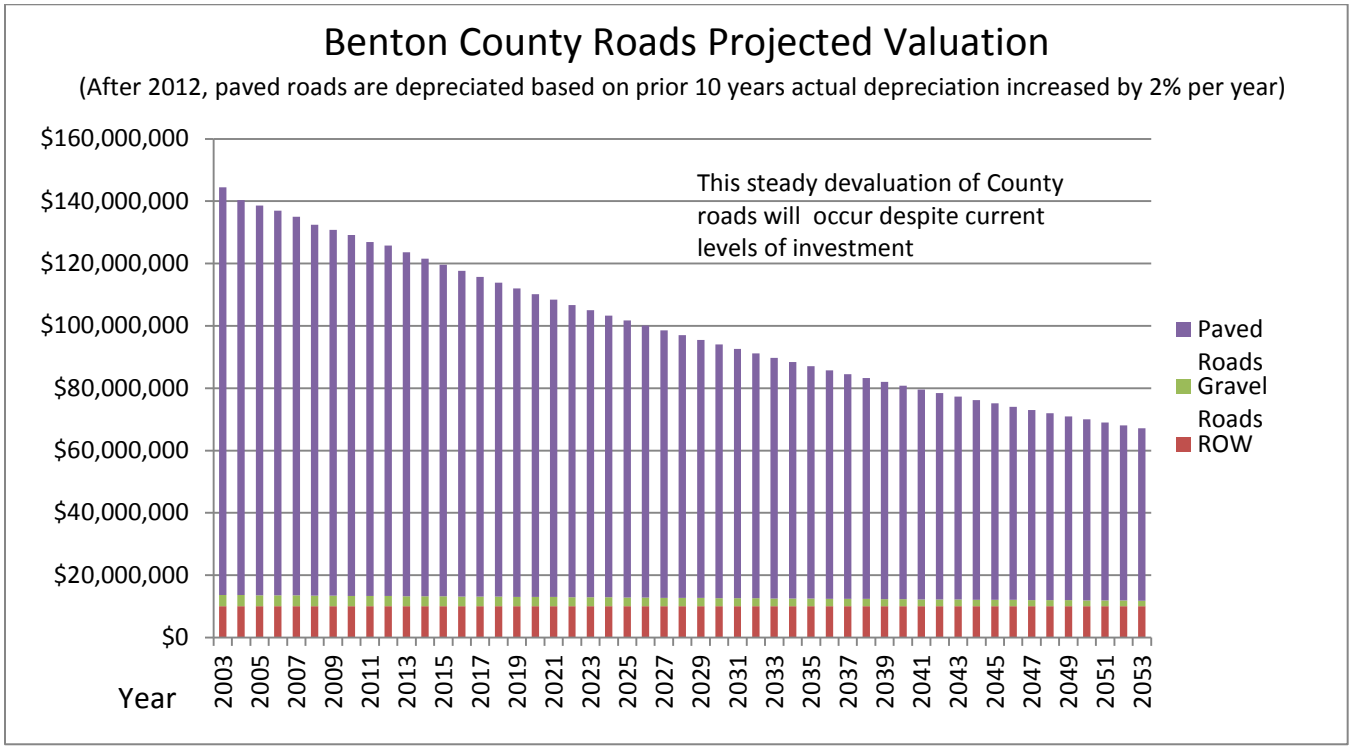
EXISTING CONDITIONS

One third of the County's paved roads are evaluated every year to establish their overall condition based upon a variety of defects. The most common distress types are shown in Attachment 1. This results in a Pavement Condition Index (PCI) which ranges from 0 for a fully deteriorated pavement to 100 for a new pavement. Generally roads will be considered for some type of treatment when the PCI drops below 80 with increasingly more extensive maintenance as

the PCI decreases. The following targets are guides only as there are distress or degradation types, requiring maintenance that is not reflected in PCIs.

Functional Classification	Miles	PCI Target
Arterial	61	80
Major Collector	61	80
Minor Collector	20.25	75
Resource Collector	80.28	70
Local	51.28	70
Total	273.81	

Using the current condition of County pavements and level of annual maintenance investment the value of the County road system can be shown as follows:



MAINTENANCE OPTIONS

Choosing the right maintenance treatment can be complicated. The cause of a particular distress, the expected life of different treatments, the cost (and cost / benefit), and function of the road must be taken into account. Cost is often the dominating factor. In general, maintenance options fall within these ranges::

Preventative Maintenance $ 3,000-47,000 per mile

Corrective Maintenance (rehabilitation)	$ 55,000-250,000 per mile
Reconstruction	$400,000-500,000 per mile

With proper maintenance applications, the life expectancy of a road can be extended by a number of years, as seen in the following table.

Estimated Life Extension (Years)

Surface Treatment	Good Condition (PCI=80)	Fair Condition (PCI=60)	Poor Condition (PCI=40)
Fog Seal	3-5	1-3	1-2
Chip Seal/Slurry	7-10	3-5	1-3
Overlay 3-5”	10-12	5-7	2-4
Reconstruction			20

A detailed description of the varied specific maintenance treatments and costs are described in Attachments 2-3.

MAINTENANCE STRATEGY

General Principles

- Allocate resources such that some level of effort is provided for all classes of paved roads;
- Prioritize arterial and collectors;
- Provide both preventative and corrective maintenance on an annual basis;
- Consolidate maintenance annually by area to maximize efficient resource delivery;
- Perform minor and major maintenance activity prior to pavement maintenance—crack sealing, deep patching, culvert repair/replacement, etc;
- Program maintenance in a four year schedule to allow road preparation a year in advance and provide a surplus of prepared road to take advantage of unanticipated funding.

Project Selection

- Technical Review---Road segments selected for maintenance will be chosen based on their pavement condition ratings (PCIs) Public Works staff will identify specific defects (or distresses) in addition to other factors, such as maintenance history, Average Daily Traffic count (ADT), number of trucks using the road, economic importance, safety, and cost that may influence the selection of a particular maintenance option. This preliminary list will identify a sufficient number of projects for a four year maintenance program.

- Roads Advisory Committee Review---The RAC will review data from the technical review to establish their recommendations for a program within budget constraints and the following considerations:

Preventative Maintenance:--Fog seals will be applied to all new pavements within the first three years of their construction. Preventive maintenance will comprise at least 10% of the maintenance resources on an annual basis.

Corrective Maintenance--At least 70% of available pavement maintenance resources will be committed to this category on an annual basis.

Rehabilitation--At least 20% of available resources will be committed annually, usually grinding work. Structural overlays will be considered on a limited basis due to the high cost unless specific funding is identified above the annual pavement maintenance budget.

Asphalt Grindings (Attachment 4) Asphalt grindings will be given priority for consideration under the rehabilitation category for funding along with a chip seal or other seal from the preventive or corrective budget. Grinding projects will be selected based upon location, amount of available materials, and the following options:

- Structural Reinforcement of Existing Pavements—This is a good preservation strategy but produces a reduced ride quality compared to plant mix asphalts. Consequently, lower volume and resource roads with heavy truck traffic are a preferable choice over collectors and arterials.
- Gravel Road Paving—Grindings have been a very successful strategy for converting gravel roads to a paved surface where increased traffic or isolated gravel road segments require disproportionate maintenance effort.
- Safety Improvement—Where there is sufficient shoulder width and the addition of paved shoulders, bike lanes and/or corner widening will improve safety on an existing paved road grindings may be a cost-effective choice.

Reconstruction—Reconstruction involves the complete replacement of the pavement structure.

- Full Removal-The entire pavement structure is removed and replaced with a new aggregate base and wearing surface.
- In-Place Recycling-The existing pavement and base material is pulverized and mixed with a binding agent such as asphalt or Portland Cement Concrete and compacted. A new wearing surface of hot asphalt concrete, oil mat or chip seal is applied.

Due to the high cost of reconstruction, the County has only used a Portland Cement Concrete treated base or full reconstruction on roads that have grant money or MPO money to fund the project.

ATTACHMENT 1

FLEXIBLE PAVEMENT

I. Cracking

A. Alligator Cracking

1. Description---Alligator cracking is a series of interconnected cracks in an asphalt layer forming a pattern, which resembles an alligator's hide or chicken wire. The cracks indicate fatigue failure of the asphalt layer generally caused by repeated traffic loadings and this distress allows water to penetrate the surfacing materials and subgrade, which furthers the damage. Alligator cracking, also called fatigue cracking, usually first begins as a single longitudinal crack in the wheel path.

2. Possible Causes

- Insufficient pavement structure
- Inadequate base support
- Poor base drainage
- Aging and traffic loading

3. Maintenance Treatments

- Do Nothing
- Fog Seal
- Slurry Seal
- Chip Seal
- 2" Hot mix overlay
- Patching

Except for patching, most of these treatments will probably not extend the life of the roadway significantly, since additional structure is needed.

Low - Longitudinal disconnected hairline cracks no greater than 1⁄8- inch wide.

Moderate - Longitudinal cracks in wheel paths forming an alligator pattern; cracks may be lightly spalled and about 1⁄8- to 1⁄4-inch wide.

High - Pieces appear loose with severely edges; cracks are 1⁄4-inch or greater and oil bleeding through the rock may appear on the surface.

B. Edge Cracking

1. Description---Edge cracking is similar to alligator cracking only located within 1 to 2 feet of the edge of the pavement. Failure begins at the edge of the pavement and progresses toward the wheel path. Pavement edge distress can result in worsening of the wheel path condition and allow moisture into the subgrade soils and base materials. Edge cracking also includes the longitudinal cracking associated with concrete base course widening.

2. Possible Causes

- Traffic Loading
- Environmental
- Construction Related
- Low Shoulder
- High Shoulder Holding Water

3. Maintenance Treatments

- Do Nothing
- Crack Fill
- Thin Cold Mix Overlay
- Shoulder Maintenance

Low - Hairline cracks just beginning to show; random with no pattern; may be up to 1⁄8-inch wide.

Moderate - Cracks 1⁄8- to 1⁄4-inch located 1 to 2 feet from the edge of the road; may have an alligator pattern.

High - Cracks greater than 1⁄4-inch; may have loose or missing pieces or potholes or alligator cracking.

C. Longitudinal Cracking

1. Description Longitudinal cracking denotes cracks that run predominantly parallel to the centerline. These cracks may be in the wheel paths, between wheel paths and/or at lane joints such as centerline or shoulder/surface.

2. Possible Causes

- Traffic Loading (wheel path cracks)
- Environmental (frost action)
- Improper Construction Practices (joint cracks)
- Poor Drainage
- Reflection Cracks

3. Maintenance Treatments

- Do Nothing
- Crack Seal/Fill
- Chip Seal
- Patching

Low - Hairline crack(s) running parallel to centerline.

Moderate - Cracks parallel to centerline are about 1⁄8-inch wide.

High - Single cracks are wider than 1⁄8-inch.

D. Random/Block Cracking

1. Description---Random or block cracks divide the pavement into rough rectangular pieces and typically occurs at uniformly spaced intervals.

2. Possible Causes

- Environmental (thermal)
- Aging

3. Maintenance Treatments

- Do Nothing
- Crack Seal/Fill
- Fog Seal
- Slurry Seal
- Chip Seal
- 2” Hot Mix Overlay

Low - Hairline cracks, essentially transverse but may connect to longitudinal; spacing of 50 to 100 feet.

Moderate - Cracks range from hairline to 1⁄8-inch wide and may be slightly spalled.

High - Cracks greater than 1⁄8-inch wide that are random or have a block pattern, similar to a turtle shell.

E. Transverse Cracking

1. Description---Transverse cracks are those considered to extend three-fourths of the width of the pavement or more, generally perpendicular to centerline.

2. Possible Causes

- Environmental (thermal)
- Swelling or shrinkage of the subgrade
- Reflection cracks
- Settlement (trench, backfill)

3. Maintenance Treatments

- Do Nothing
- Crack Seal/Fill
- Fog Seal
- Slurry Seal
- Chip Seal
- Mill
- Patching

Low - Hairline to 1⁄4-inch wide cracks perpendicular to centerline with no distortion.

Moderate - Cracks 1⁄4- to 1⁄2-inch in width, perpendicular to centerline and the full width of the pavement; slight distortion.

High - Cracks 1⁄2- to 2-inch wide; larger cracks often are spalled and/or have noticeable distortions near them.

II. Raveling/Weathering

A. Description---Raveling is the progressive wearing away of the pavement from the surface downward caused by the loss of asphalt binder and the dislodging of aggregate particles.

B. Possible Causes

- Poor mixture quality
- Asphalt hardening due to aging
- Insufficient asphalt content
- Improper construction methods

C. Maintenance Treatments

- Do Nothing
- Fog Seal
- Slurry Seal
- Chip Seal
- 2” Hot Mix Overlay

Low - Minimal loss of aggregate or binder.

Moderate - Some aggregate loss; small areas may be stripped away.

High - Sections greater than one square foot may be pitted, stripped or eroded away.

III. Rutting

A. Description---A rut is a surface depression in the wheel path after pavement layers or subgrade deform from traffic load applications.

B. Possible Causes

- Poor mixture quality
- Insufficient support
- Improper construction procedures

C. Maintenance Treatments3

- Do Nothing
- Chip Seal
- Mill
- 2" Hot Mix Overlay

There are no preventive applications currently available.

Low - Depressions in the wheel path less than 1⁄8-inch.

Moderate - Wheel path depressions of 1⁄4 - to 1⁄2-inch.

High - Wheel path depressions greater than 1⁄2-inch.

IV. Excess Asphalt

A. Description---Excess asphalt, also called bleeding or flushing, is used to describe a free film of asphalt on the surface of the pavement that creates a smooth, shiny, greasy, and reflective surface. It is usually found in the wheel paths and becomes quite sticky when hot weather.

B. Possible Causes

- Mixture problems (bad oil, stripping aggregate, low air voids, high AC content, etc.)
- Improper construction practices
- Paving over excess asphalt

C. Maintenance Treatments

- Do Nothing
- Chip Seal
- Mill
- 2" Hot Mix Overlay

Low - Intermittent films of bituminous material create a shining, reflective surface.

Moderate - Large areas or continuous strips of bituminous films where little, if any, aggregate can be seen.

High - Excess bituminous material appears wet and actually liquefies during hot weather.

ATTACHMENT 2
BENTON COUNTY PUBLIC WORKS
PAVEMENT PRESERVATION PROCESSES

PREVENTIVE MAINTENANCE

Preventive Maintenance applies lower-cost treatments to retard a road's deterioration, maintain or improve the functional condition, and extend the pavement service life. Various treatments can extend pavement life an average of 5 to 10 years. Timely preventative maintenance can be 4 to 5 times more cost effective than delaying maintenance until rehabilitation is needed.

Fog Seal—A light application (0.10-0.15 gallons per square yard) of asphalt emulsion diluted with water and without the addition of any aggregate applied to the surface of asphalt pavements. In cases where there is a loss of large aggregate or high heavy traffic volume, the application of a dilute polymer modified asphalt emulsion (at a rate of 0.15-0.30 gallons per square yard) may be used. Fog seals renew aged surfaces, and seal small cracks and surface voids. Research shows that the addition of fog seals to new pavements extends their initial life. Crack seals should only be applied after the completion of a fog seal or a minimum of one year prior to fog seal application.

Crack Filling—The placement of asphalt or other elastic materials into medium and larger cracks to prevent the intrusion of water and incompressible material. Crack Seal only after Fog Seal and prior to Chip Sealing, preferably one year in advance.

Slurry Seal—A mixture of emulsified asphalt and fine aggregate used to fill cracks, restore surface texture, and protect aging asphalt surfaces. Harder asphalt than a chip seal, it works well in parking lots and cul-de-sacs.

Chip Seal—A surface treatment in which the pavement is sprayed with asphalt and then immediately covered with crushed 3/8" aggregate (at a rate of 20-30 pounds per square yard) and rolled. The asphalt is generally emulsified at a rate of 0.30-0.50 gallons per square yard or can be modified with polymers for use on roads with heavy traffic or travelled by heavy trucks. Chip seals are used to seal small cracks, protect aging asphalt, restore surface friction and provide a wearing course on low volume roads.

Double Chip Seal---In cases where it is needed, following the Chip Seal (above) apply a second Chip Seal at a rate of 10-20 pounds per square yard, or as needed. The first chip seal will be a larger size aggregate, followed by a smaller sized second chip seal. On high traffic roads this might be a 5/8" chip, followed by a 3/8" chip. On lower traffic roads, the first layer might be 3/8", followed by a ¼" chip seal.

Cape Seal--- This process includes two steps. First, a chip seal is applied to the existing pavement. Then a slurry seal is applied on top of the chip seal one week later. This helps with tight turns and smoother ride so is particularly helpful on curves and hills.

CORRECTIVE MAINTENANCE

1. **Rehabilitation**---Rehabilitation applies structural enhancements to improve a pavements load-carrying capability and extend the service life. Rehabilitation projects are designed to last 10 to 20 years. Less costly than reconstruction, rehabilitation still requires a significant level of investment.

    - Full-Depth Patching—Removal and replacement of a failed segment of pavement to the level of the subgrade or lower in order to restore structural integrity.

    - Structural Overlay—One or more layers of 3" plus asphalt concrete placed over an existing pavement to restore or increase its load carrying capacity. This is commonly performed with hot mix asphalt concrete but can also be accomplished with asphalt grindings followed by a chip seal.

    - Oil Mat (Macadam)—This treatment consist of 3-5 layers of large and small aggregate placed individually as with a chip seal to restore some structure, friction, and surface sealing on low volumes roads.

    - Leveling Coarse—A thin layer of asphalt concrete (less than 2 inches) placed over an existing pavement to restore the crown and cross section of the road and fill ruts. This treatment is often used in advance of a chip seal to project the pavement from water intrusion.

    - Grind/Inlay—Grinding removes several inches of existing asphalt which is then replaced with a new layer of asphalt and concrete. This treatment is generally used where existing grades need to be maintained such as curb and gutter streets.

2. **Grindings**

    The purpose of the Benton County Grinding Strategy is to maximize the service life of County roads with minimal maintenance cost while maintaining and improving traffic safety. The County has the opportunity to purchase a limited amount of grindings each year due to their transportation costs. The location of grindings will play a large part in choosing areas for placement. Once the most cost effective areas have been selected, roads will be assessed according to current pavement preservation quality and safety needs. The roads will be selected by looking at PCI ratings, traffic levels, functional classification, and safety concerns (see Attachment 4)

    - Traffic Safety---Widen lanes to reinforce edges of pavement and give large vehicles more operating room around corners. Widen shoulders to add bike lanes to remove heavy walking/biking traffic from roadway.

- Rehabilitation---Apply grindings to improve each pavement's load-carrying capability and extend the service life of the road. This is particularly suited to heavy truck traffic roads in arterial and collectors classifications.

- New Pavements---Applying grindings to gravel roads has been a very successful strategy in converting gravel roads to a paved surface where increased traffic or isolated gravel road segments exist or when the maintenance cost exceeds maintenance cost for a paved road.

  Cost per mile:

  Traffic Safety: A bike path on both sides will average $ 82,000.00 per mile.

  Rehabilitation: 6" of grindings for overlay will average $ 96,300.00 per mile.

  New Pavement: 8" of grindings for a new surface over an adequate gravel base will average $107,500.00 per mile.

RECONSTRUCTION

Reconstruction involves complete replacement of the pavement structure usually designed to last 20 years. This is the most costly treatment

Full Removal—The entire pavement structure is removed and replaced with new aggregate base and wearing surface.

In-Place Recycling—The existing pavement and base material is pulverized and mixed with a binding agent such as asphalt or Portland Cement Concrete and compacted. A new wearing surface of hot mix asphalt concrete, oil mat or, chip seal is applied.

ATTACHMENT 3
BENTON COUNTY 2014 PAVEMENT PRESERVATION STRATEGIES AND COST

PAVEMENT CONDITIONS WITH REPAIR CONSIDERATON

Oxidation Surface (PCI Ratings 85 – 100) Oxidation with Minor Loss of Fine Aggregate and Light Oil

- Fog Seal
  - Prep. Work before Seals: Sweeping

Total cost per mile at this service level **$ 2,800.00**

This treatment will keep the PCI in this rating for 3 to 5 years.

Oxidation Surfaces (PCI Ratings 70 – 85)--Oxidation with Minor Loss of Fine Aggregate and Light Oil

- Fog Seal
  - Prep. Work before Seals: Sweeping before seal and crack sealing

Cost for crack seal per mile	$ 11,000.00
Cost for fog seal per mile	$ 2,800.00
Total Cost per mile at this service level	**$ 13,800.00**

This treatment will keep the PCI in this rating for 3 to 5 years.

- Chip Seal
  - Prep. Work for Seal: Crack Seal

Cost for crack seal per mile $ 11,000.00

  - Prep. Work for fog seal: Sweeping

Prep. Cost per mile (crack seal)	$ 11,000.00
Cost for chip seal per mile	$ 33,000.00
Cost for fog seal per mile	$ 2,800.00
Total Cost per mile at this service level	**$ 46,800.00**

This treatment will improve the PCI rating up into the 85 – 100 level

Oxidation Surfaces (PCI Ratings 55–70) The roads are degraded by oxidation with loss of the large aggregate. Oxidation with Loss of Large Aggregate

- Chip Seal
  - Prep. Work for Seal: Crack Seal and level patching

Cost for Crack Seal per mile	$11,000.00
Cost for Level patching per mile	$ 9,000.00

Prep. Cost per mile		$20,000.00
Chip Seal per mile	$33,000.00	
Fog Seal per mile	$ 2,800.00	$35.800.00
Total Cost per mile at this service level		**$55,800.00**

Oxidation Surfaces (PCI Rating 40 -55) Road Surface with Minor Rutting

- Chip Seal
  - Prep. Work for Seal: Crack Seal and level patching and Deep base

Cost for crack seal per mile	$11,000.00	
Cost for Level patching per mile	$ 9,000.00	$20,000.00
Cost for Deep Base Repair		$20,000.00

- Chip Seal and Fog Seal per mile $35,800.00

Total Cost per mile at this service level $75,800.00

This treatment will improve the PCI rating up into 85-100 level.

Oxidation Surfaces (PCI Rating 25–40) Road Surface with Heavy Rutting and Variable Base Condition

- Chip Seal
  - Prep. Work for Seal: Crack Seal and level patching and Deep base

Cost for crack seal and level patching per mile	$ 20,000.00
Cost for Deep Base Repair	$ 20,000.00
Cost for 1.5 overlay per mile	$ 78,613.00
Chip Seal and Fog Seal per mile	$ 35,800.00
Total Cost per mile at this service level	**$154,413.00**

- Grindings—Single Seal
  - Prep. Work for Grindings Deep base repair

Prep. Cost per mile	$20,000.00
Grindings Cost per mile	$40,000.00
Chip Seal and Fog Seal per mile	$35,800.00
Total Cost per mile at this service level	**$95,800.00**

- Grindings--Double Chip Seal
  - Prep. Work for Seals: Crack Seal, Level Patching and Deep Base Repair

Cost for crack seal and level patching per mile	$20,000.00
Cost for Deep Base Repair	$20,000.00

  - Prep. Work for Fog Seal: Sweeping

Prep. Cost per mile Grindings		$40,000.00
Double Chip Seal per mile	$66,000.00	

Fog Seal per mile	$ 2,800.00	
o Prep Cost per mile		$68,800.00
Total Cost per mile at this service level		**$108,800.00**

- Structural overlay 4” asphalt
  - Prep. Work for overlay: Crack Seal and Deep Base

Cost for crack seal per mile	$ 11,000.00	
Cost for Deep Base Repair	$ 20,000.00	
Prep Cost per mile		$ 31,000.00
Overlay 4” asphalt		$209,635.00
Total Cost per mile at this service level		**$241,635.00**

This treatment will improve the PCI rating up into 85-100 level.

ATTACHMENT 4

Benton County Public Works

Grindings Strategy

The purpose of the Benton County Grinding Strategy is to maximize the service life of our roads with minimal maintenance cost while maintaining and improving traffic safety. The County has the opportunity to acquire a limited amount of grindings each year. The location of stockpiles of grindings will play a large part in choosing areas for placement. Once the most cost effective areas have been selected, roads will be assessed according to current pavement preservation quality and safety needs. The roads will be selected by looking at PCI ratings, traffic levels and safety concerns.

Technical: Public works staff will assess the roads in the area of placement and develop a list of roads by using PCI ratings, ADT, width of lanes, bike\walk traffic, safety concerns and classification.

Review: RAC will review the roads list and work with staff to prioritize roads.

Traffic Safety Options:

Widen lanes to reinforce edges of pavement and give large vehicles more operating room around corners.

Widen or move bike lanes to remove heavy walking/biking traffic from roadway.

Rehabilitation: Apply grindings to improve each pavement's load-carrying capability and extend the service life of the road. This is particularly use for roads with heavy truck traffic in arterial and collectors classifications.

New Pavements: Apply grindings to gravel roads when the maintenance cost exceeds maintenance cost for a paved road.

Cost per mile:

Traffic Safety: 5' bike path on both sides will average $ 82,000.00 per mile
Rehabilitation: 6" of grindings for overlay will average $ 96,300.00 per mile
New Pavement: 8" of grindings for hard surface will average $ 107,500.00 per mile