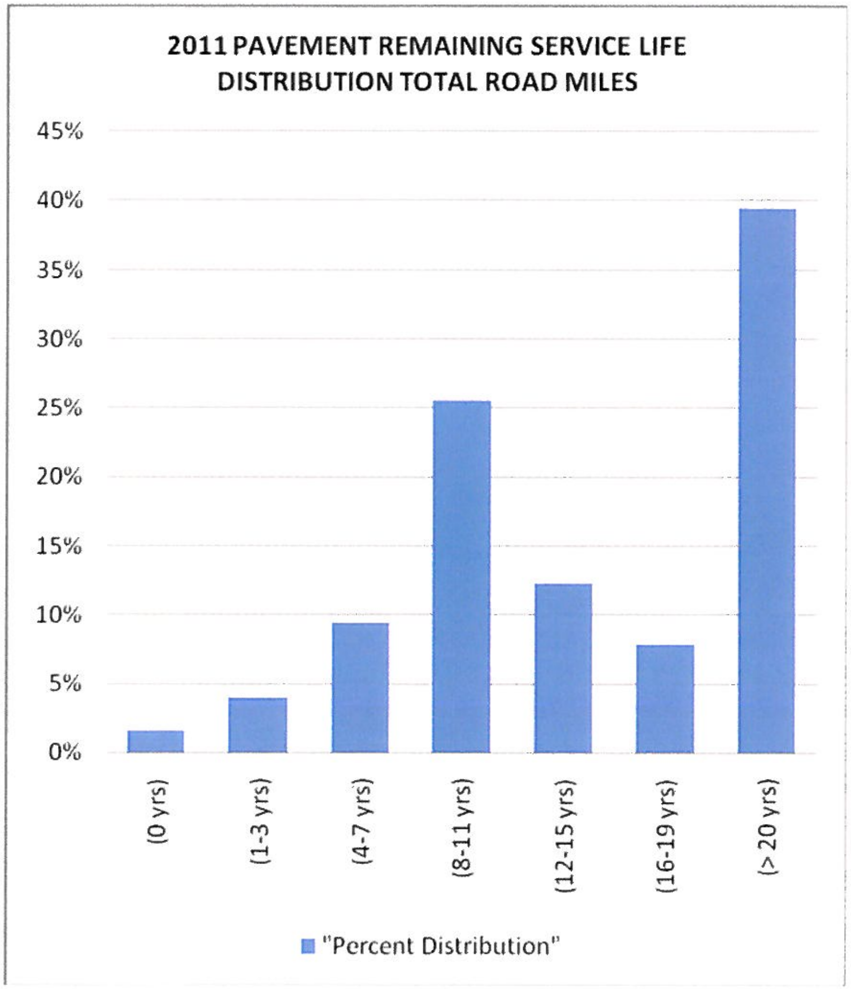
LAKES HIGHWAY DISTRICT
2011 PAVEMENT MANAGEMENT PLAN



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LAKES HIGHWAY DISTRICT KOOTENAI COUNTY, IDAHO

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Executive Summary

Since we know that the cost of maintenance only becomes more expensive over time, the primary objective of this report is to provide guidance that will optimize an appropriate spending plan for the District. Furthermore, the goal of this report is to provide a clear direction based on the pavement management plan in order to retain a high serviceability and performance of the Districts Road Network.

With a pavement management plan that takes inventory of the road network, we can produce specific treatments that will provide the best strategy to preserve area roads in the most cost effective manner.

Specific phases of maintenance include:

- Routine Maintenance
- Preventative Maintenance
- Road Rehabilitation
- Road Reconstruction

Each phase of maintenance is analyzed herein based on its effectiveness, cost of treatment and when a given phase of maintenance should be implemented based on a direct relationship to Remaining Service Life (RSL).

Using data obtained by an inventory of the road network, the existing RSL distribution is used herein to assess potential impacts on the future RSL distributions by applying certain maintenance strategies to certain categories of road miles, over a given period of time. This scientific approach provides the District a mechanism for at least sustaining the current average remaining service life of its road network.

Based on a recommended RSL distribution obtained through analysis in this report, the District is provided a mechanism of selecting specific roads, for certain treatments that are in turn included in the proposed Capital Improvement Project (CIP) List, include herein.

Introduction

Lakes Highway District's (LHD) road network consists of 262 miles of total roadway with 32 miles of gravel and 230 miles roadway pavements consisting of Base Surface Treatments (BST's) and Asphalt Concrete Pavement (AC). Jurisdictional boundaries of the LHD encompass eight (8) cities[1] with maintenance jurisdiction in both the urbanized and rural areas. LHD is generally located in the north half of Kootenai County, Idaho.

The purpose of this pavement management plan is to provide the LHD with a structured approach to evaluate the condition of the road network and develop a strategic plan for maintenance operations. This pavement management plan will provide LHD with an opportunity to better understand the state of the road network. Direct relationships between budget, repair strategies and remaining service life can be obtained from this plan, which will empower the LHD with a systematic approach of performing budget analysis. The analysis in this report is imperative to understand future needs related to potential budget limitations.

It is also important to recognize the importance of a pavement management plan and to realize the potential dividends on successful implementation. As the population of the District grows over time, the demand on the road network will intensify. A pavement management plan will improve the District's awareness of the networks condition. Having the capability to analyze the network will allow the LHD to identify and take action in a more strategic approach.

Goal of the Report

Since we know that the cost to repair a road only becomes more expensive over time, the primary objective of this report is to provide guidance to optimize an appropriate spending plan for the District. Furthermore, the goal of this report is to provide a clear direction based on the pavement management plan in order to retain a high serviceability and performance of the Districts Road Network. With a pavement management plan that takes inventory of the network, we can produce specific treatments that will provide the best strategy to preserve area roads in the most cost effective manner.

This report will be considered as a "living" document. Inspections of the road network should be performed on a rotational basis with 50% of the roads being inventoried each year; the entire network inventory completed every two years.

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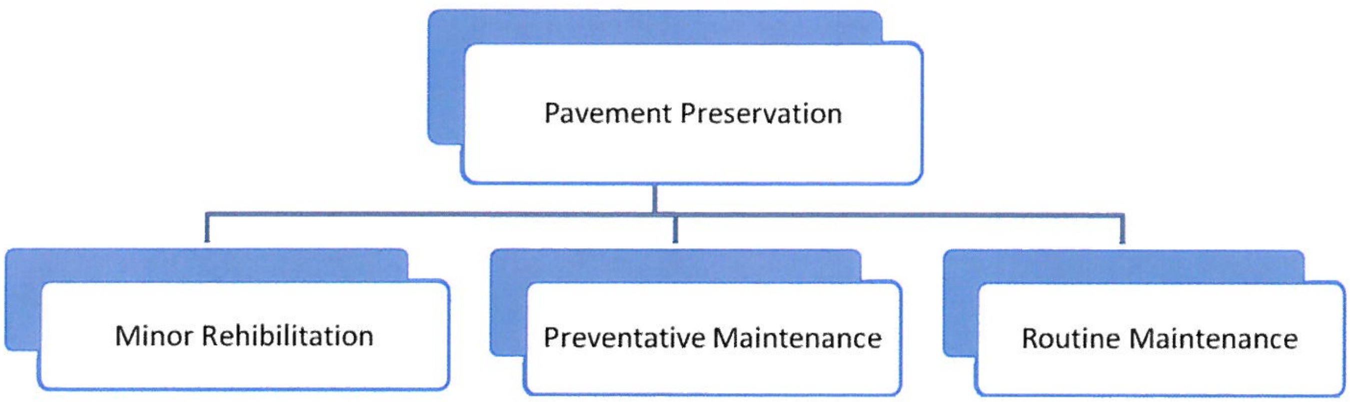
[1] Cities: City of Coeur d'Alene, Dalton Gardens, Hayden, Hayden Lake, Rathdrum, Spirit Lake, Athol and Bayview

It is important to recognize that in order to implement a successful pavement management plan; guidelines established by this report should be continually referenced to ensure the continuity of data collected. This will ensure results will remain consistent even with changes in staff or management. Most importantly, it will provide the mechanism for increasing efficiencies in this process and strengthening the level of service provided to those who use our roadways.

Pavement Preservation

Pavement preservation represents a proactive approach in maintaining our existing highways. It enables the District to reduce costly, time consuming rehabilitation and reconstruction projects and the associated traffic disruptions. With timely preservation we can provide the traveling public with improved safety and mobility, reduced congestion with smoother and longer lasting pavements at a reduced cost to the taxpayer.

A Pavement Preservation program consists primarily of three components: preventive maintenance, minor rehabilitation (non structural), and some routine maintenance activities as seen below.



An effective pavement preservation program can benefit LHD by preserving its current investment in roads, enhancing pavement performance, ensuring cost-effectiveness, extending pavement life, reducing user delays, and providing improved safety and mobility.

It is LHD's goal to support the development and conduct an effective pavement preservation program. As indicated above, pavement preservation is a combination of different strategies which, when taken together, achieve a single goal (retain serviceability and performance). It is useful to clarify the distinctions between the various types of maintenance activities, especially in the sense of why they would or would not be considered preservation.

For a treatment to be considered pavement preservation, one must consider its intended purpose. As shown in Table 1 below, the distinctive characteristics of pavement preservation activities are that they restore the function of the existing system and extend its service life, not increase its capacity or strength.

Table 1: Pavement Preservation Guidelines

	Type of Activity	Increase Capacity	Increase Strength	Reduce Aging	Restore Serviceability
Pavement Preservation	Construction	X	X	X	X
	Reconstruction	X	X	X	X
	Major Rehabilitation		X	X	X
	Structural Overlay		X	X	X
	Minor Rehabilitation			X	X
	Preventative Maintenance			X	X
	Routine Maintenance				X
	Corrective (Reactive)				X
	Maintenance (Catastrophic)				X

Definitions for Pavement Maintenance Terminology

Pavement Preservation is "a program employing a network level, long-term strategy that enhances pavement performance by using an integrated, cost-effective set of practices that extend pavement life, improve safety and meet motorist expectations." Source: FHWA Pavement Preservation Expert Task Group

An effective pavement preservation program will address pavements while they are still in good condition and before the onset of serious damage. By applying a cost-effective treatment at the right time, the pavement is restored almost to its original condition. The cumulative effect of systematic, *successive preservation treatments is to postpone costly rehabilitation and reconstruction*. During the life of a pavement, the cumulative discount value of the series of pavement preservation treatments is substantially less than the discounted value of the more extensive, higher cost of reconstruction and generally more economical than the cost of major rehabilitation. Additionally, performing a series of successive pavement preservation treatments during the life of a pavement is less disruptive to uniform traffic flow than the long closures normally associated with reconstruction projects.

Routine Maintenance "consists of work that is planned and performed on a routine basis to maintain and preserve the condition of the highway system or to respond to specific conditions and events that restore the highway system to an adequate level of service."
Source: AASHTO Highway Subcommittee on Maintenance

Routine maintenance consists of day-to-day activities that are scheduled by maintenance personnel to *maintain and preserve the condition of the highway system at a satisfactory level of service*. Examples of pavement-related routine maintenance activities include cleaning of roadside ditches and structures, maintenance of pavement markings and crack filling, pothole patching and isolated overlays.

Crack filling is another routine maintenance activity which consists of placing a generally, bituminous material into "non-working" cracks to substantially reduce water infiltration and reinforce adjacent top-down cracks. Depending on the timing of application, the nature of the distress, and the type of activity, certain routine maintenance activities may be classified as preservation. Routine Maintenance activities are often "in-house" or agency-performed and are not normally eligible for Federal-aid funding.

Preventive Maintenance is "a planned strategy of cost-effective treatments to an existing roadway system and its appurtenances that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system (without significantly increasing the structural capacity)." Source: AASHTO Standing Committee on Highways, 1997

Preventive maintenance applies *lower-cost treatments to retard a highway's deterioration, maintain or improve the functional condition, and extend the pavement's service life*. Preventive maintenance is typically applied to pavements in good condition having significant remaining service life. With various short-term treatments, preventive maintenance can extend pavement life an average of 5 to 10 years. Applied to the right road at the right time-when the pavements are mostly in good condition-preventive maintenance can improve the network condition significantly at a lower unit cost.

Examples of preventive treatments include asphalt crack sealing, chip sealing, slurry or micro-surfacing, thin and ultra-thin hot-mix asphalt overlay.

Pavement Rehabilitation consists of "structural enhancements that extend the service life of an existing pavement and/or improve its load carrying capacity. Rehabilitation techniques include restoration treatments and structural overlays." Most rehabilitation projects are designed to last 10 to 20 years. Source: AASHTO Highway Subcommittee on Maintenance

Rehabilitation projects *extend the life of existing pavement structures* either by restoring existing structural capacity through the elimination of age-related, environmental cracking of pavement surface or by increasing pavement thickness to strengthen existing pavement sections to accommodate existing or projected traffic loading conditions.

Two sub-categories result from these distinctions, which are directly related to the restoration or increase of structural capacity.

- Minor rehabilitation consists of non-structural enhancements made to the existing pavement sections to eliminate age-related, top-down surface cracking that develop in flexible pavements due to environmental exposure. Because of the non-structural nature of minor rehabilitation techniques, these types of rehabilitation techniques are placed in the category of pavement preservation.

- Major rehabilitation “consists of structural enhancements that both extend the service life of an existing pavement and/or improve its load-carrying capability.” Source: AASHTO Highway Subcommittee on Maintenance Definition

Although less costly than reconstruction, rehabilitation to improve the overall network condition still requires a prohibitive level of investment. Combined with a reconstruction program, rehabilitation can provide a marginal increase in pavement performance, but the results are not optimal.

Other activities in pavement repair are an important aspect of the Districts construction and maintenance program, although they are outside the realm of pavement preservation:

- Corrective Maintenance activities are performed in response to the development of a deficiency or deficiencies that negatively impact the safe, efficient operations of the facility and future integrity of the pavement section. Corrective maintenance activities are generally reactive, not proactive, and performed to restore a pavement to an acceptable level of service due to unforeseen conditions. Activities such as pothole repair, patching of localized pavement deterioration, e.g. edge failures and/or grade separations along the shoulders, are considered examples of corrective maintenance of flexible pavements. Examples for rigid pavements (concrete) might consist of joint replacement or full width and depth slab replacement at isolated locations.

- Catastrophic Maintenance describes work activities generally necessary to return a roadway facility back to a minimum level of service while a permanent restoration is being designed and scheduled. Examples of situations requiring catastrophic pavement maintenance activities include concrete pavement blow-ups, road washouts, avalanches, or rockslides.

- Pavement Reconstruction is the replacement of the entire existing pavement structure by the placement of the equivalent or increased pavement structure. Reconstruction usually requires the complete removal and replacement of the existing pavement structure. Reconstruction may utilize either new or recycled materials incorporated into the materials used for the reconstruction of the complete pavement section. Reconstruction is required when a pavement has either failed or has become functionally obsolete.

Reconstruction involves the complete replacement of the pavement structure with a new equivalent a long-term action that is designed to last at least 20 years. Most favorable to the traveling public, reconstruction is also the most costly fix and due to the high cost, neglects the majority of the system.

Like most other transportation agencies, LHD does not have sufficient funds to sustain the level of investment for continual reconstruction of the road network. Therefore, the LHD has developed a Pavement Management System as a tool to help manage the existing network. Our Pavement Management System is discussed in the following section of this report.

Pavement Management System

What is a Pavement Management System ("PMS")?

A Pavement Management System is a tool that collects and monitors information on current pavement conditions, evaluates and prioritizes alternative maintenance, rehabilitation and reconstruction (repair) strategies. When properly implemented, it provides the necessary information for decision makers to be well informed and to understand the long term consequences of short-term budget decisions.

Pavement Management (PM) is a structured program that is set up for rating the pavement conditions, based on inspected and surveyed pavement conditions, of jurisdictional paved-road networks. This program also recommends more-immediate maintenance treatments and performs short- and long-term effectiveness of financing strategies. As well as many other Highway Districts within the State of Idaho as recommended by the Local Highway Technical Assistance Council (LHTAC), LHD utilizes IWORQ's as basis for our PM program.

PM brings "science" into the process of determining pavement treatments. It includes:

- A system to regularly collect pavement condition data (Full Inspection every 2-years),
- A database to store and sort collected data (IWORQ's),
- An analysis program to evaluate treatment strategies and suggest cost-effective treatments (remaining service life vs. cost of maintenance).

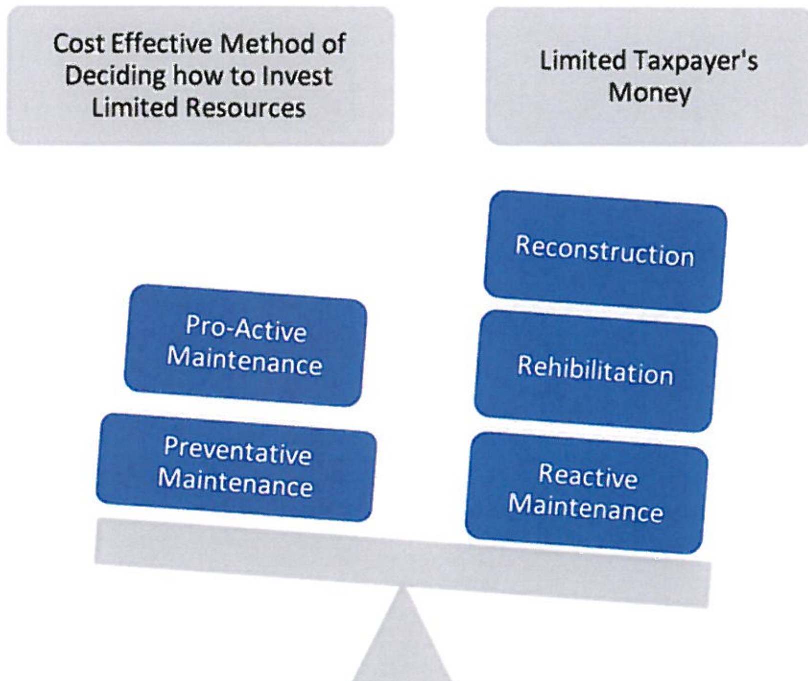
Why Use a Pavement Management System?

Public roads allow for moving people and freight. Due to their value and importance to the national economic vitality, preserving their condition and performance should be a priority. Pavement Management is used to maximize financial investment in those assets and to save motorist money spent annually on rough road impacts.

The LHD road network is a multi-million dollar taxpayer investment that directly impacts the economy and quality of life. Since budgets are based on limited resources, it is necessary to answer some very important questions, such as:

- What is the current condition of the road network?
- What roads should be repair or surfaced first?
- What techniques should be used for the best results?
- What are the projected long-term consequences if we delay or defer repairs?

Investing these limited resources cannot be left to an arbitrary process that fails to look at the larger picture and at possible long-term consequences. An objective, scientific approach that is proactive, rather than reactive, is necessary. A PMS provides this objective, intelligent approach, to answering these difficult questions.



Goal

The ultimate goal of a Pavement Management (PM) system is to effectively strategize short- & long-term usages of current and future limited monies to restore and maintain pavement at "Fair to Better" conditions for the ENTIRE road pavement network.

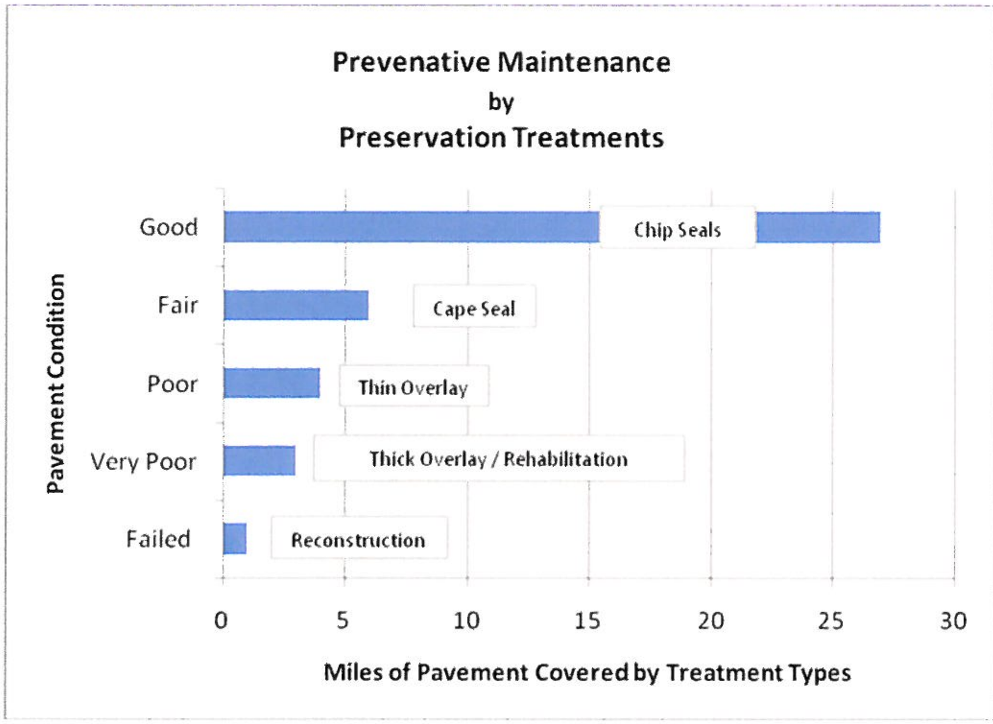
Good-condition road networks will ensure the economic vitality of the District and will benefit motorists with safety assurances and minimized additional costs.

Preventative Preservation First

As alluded to previously, it is important to implement the most efficient, cost-effective ("biggest bang for the buck") and timely maintenance strategies. Especially, preservation treatments are highly recommended, because of their more reasonable costs, their larger coverage areas and their ability to extend the life of pavement. This, as opposed to an alternative approach of pavement maintenance and repair that is "fix the worst first", which is in the long run the least cost-effective strategy.

Cost and Coverage Comparisons

Costs per lane mile for reconstruction after 25 years can be more than 3x the cost of periodic preservation treatments over the same 25-year period (AASHTO, 2009). The following Chart represents the costs of preservation treatments and compares this total to the cost of reconstruction.



Cape Seal – A surface treatment that involves the application of a slurry seal to a newly constructed surface treatment or chip seal. Cape seals are used to provide a dense, waterproof surface with improved skid resistance. Usually performed on residential streets.

Chip Seal – A surface treatment in which a pavement surface is sprayed with an asphalt emulsion and then immediately covered with aggregate and rolled. Chip seals are used primarily to seal the surface of a pavement with non load-associated cracks and to improve surface friction, although they also are commonly used as a wearing course to improve skid resistance.

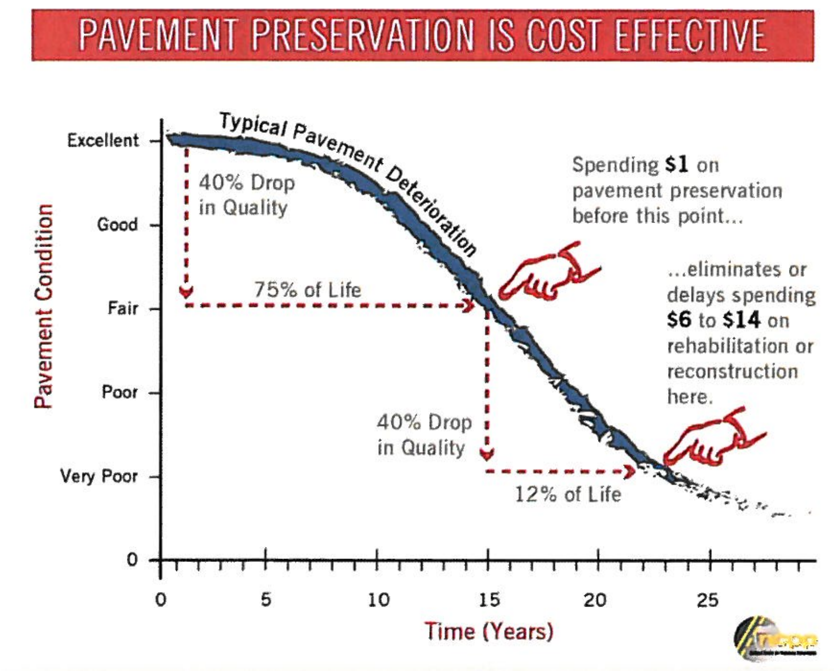
The cost to reconstruct one mile of roadway is equivalent to: 3 miles of a Major Rehabilitation; 4 miles of Thin Asphalt Overlay = 6 miles of cape (scrub seal plus micro-surfacing) seal = 27 miles of chip seal

How Does the Pavement Management System Work?

One of the main goals of a PMS is to select the type of repair that is the most cost effective for the condition of each surface type. The selection is based upon the current condition of the pavement. This is best illustrated using the deterioration curve.

A deterioration curve illustrates how the overall condition of the pavement changes as it ages. When first built, the pavement is hopefully in very good condition. Typically, the condition slowly decreases in the first years of the service from very good to good. As the pavement approaches the end of its surface life the rate of deterioration accelerates.

The following diagram shows a typical deterioration curve:

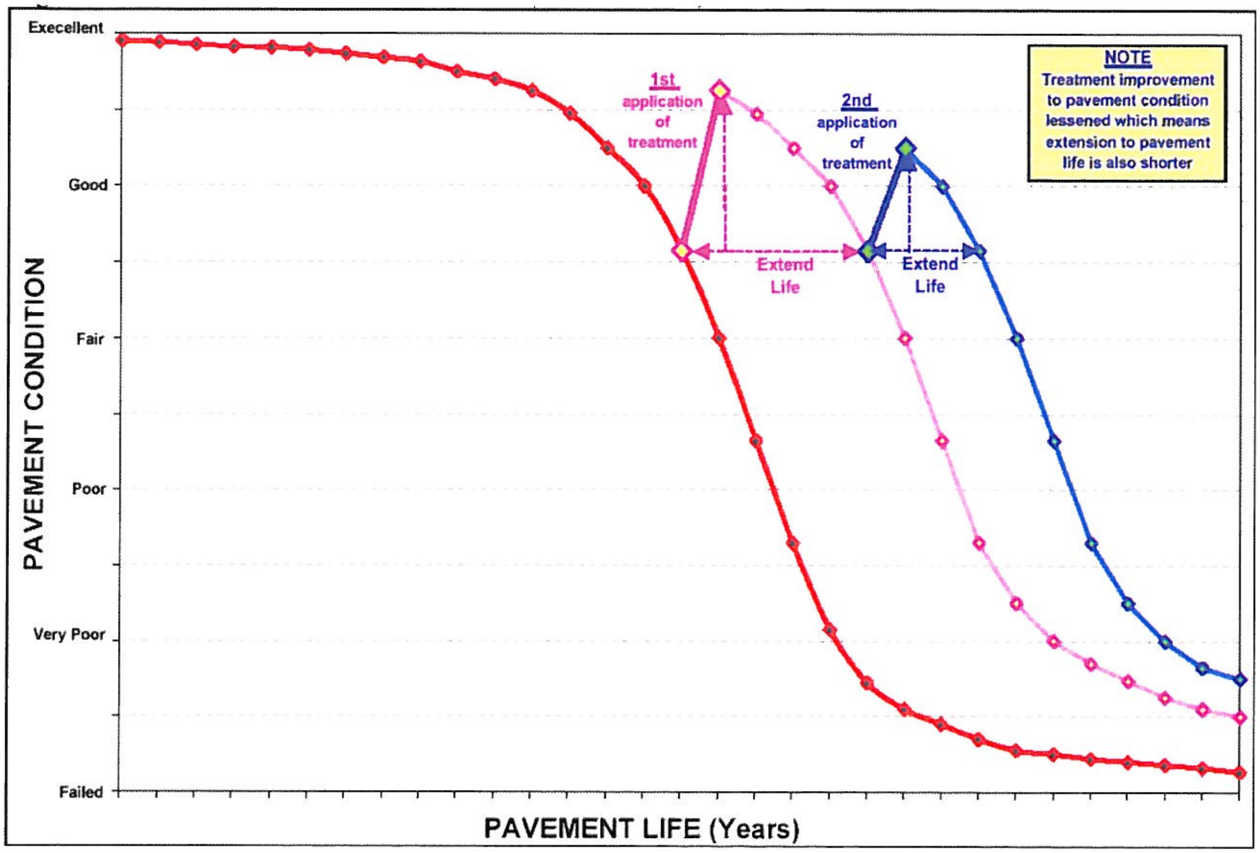


Source: National Center for Pavement Preservation

Research has shown that when certain maintenance techniques are applied too early or too late, they are not cost effective and/or the cost could increase dramatically. For example, crack-sealing and/or chip sealing roads that have extensive structural damage are not cost effective. Or, if you wait too long to crack seal, the pavement condition may deteriorate to a point such that the road may need to be reconstructed vs. a less costly maintenance technique such as a chip seal or overlay. Therefore, it is imperative that the correct repair alternative be selected for the specific condition of each road segment.

Preservation strategy implies spending "smart" by making investments needed to keep a road in good repair, rather than paying more later to address greater deterioration.

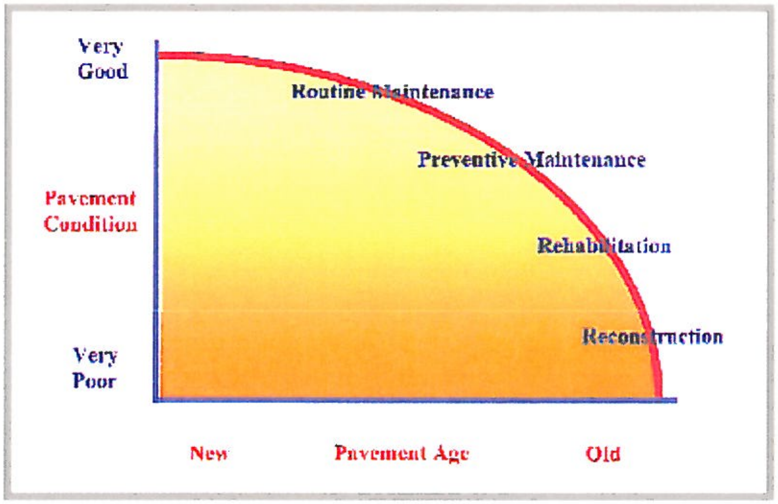
As shown in the following figure, by performing appropriate treatments in a timely manner, the life of the pavement could be extended (retaining serviceability and performance), thereby, delaying the need for costly rehabilitation and reconstruction.



There are preferred strategies for the different levels of pavement deterioration. As pavement ages and the amount of deterioration increases, the strategy changes. When the pavement is in good condition, relatively inexpensive preventative maintenance treatments are cost-effective. When the pavement reaches the end of its design life, expensive reconstruction will be necessary.

It is important to note that no matter how many chip seals or other types of preventative maintenance that are performed throughout the life of a road, you never get back to the original (new) condition. At some point the structure will deteriorate and will need to be replaced.

Preferred strategies for the different levels are shown in the following diagram at the time in which they should be implemented during the life span of the road.



Managing the Process

Data Collection

Although a complete assessment of the roads within the LHD has only been performed twice in the last 10-years, the LHD continually updates IWORQ's on a yearly basis. For the purpose of this report, data output from IWORQ's was ground truthed by staff and was deemed sufficient for this study. However, from this point forward a more complete, full road assessment should be performed at a minimum (if not more frequently) every two years, with 50% of the road inventory completed every year. This will allow for the entire network to be surveyed every 2 years.

The survey and road assessment will collect information in accordance with the National Association of County Engineers (NACE) Action Volume III-1, Road Surface Management. Data collected in the analysis will then be input into IWORQ's to assist with preparation of a Remaining Service Life (RSL) Distribution. The generated RSL Distribution will then be analyzed to determine where the LHD should focus its attention and selection of an appropriate maintenance treatment based on road miles and given conditions of the road. This strategy allows LHD to create long-term strategies and projects to achieve the District's long-term goals, which is to retain serviceability and performance.

Consolidating Gains

The mix-of-fixes approach provides the greatest flexibility for the LHD in enhancing pavement performance, with a three-tier program of reconstruction, rehabilitation, and preventive maintenance. Basically, LHD can address the worst roads through reconstruction, improve poor roads by rehabilitation, and preserve good roads with timely preventive maintenance. Preventive maintenance can improve pavement performance cost-effectively and efficiently, as measured by such attributes as ride quality, safety, and remaining service life.

Preventive maintenance is integral in the strategy designed to meet long-term pavement condition goals. Funding for the pavement preventive maintenance program should continue to grow in order to extend the greatest benefit to our network. The performance of the preventive maintenance treatments and the extension of service life imparted to the original pavements are evaluated regularly.

LHD has a strong partnering relationship with preventive maintenance contractors and suppliers for improving products and materials. As a result, even better-performing treatments are expected in the future.

Prescribing Treatments

Although evaluations continue, the extended service life of a preventive maintenance treatment depends on the pavement's rate of deterioration. Pavement condition is possibly the most important factor in achieving the maximum benefit from a preventive maintenance treatment.

The LHD should evaluate a road like a doctor diagnoses a patient, each patient has different physical traits, and the doctor prescribes a medication to fit the particular individual. Similarly, the District must select a preventive maintenance treatment that fits the unique condition of the pavement.

In order to achieve the benefits of a “Mix of Solutions” approach, the LHD will need to prescribe treatments according to pavement condition, not by schedules for timely applications. The likely gains in extended service life from various treatments applied to different types of pavement are indicated in the following table.

TREATMENT TYPE	MAINT. TYPE	BENEFIT OF TREATMENT (in yrs.) BASED ON RSL EXISTING							
		0	1-3	4-6	7-9	10-12	13-15	16-18	19-20
Crack Seal	Routine	0	0	0	0	1	2	3	4
Single Chip Seal	Preventative	0	1	3	5	5	5	5	5
Thin Hot Mix Overlay (<2")	Rehabilitation	0	4	6	7	7	7	7	7
Thick Overlay (3")	Reconstruction	12	12	12	12	12	12	12	12
Base & Pavement Replacement	Reconstruction	20	20	20	20	20	20	20	20

Approach to Pavement Management - "The Mix of Solutions Approach"

The LHD's strategy described herein incorporates long-term solutions (reconstruction), medium-term (rehabilitation), and short-term (preventive and routine maintenance). In this "mix of solutions" approach, each fix category has a critical role in improving the future condition of the District's road network.

Combining Components

Combining all three programs into a single comprehensive strategy achieves the most manageable roadway network.

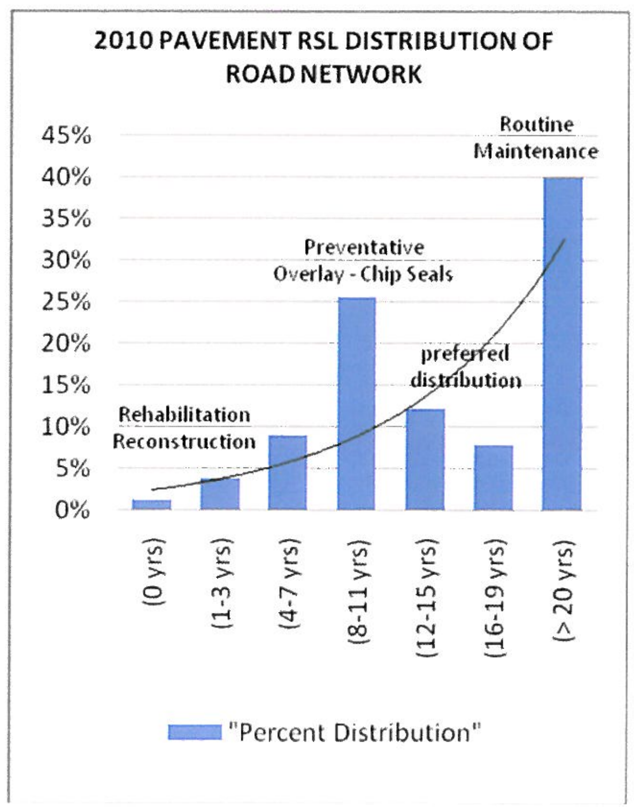
Preventive maintenance is perhaps the single most influential component of the network strategy, allowing the District to manage pavement condition. Preventive maintenance postpones costly reconstruction or rehabilitation activities by extending the service life of the original pavement. The challenge is to ascertain the right time to apply a treatment to achieve maximum benefit or return on investment.

Routine maintenance is important for a road; but routine maintenance is a holding action, maintaining the service level without extending the pavement life. Routine maintenance will not improve the overall condition of a road network.

Balancing Service Life

The adjacent bar chart shows the remaining service life of the District's pavement network with an average remaining service life (RSL) of 13-yrs. Although, the RSL is within a desired range, the unequal distribution of remaining service life could represent a significant future problem when the 2nd largest group approaches no remaining life. With no service life remaining, the pavements are candidates only for costly rehabilitation and reconstruction. Refer to Appendix A for IWORQ's RSL Detail used to generate the distribution of road miles.

Ideally, a uniform distribution, increasing with age is preferable.



Large surges in construction can be devastating to overall maintenance and the District's budget. First, large fluctuations in funding (should funding be roadway repair costs) are an unpopular alternative for the public as it requires at times revenue increases through taxation. Second, the variation in construction activities from year to year creates staffing and logistical problems for the highway agency and the contractor. The practice of hiring and laying off personnel as workloads change hurts employees and disrupts the organization. Finally, contractors and suppliers need a stable source of work to survive in the marketplace. Years of heavy workloads followed by years of light workloads can force many contractors out of business.

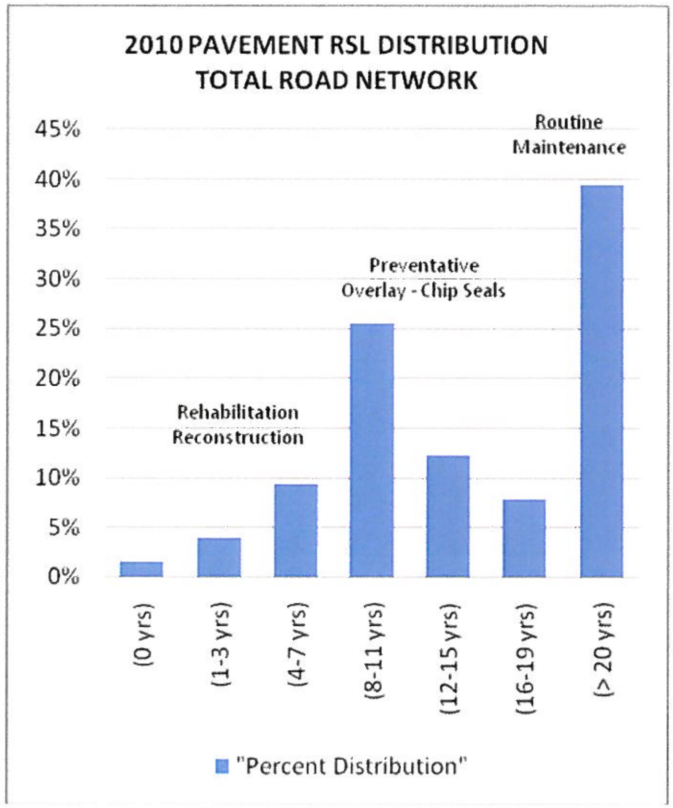
Preventive maintenance can alter the distribution of a pavement's remaining service life. By targeting large concentrations of pavements with similar remaining service lives, preventive maintenance treatments can balance projected workloads before a management problem develops. Balancing the remaining life of the network pavements will ensure manageable workloads at available funding.

Remaining service life (RSL) has been defined as the anticipated number of years that a pavement will be functionally and structurally acceptable with only routine maintenance. RSL is computed from pavement condition survey results (IWORQ's) with a preferred target range of 10 to 12 RSL, which according to FHWA represents a level that can be reasonably sustained. A lower average RSL results in a system that requires a significant amount of rehabilitation and reconstruction at a much higher cost than preventative treatments. Preventative treatments become less effective (less added RSL) when the roads existing RSL is low. Conversely, the cost associated with achieving a high RSL is quite high.

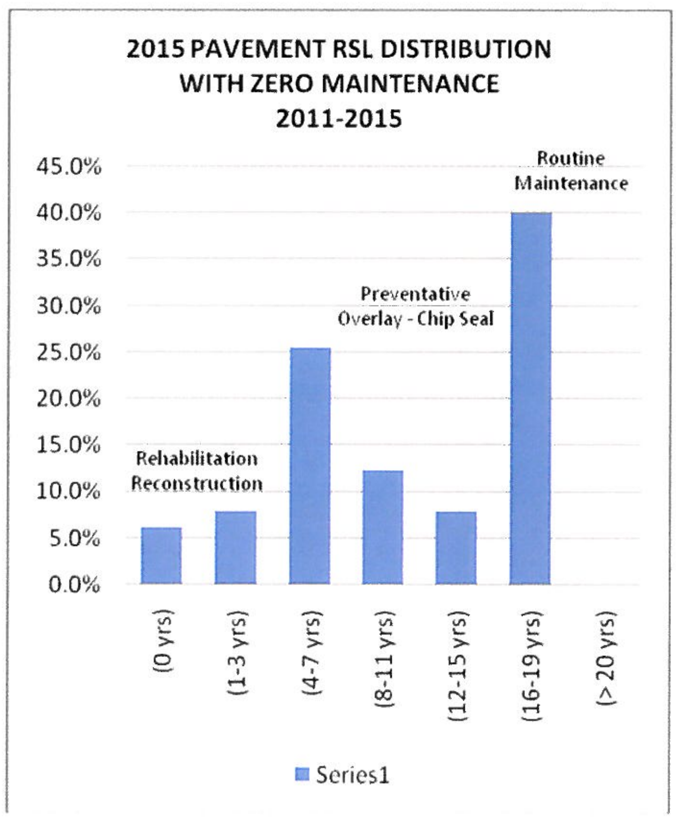
Funding

Determining the most cost effective treatment strategy for any road system is a matter of identifying the general roadway deficiencies and formulating strategic alternatives to find the best fit. The impact of insufficient funding can have a significant and long term impact on a road system as timely repairs are delayed.

Allocation of funding for different types of repair strategies can also affect the overall Remaining Service Life ("RSL") of a road network. The following examples using LHD's road system demonstrates the impact of lower funding on overall road conditions. The adjacent figure shows the current RSL for the District's entire road network, which is 13-yrs.



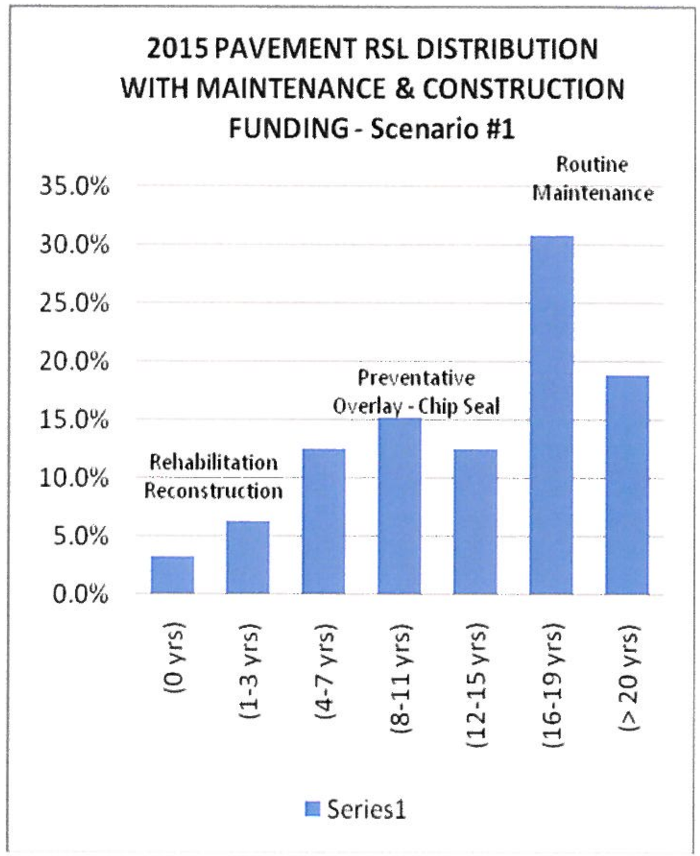
Alternatively, the adjacent figure shows a projection of RSL given an extreme case of zero spending on construction and/or maintenance between 2011 and 2015. The resulting RSL of this extreme case is 9-yrs. Although, this example of zero spending is not recommended, it does prove that smart spending needs to be done in order to sustain the life of our roads.



As a less extreme comparison to the zero spending approach, projecting LHD's 2008 budget and percent allocation over the next five years would result in a slight decrease in the current remaining service life, from 13 to 12-yrs. Refer to discussions in this report regarding funding distribution for both the current and proposed percent funding allocations.

The adjacent 2015 RSL distribution is an example of how the District might consider an allocation of funding. This example considers the following allocation of funding:

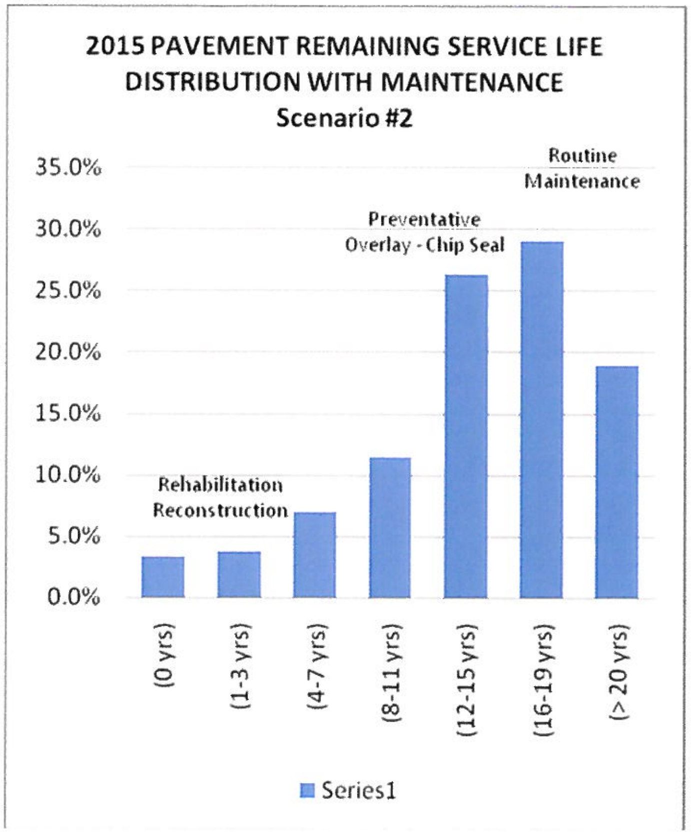
- Total funding for the period is $9,900k or $1,980k per year.
- $600k per year for new construction and/or reconstruction, which is equivalent to 1 new mile per year. Reconstruction adds approximately 20-years of service life.
- $600k per year for rehabilitation projects of existing roads, using techniques such as recycled asphalt based and pavement overlays. $600k per year would be equivalent to 3 miles per year. Rehabilitation adds approximately 12-15 years of service life.



- $450k per year for thin asphalt overlays. Or, overlay 3 miles per year. Overlays add approximately 12-years of service life.
- $330k per year to chip seal 15 miles each year from 2011-2015. Chip seals add approximately 5-7 years of service life.

Given the funding allocation in this example and the known added service life for each type of treatment, an assessment of mileage within each of the RSL groups was done to best determine where each of the funding allocations should be spent. As an example, when looking at the 2015 RSL graph that included zero maintenance spending, one can see that there was over 5% of the District's road miles in the RSL category of zero (0) years. Therefore, this approach was to allocate all four (4) of the reconstruction miles in this category, subtracting those miles from the 2015 RSL with no maintenance spending and adding those miles into the greater than 20-yr RSL category. This type of analysis and re-distribution of mileage was continued given the mileage from rehabilitation, overlays and chip seal, which resulted in a revised 2015 RSL of 15-yrs. As you can see the resulting RSL from this analysis added 2-yrs to the current RSL discussed earlier.

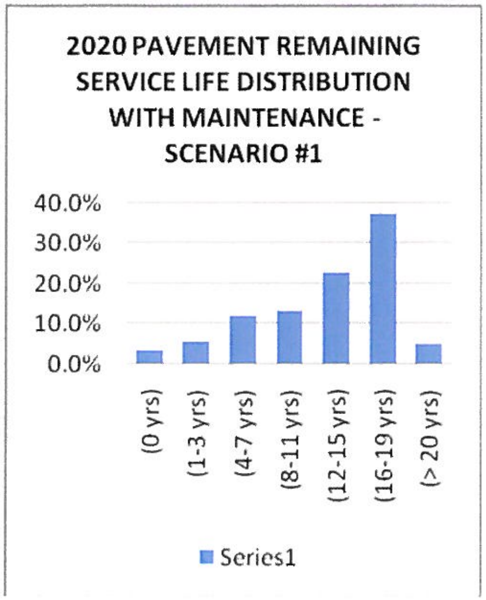
Subsequent to the first example, a second analysis was done using a different funding allocation. This alternative approach included the following spending plan:

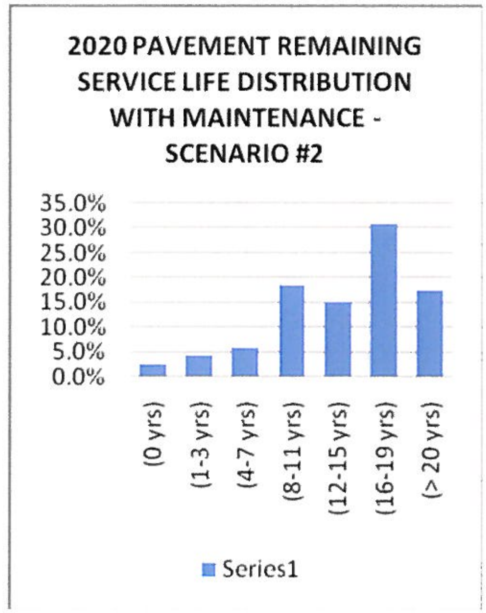


- Total funding for the period is $9,800k or $1,960k per year, which is relatively the same as the first example.
- 600k per year for new construction and/or reconstruction, which is equivalent to 1 new mile per year.
- $400k per year for rehabilitation projects of existing roads, using techniques such as recycled asphalt based and pavement overlays. $400k per year would be equivalent to 2 miles per year.
- *$300k* per year for thin asphalt overlays. Or, overlay 2 miles per year.
- *$660k* per year to chip seal 30 miles each year from 2011-2015.

Given this alternative analysis, the resulting RSL is also approximately equal to 15-yrs. The important difference to note between the two proposed alternatives is the relationship of chip seal miles vs. miles to be rehabilitated and/or overlaid. Although, it is more cost effective to chip seal than to perform alternative treatment techniques, there is a breakeven point where it might make sense to spend more on rehabilitation or overlays than chip sealing. Case in point, given the number of miles to be sealed in alternative number 2 as compared to the total number of miles in the network and how they fall within certain RSL groups, alternative number 2 requires allocating chip seal miles into the lower RSL categories (0-4 yrs) – simply because there are insufficient miles in the other categories. Therefore, LHD needs to consider whether or not it makes sense to chip seal roads with lower RSL that are known to need overlays or other treatments, followed by a chip seal of new paving. This could ultimately result in a potential savings of $22,000 per mile if the initial chip seal is postponed until after the overlay is complete vs. once before and once again after the overlay is done.

Finally, this funding analysis should consider impacts related to spending in years beyond 2015. Therefore, both 2015 scenarios where projected into 2020 in the same manner with respect to the funding distribution previously identified. The resulting graphs are as follows:

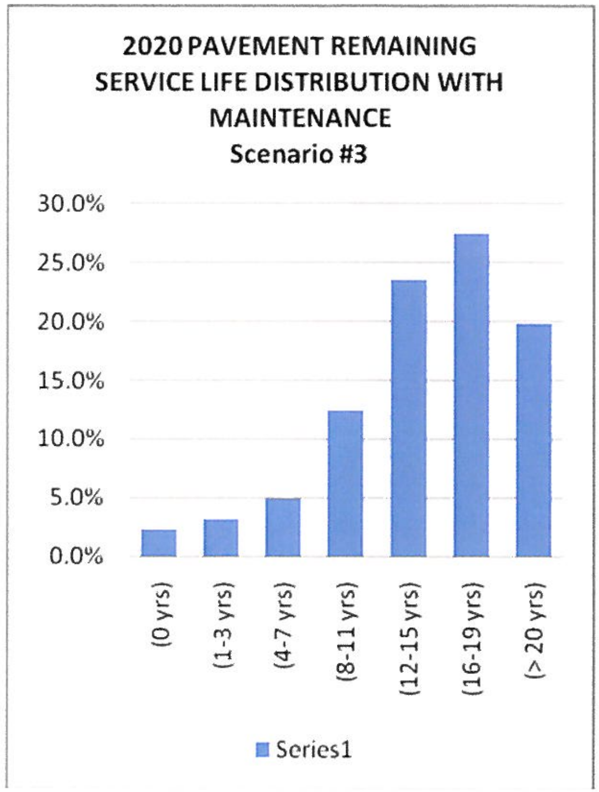




The results from this analysis show that we begin to see additional road mileage in the lower RSL categories and thereby decreasing the average RSL. The average RSL in scenario number 1 and 2 become 13 and 14, respectively as compared to results from the 2015 analysis, which is 15 yrs for both scenarios.

Given the projected increase in RSL from 2010-2015 vs. the decrease in RSL from 2015-2020, this would indicate that spending should be increased in the Preventative Maintenance Category (8-12-yrs RSL) early on in the life of a road (2015 scenario) in order to at least preserve the increase of RSL seen with the proposed spending plan for 2010-2015. This can be seen by looking at the mileage distribution in 2014 that shows mileage beginning to increase in the 4-11 year categories. This is a result of insufficient spending on preventative maintenance – roads that fall in the average RSL category. Focusing on preventative maintenance (preserving what you have) has the **biggest bang for the buck**. Therefore, the following revisions are proposed for 2014 Scenario #2.

Scenario #3, associated proposed spending plan 2015-2020:



- Total funding for the period is proposed to be $2,310k per year.
- Maintain on average 1 mile of reconstruction each year, or $600k per year.
- Increase spending on Rehabilitation from $400k per year to $600k per year, which is an increase from 2 miles per year to 3 miles per year.
- Increase spending for overlay work from $300k per to $450k per year, which is an increase from 2 miles per year to 3 miles per year.
- Maintain spending on the chip seal program; to achieve 30 miles per year or $660k per year.
- Note that each of the proposed funding scenarios uses 2011 monies and an estimated cost of inflation should be applied to each year within the funding periods.

The resulting average RSL with the increased spending plans increases from 14 to 15 years.

The point of this analysis is that LHD needs to review the RSL Distribution to best determine where to spend the District's funds (work on specific roads that fall within RSL categories that need to be addressed in order to achieve a reasonable average RSL). Preferably as previously mentioned in this report, LHD should use this tool to identify needs early on by focusing on the RSL distribution. This proactive vs. reactive approach will ultimately extend the Districts already limited funding.

What does this mean? Well, it may mean focusing our attention on paving roads and performing certain maintenance techniques when it makes sense from an objective analysis of road miles, condition of the road and costs based on performance of certain techniques. Additionally, this may also mean that LHD should focus on other roads that are currently not paved, when it makes sense financially based on an analysis of maintenance costs of gravel roads. An analysis of paving gravel roads vs. continuing to maintain a road as gravel is discussed in subsequent sections of this report.

Gravel Roads

The purpose of this analysis is to determine the "tipping point" at which it makes sense to pave an existing gravel road, or simply treat the road with a BST vs. simply continuing to maintain the gravel road over a period of time. To do this we need to consider the following commonly excepted design life for each of the surface types:

Gravel Roads	0-1 Year Service Life
BST Roads	7 Year Service Life
Overlays	15 Year Service Life
Reconstructed Paved Roads	20 Year Service Life

Given the service life of the individual surface types, one can determine an equivalent annual uniform costs by amortization of the initial costs of a road. Upon obtaining an equivalent annual cost for an asphalt and BST road, these annual costs can be compared to continued maintenance costs of the gravel road for a given traffic volume. The following table identifies an equivalent annual uniform costs for a given surface type, for one mile of road:

Type of Road	Initial Cost of Construction $/Mile	Amortized Cost of Construction, $/Yr[1] A = P(A/P, %, yrs)	Maintenance Costs per Year[2] $/Yr.	Amortized Cost of Gravel Replacement[3] $/Yr.	Total Annual Costs $/Yr
Reconstruction Asphalt[4,5]	$650,000	$43,680 650,000(0.0672, 3%, 20-yrs)	$3,500		$47,200
Overlay	$150,000	$10,000 150,000(0.0838, 3%, 15-yrs)	$3,500		$13,500
BST[6]	$44,000	$7,100 44,000(0.1605, 3%, 7-yrs)	$1000		$8,100
Gravel ADT > 400			$7,500	$4,600	$12,100
Gravel ADT: 150-400			$5,300	$3,000	$8,300
Gravel ADT: 0-150			$3,800	$2,300	$6,100

1. Assumes 3% Annual Inflation Rate
2. Refer to the appendices for cost breakdowns of maintenance to include gravel replacement costs.
3. Gravel replacement every 15-20 yrs on roads w/ADT : 0-150; 10-15 yrs w/ADT: 150-400 and 5-10 yrs w/ADT > 400
4. 2" Pavement thickness, 28-ft in width
5. $60/ton Asphalt
6. Double Shot Chip Seal at $44,000; Single shot chip seal at $22,000 with life of 7-yrs, single shot twice in 20-yr life of pavement.

Refer to Appendix B for job costing and IWORQ's detail used to determine maintenance costs for gravel roads.

Based on an the equivalent annual costs over the given service life, the "tipping point" where it begins to makes sense to overlay *or surface treat* an existing gravel road with a BST is at the point when traffic volumes are approximately greater than 400 ADT and *150-400 ADT*, respectively. Additionally, the results show that it is less cost to maintain a gravel road with an ADT 0-150 vpd vs. providing a BST or Pavement Surface. This analysis considers the road structure is sufficient for a BST or Pavement overlay. LHD currently does not have any gravel roads with sufficient structure greater than the +/- four (4) inches of gravel in place over native soils. Additional consideration should be given to whether or not other modifications to the horizontal and/or vertical curvature are necessary to improve sight distance. Therefore, this analysis should be considered for particular roads on a case by case basis, given traffic volumes, existing structure and alignment.

Conclusions and Recommendations

Conclusions

LHD applies many different maintenance treatments to flexible pavements. The selection process however used to determine these treatments is becoming increasingly important because of the limited funds that agencies have available and the growing backlog of needs.

A framework for determining the most effective pavement preventive maintenance treatment for a flexible pavement is presented in this report. Although simplistic, the process provides a logical approach that can be used by the District. LHD through its PM Program must recognize the type and cause of existing pavement distresses before evaluating available treatments and the other factors that will influence the decision making process. Although cost must be considered, it should not always be the overriding factor in deciding which treatment to use. Finally, engineering judgment and traditional successful methods should play a deciding role in the overall process.

The Budget and Financing Road Work

Not only due to the given current downturn in our economy, but also for the sake of becoming better stewards of the tax-payer dollar, we need to become more efficient in understanding the long-term impacts associated with short-term budget decisions. To do so, we need to improve on our current practices by implementing the following:

- Rate our roads more frequently. A little time up front, will save money in the long-term.
- Look outside of the box when it comes to maintenance. What we've always done doesn't necessarily mean we've done it right.
- We need to provide a mix-of-fixes approach to our road network. Apply the correct technique for the given age and condition of the road. Simply chip sealing our roads every 9-years on a rotational basis may not always be the solution.
- Do not cover up the bad spots, with a chip seal – fix it first.

The bullet items above are further described below.

Rating Roads

In order to sufficiently determine long term impacts associated with short-term decisions the District needs to rate all of the roads every two years, 50% of the roads each year. A total analysis of the road network needs to occur every two years.

Repairs

In order to accurately improve the remaining service life of the District's road network, time and attention needs to be given to other necessary repairs such as crack sealing, patch work and ditching, before roads are covered with chip seals, overlays and/or other (routine maintenance). Previous District practices have dedicated personnel towards road construction projects vs. providing sufficient staffing necessary to address crack sealing and patching of the District's roads, prior to chip sealing. Sufficient staffing needs to be provided such that routine maintenance activities can be performed on approximately 10% of the network, prior to chip sealing of the same percentage.

Recommendations

Concepts presented in this report lay the ground work and fully support the need for a Pavement Preservation Program with dedicated funds. LHD can provide the traveling public a higher level of service at reduced overall costs by making the correct decision to apply the right treatment, to the right road at the right time.

Proposed Spending Plan

Given the analysis completed in this report and using the remaining service life distribution discussed in this report, the following is a proposed 10-year Capital Improvement Project List.

Lakes Highway District Capital Improvement Program 2011-2021

Selected Priority	Recommended Priority to Maintain Current RSL	Capital Improvement: Project	Year	Value	Length (miles)	Amount from General Fund	Grant Funds
		CONSTRUCTION					
	1	Diagonal Road - Full Road Structure Ramsey Estates to Granada Est.	2011	$615,530	1.23	$615,530	$0
	2	Diagonal Road - Granada Est. to The Grove, Reconstruct @2 lanes	2011	$331,439	0.66	$331,439	$0
	3	Diagonal Road - The Grove to Brunner, Reconstruct @2 lanes	2011	$549,242	1.10	$549,242	$0
	4	Lancaster Road, Govt Way to Ferndale - Unfunded match for the Federal Aid	2011	$3,326,007	0.84	$244,129	$3,081,878
	5	Old Hwy 95, Hwy 53 to Chilco Unfunded Federal Match at 7.34%	2012	$3,720,000	3.00	$273,048	$3,446,952
	6	Gov't Way - Aqua to Wilbur, Unfunded Federal Match at 7.34% match	2013	$372,000	0.30	$27,305	$344,695
	7	EHLR - Reconstruct Rockaway Bay Rd. to Dodd Rd.	2014	$640,500	0.70	$640,500	$0
	8	Miles Ave, Strahorn to Lakeview Joint STP Rural Project w/City of Hayden	2015	$463,650	0.33	$13,613	$450,037
	9	English Pt. Rd-Reconstruct Rimrock to Meadowood Ln.(funded by others)	2016	$750,000	1.00	$750,000	$0
	10	Twin Lakes Road, Cone Crest to Twin Echo	2017	$567,543	0.62	$567,543	$0
	11	Old Hwy 95, Corbin to Brunner	2019	$600,000	1.00	$600,000	$0
		TOTAL Proposed Reconstruction Miles =			**10.78**	need 10 miles	
		TOTAL Proposed Reconstruction Costs =			$11,936,000	**$4,612,300**	**$7,323,600**
						budget	6 mil
		REHABILITATION					
	1	East Hayden Lk Rd Paving - Honeysuckle Rd to Half Mile Lane	2011	$243,000	0.70	$243,000	$0
	2	E Upper Hayden Lk Rd Paving - E H L Rd to Doe Run Rd	2012	$200,000	1.00	$200,000	$0
	3	Garwood Road - Reconstruct US 95 to Rimrock rd ATB	2013	$560,000	1.60	$560,000	$0
	4	Garwood Road - Reconstruct Ramsey Rd to Old 95 ATB	2013	$432,000	1.35	$432,000	$0
	5	Strahorn Rd - Kensington to Miles	2015	$162,000	0.81	$162,000	$0
	6	Spirit Lake Road - Grind and pave	2016	$1,150,000	4.60	$1,150,000	$0
	7	Government Way, Hwy 95 to City Limits at Boekel	2017	$223,000	1.11	$223,000	$0
	8	Ohio Match Hwy 95 to Ela Road	2018	$344,000	1.72	$344,000	$0
	9	Old Hwy 95, Brunner to Athol	2020	$400,000	2.00	$400,000	$0
	10	Twin Lakes Road, Twin Echo to End of AC	2022	$752,000	3.01	$752,000	$0
	11	Bunco, Hwy 95 to Nunn	2023	$603,000	2.41	$603,000	$0
	12	Perimeter Road - ATB Traffic Circle to Bayview	2020	$563,000	2.50	$563,000	$0
	13	Perimeter Road, Careywood to Cape Horn, 2.4 miles	2021	$600,000	2.40	$600,000	$0
		TOTAL Proposed Rehabilitation Miles =			**25.21**	need 25 miles	
		TOTAL Proposed Rehabilitation Costs =			6,232,000	**$6,232,000**	
						budget	5 mil
		OVERLAYS					
	1	Lancaster Road, Hwy 95 to Huetter, unfunded Federal Match at 7.34%	2011	$596,000	2.25	$596,000	$0
	2	E. Hayden Lake Road Overlay, Mokins to Yellow Banks	2011	$510,000	3.40	$510,000	$0
	3	E. Hayden Lake Road Overlay, Mokins to Dr. Hayes Property	2012	$300,000	2.00	$300,000	$0
	4	E. Hayden Lake Road Overlay, Dr. Hayes Property to Hayden Creek	2013	$411,000	2.74	$411,000	$0
	5	E. Hayden Lake Road Overlay, Hayden Creek to Dodd	2014	$300,000	2.00	$300,000	$0
	6	Diagonal Rd. Hwy 41 to Reconstructed Section	2015	$209,000	1.39	$209,000	$0
	7	Ramsey Rd, Scarcello to Brunner	2016	$413,000	2.75	$413,000	$0
	8	Clagstone, Hwy 54 to County Line	2017	$391,000	2.61	$391,000	$0
	9	Seasons Road, Hwy 41 to Ramsey	2018	$361,000	2.41	$361,000	$0
	10	Careywood, Perimeter Road to County Line	2019	$226,000	1.50	$226,000	$0
		TOTAL Proposed Overlay Miles =			**23.05**	need 25 miles	
		TOTAL Proposed Overlay Costs =			$3,717,000	**$3,717,000**	
						budget	3.75 mil
		INTERSECTIONS					
		Prairie and Mineral Drive	2015+	$310,000			
		Seasons Road - Intersection improvement @ SH 41w/ ITD	2015+	$250,000			
		Dodd Rd Intersection - Reconstruct at East H L Road	2015+	$398,000			
		SUB-TOTAL Proposed Intersection Costs =			$958,000		
		TURN LANES					
		Rimrock Road @ English Pt. Rd and Lakeview Dr Intersections	2015+	$462,000			
		Ramsey Road - Turn Lanes @ Scarcello Road	2015+	$281,000			
		Ramsey Road - Turn Lanes @ Chilco Road	2015+	$281,000			
		East Hayden Lake Road - Reconstruct Cv's @ Sportsman Access	2015+	$398,000			
		Scarcello Road - Turn Lanes @ Ramsey & SH 41	2015+	$343,000			
		SUB-TOTAL Proposed Costs for Turnlanes =			$1,765,000		
		OTHER					
		East Hayden Lake Road - Additional traffic,safety & Curve Improvements	2015+	$1,200,000			
		Diagonal Road and SH 41	2015+	$200,000			
		Dodd Road, Strahorn to Rimrock Paving	2015+	$350,000			
		Parks Rd - Reconstruct 1000' of road east of US 95 (funded by others)	2015+	$114,000			
		Parks Road, Cont for 2008 Prj to Bohn	2015+	$384,000			
		Ramsey Road - Lancaster Rd to SH 53, Additional road structure	2015+	$525,000			
		Bridging the Valley - Match on Fed. Aid Project @ Ramsey/Diagonal	2015+	$325,000			
		Seasons Road - New connection Ramsey Rd. to Weir Rd.	2018+	$848,000			
		Ramsey Road - Turn Lanes @ Brunner Road	2015+	$219,000			
		Ramsey Road - Turn Lanes @ Remington Road	2015+	$219,000			
		Ramsey Road - Turn Lanes @ SH 54 w/ ITD	2015+	$94,000			
		Bridging the Valley - Match on Fed. Aid Project @ Brunner RR Xing	2015+	$263,000			
		SUB-TOTAL Proposed Costs for Other =			4,741,000		
		Total Infrastructure		$29,348,912			

CIP Discussion

Given both the proposed spending alternatives from 2010-2015 provide similar RSL, in addition to the proven increased need for spending in 2015-2020 that is required to maintain the average RSL, the proposed CIP considers allocating funding in accordance with the following:

Present through yr. 2015

- 600k per year for new construction and/or reconstruction, which is equivalent to 1 new mile per year. Reconstruction adds approximately 20-years of service life.
- $400k per year for rehabilitation project of existing roads, using techniques such as recycled asphalt base and pavement overlays. $400k per year would be equivalent to 2 miles per year. Rehabilitation adds approximately 12-15 years of service life.
- *$300k* per year for thin asphalt overlays. Or, overlay 2 miles per year. Overlays add approximately 12-years of service life.
- *$660k* per year to chip seal 30 miles each year from 2011-2015. Chip seals add approximately 5-7 years of service life.
- Average Budget per year = $1,960k

2015-2020

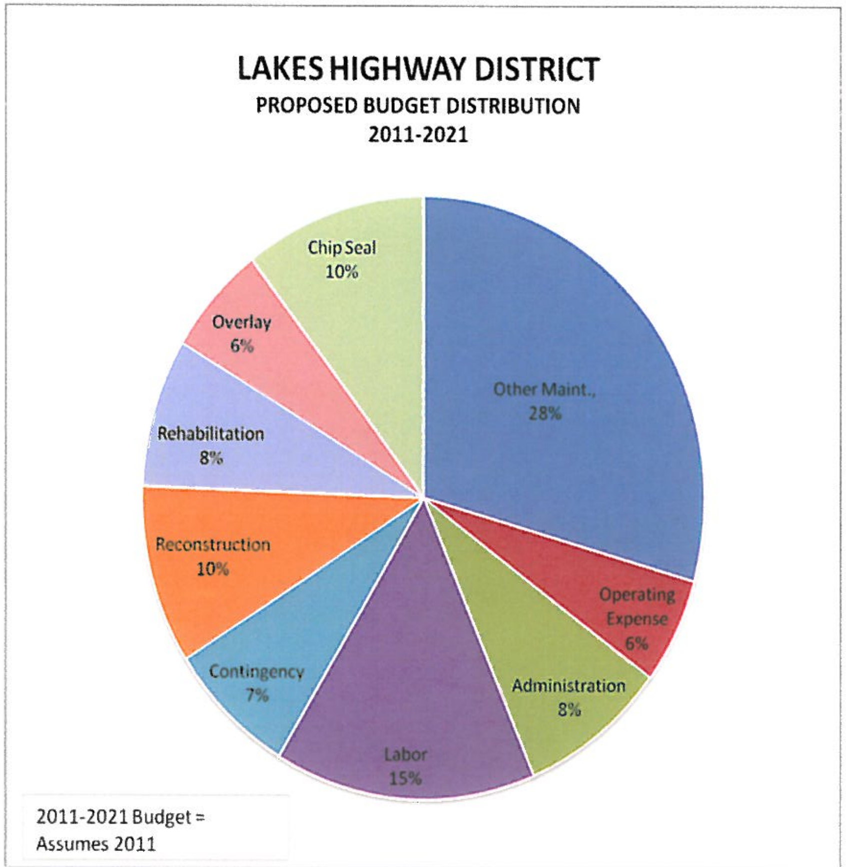
- Maintain on average 1 mile of reconstruction each year, or $600k per year.
- Increase spending on Rehabilitation from $400k per year to $600k per year, which is an increase from 2 miles per year to 3 miles per year.
- Increase spending for overlay work from $300k per to $450k per year, which is an increase from 2 miles per year to 3 miles per year.
- Maintain spending on the chip seal program; to achieve 30 miles per year or $660k per year.
- Average Budget per year = $2,377k

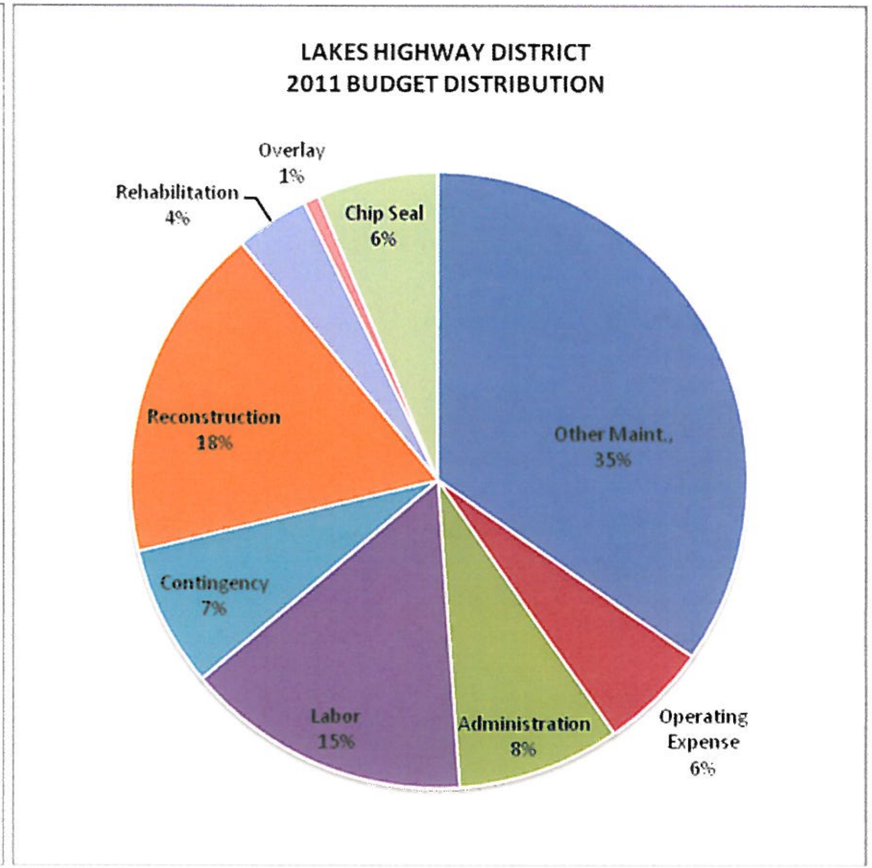
Combining each of the spending plans from present time to 2020 concludes the following:

- Total Reconstruction Miles = 10 miles or 1.0 miles per year or $600k/yr in 2011 dollars.
- Total Rehabilitation Miles = 25 miles or 2.5 miles per year or $500k/yr in 2011 dollars.
- Total Overlay Miles = 25 miles or 2.5 miles per year or $375k/yr in 2011 dollars.
- Total Chip Seal Miles = 300 miles or 30 miles per year or $660k/yr in 2011 dollars.
- Average Budget per Year Dedicated towards Construction and Maintenance = $2,135k

Refer to Appendix C for supporting documentation used to select projects based on projected RSL.

Proposed Budget Distribution

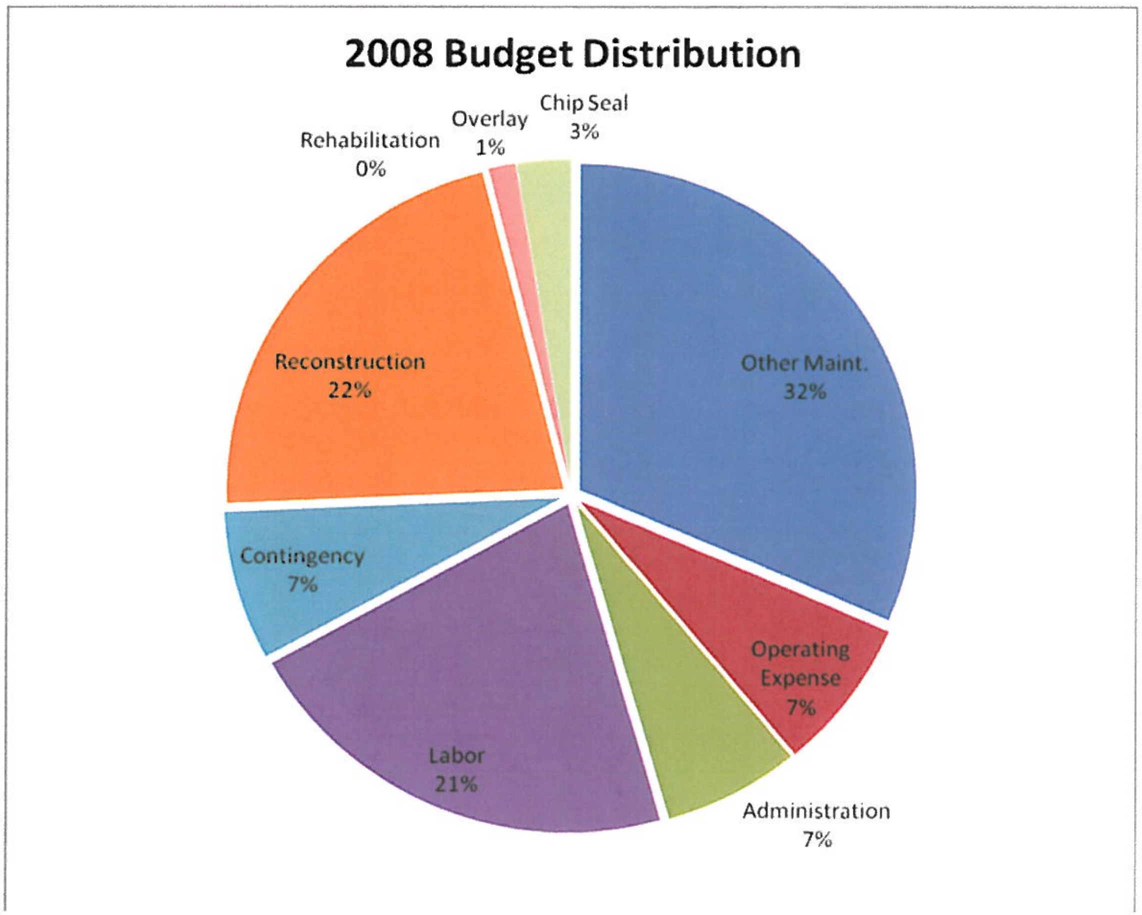




The noticeable difference in the proposed 2011-2021 budget distribution from the current 2011 budget is the reallocation of funding in reconstruction, rehabilitation, overlay and chip sealing. These reallocations directly impact the category of "Other Maintenance" as it is the assumption that the remaining categories remain constant.

Items included in "Other Maintenance" are: road stabilization, federal matching, erosion control, traffic control, signing and stripping, crack sealing, bridge and culvert, rock crushing, snow removal, engineering, land survey and miscellaneous contract maintenance, all of which are necessary District expenditures.

The moral to this story is during each budget cycle, commissioners need to consider impacts to other budgetary items when considering how to maintain a current level of service while also considering how to maintain a reasonable remaining service life of the District's Roads. As an example, the following graph shows the 2008 distribution as a comparison to the 2011 distribution. The results of this comparison show a re-direction in the District's budget allocation that focuses more on preservation of the current road network vs. less reconstruction or new construction.



Appendix A – IWORQ's RSL Pavement Detail

Appendix B – Gravel Road Analysis Supporting Documentation

Appendix C – Remaining Service Life Projections

Appendix D – Extended Service Life Gains per Treatment

Extended Service Life Gains for Preventative Maintenance Treatments		
Treatment	Pavement Type	**Extended Service Life (years)**[a]
Crack sealing	Flexible	Up to 3
	Composite	Up to 3
	Rigid	Up to 3
Single chip seal	Flexible	3 to 6
	Composite	N/A[b]
Double chip seal	Flexible	4 to 7
	Composite	3 to 6
Slurry seal	Flexible	N/A[b]
	Composite	N/A[b]
Hot-mix asphalt, 1.5-in. (40-mm) overlay	Flexible	5 to 10
	Composite	4 to 9
Hot-mix asphalt, 1.5-in (40-mm) Mill and overlay	Flexible	5 to 10
	Composite	4 to 9
Joint resealing	Rigid	3 to 5
Spall repair	Rigid	Up to 5

Definitions

Annual Costs – Any costs associated with the annual maintenance and repair of the facility.

Cape Seal – Cape seal uses the advantages of two sealing and rehabilitation methods combined. It is the application of a chip seal followed within a few weeks by a slurry seal. An application of a cape seal is followed y crack sealing. A cape seal is applied when the pavement deterioration is greater than what a slurry seal is designed to correct, yet has not deteriorated to the point of requiring an expensive asphalt overlay. A cape seal prevents water penetration reducing subsequent damage to the road bed, along with providing a new wearing surface. Cape seals are used on residential streets due to its ability to provide the strength of a chip seal with the smoothness of a slurry seal. Used with crack sealing and surface patching, a cape seal significantly extends the life of a neighborhood street.

Chip Seal – A surface treatment in which a pavement surface is sprayed with asphalt (generally emulsified) and then immediately covered with aggregate and rolled. Chip seals are used primarily to seal the surface of a pavement with non load-associated cracks and to improve surface friction, although they also are commonly used as a wearing course on low volume roads.

Cold In-Place Recycling (CIR) – A process in which a portion of an existing bituminous pavement is pulverized or milled, the reclaimed material is mixed with new binder and, in some instances, virgin aggregates. The resultant blend is placed as a base for a subsequent overlay. Emulsified asphalt is especially suited for cold in-place recycling. Although not necessarily required, a softening agent may be used along with the emulsified asphalt.

Cold Milling – A process of removing pavement material from the surface of the pavement either to prepare the surface (by removing rutting and surface irregularities) to receive overlays, to restore pavement cross slopes and profile, or even to re-establish the pavement's surface friction characteristics.

Corrective Maintenance – Maintenance performed once a deficiency occurs in the pavement; i.e., loss of friction, moderate to severe rutting, extensive cracking or raveling.

Crack Filling – The placement of materials into non-working cracks to substantially reduce infiltration of water and to reinforce the adjacent pavement. Working cracks are defined as those that experience significant horizontal movements, generally greater than about 2 mm (0.1 in.). Crack filling should be distinguished from crack sealing.

Crack Sealing – A maintenance procedure that involves placement of specialized materials into working cracks using unique configurations to reduce the intrusion of incompressibles into the crack and to prevent intrusion of water into the underlying pavement layers. Working cracks are defined as those that experience significant horizontal movements, generally greater than about 2 mm (0.1 in.).

Dense-Graded Asphalt Overlay – An overlay course consisting of a mix of asphalt cement and a well graded (also called dense-graded) aggregate. A well graded aggregate is uniformly distributed throughout the full range of sieve sizes.

Discount Rate – The rate of interest reflecting the investor's time value of money, used to determine discount factors for converting benefits and costs occurring at different times to a baseline date. Discount rates can incorporate an inflation rate, depending on whether real discount rates or nominal discount rates are used.

Emulsified Asphalt – An emulsion of asphalt cement and water, which contains a small amount of an emulsifying agent. Emulsified asphalt droplets, which are suspended in water, may be either the anionic (negative charge) or cationic (positive charge) type, depending upon the emulsifying agent.

Equivalent Uniform Annual Cost (EUAC) – The net present value of all discounted cost and benefits of an alternative as if they were to occur uniformly throughout the analysis period. Net Present Value (NPV) is the discounted monetary value of expected benefits (i.e., benefits minus costs).

Fog Seal – A light application of slow setting asphalt emulsion diluted with water. It is used to renew old asphalt surfaces and to seal small cracks and surface voids.

Heater Scarification – A form of hot in-place recycling in which the surface of the old pavement is heated, scarified with a set of scarifying teeth, mixed with a recycling agent, and then leveled and compacted.

Hot In-Place Recycling (HIR) – A process which consists of softening the existing asphalt surface with heat, mechanically removing the surface material, mixing the material with a recycling agent, adding (if required) virgin asphalt and aggregate to the material, and then replacing the material back on the pavement.

Hot Mix Asphalt (HMA) – High quality, thoroughly controlled hot mixture of asphalt cement and well graded, high quality aggregate thoroughly compacted into a uniform dense mass.

Inflation Rate – The rate of increase in the general price levels, caused usually by an increase in the volume of money and credit relative to available goods. The inflation rate is also reflective of the rate of decline in the general purchasing power of a currency.

Initial Costs – All costs associated with the initial design and construction of a facility, placement of a treatment, or any other activity with a cost component.

International Roughness Index (IRI) – A ratio of the accumulated suspension motion to the distance traveled obtained from a mathematical model of a standard quarter car traversing a measured profile at a speed of 80 km/h (50 mph). Expressed in units of meters per kilometer (inches per mile), the IRI summarizes the longitudinal surface profile in the wheel-path.

Life Cycle Costing – An economic assessment of an item, system, or facility and competing design alternatives considering all significant costs of ownership over the economic life, expressed in terms of equivalent dollars.

Microsurfacing – A mixture of polymer modified asphalt emulsion, mineral aggregate, mineral filler, water, and other additives, properly proportioned, mixed and spread on a paved surface.

Net Present Value – The present value of future expenditures or costs discounted using an appropriate interest rate.

Nominal Dollars – Dollars of purchasing power in which actual prices are stated, including inflation or deflation. Hence, nominal dollars are dollars whose purchasing power fluctuates over time.

Open-Graded Friction Course (OGFC) – An overlay course consisting of a mix of asphalt cement and open-graded (also called uniformly graded) aggregate. An open-graded aggregate consists of particles of predominantly a single size.

Pavement Preservation – The sum of all activities undertaken to provide and maintain serviceable roadways. This includes corrective maintenance and preventive maintenance, as well as minor rehabilitation projects.

Pavement Preventive Maintenance – Planned strategy of cost-effective treatments to an existing roadway system and its appurtenances that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system (without increasing the structural capacity).

Pavement Reconstruction – Construction of the equivalent of a new pavement structure which usually involves complete removal and replacement of the existing pavement structure including new and/or recycled materials.

Pavement Rehabilitation – Work undertaken to extend the service life of an existing pavement. This includes the restoration, placing an overlay, and/or other work required to return an existing roadway to a condition of structural and functional adequacy.

Pavement Serviceability Index (PSI) – A subjective rating of the pavement condition made by a group of individuals riding over the pavement.

Periodic Costs – Costs associated with rehabilitation activities that must be applied periodically over the life of the facility.

Present Worth Method – Economic method that requires conversion of costs and benefits by discounting all present and future costs to a single point in time, usually at or around the time of the first expenditure.

Real Dollars – Dollars of uniform purchasing power exclusive of general inflation or deflation. Real dollars have a constant purchasing power over time.

Recycling Agents – Organic materials with chemical and physical characteristics selected to address binder deficiencies and to restore aged asphalt material to desired specifications.

Rejuvenating Agent – Similar to recycling agents in material composition, these products are added to existing aged or oxidized HMA pavements in order to restore flexibility and retard cracking.

Rubberized Asphalt Chip Seal – A variation on conventional chip seals in which the asphalt binder is replaced with a blend of ground tire rubber (or latex rubber) and asphalt cement to enhance the elasticity and adhesion characteristics of the binder. Commonly used in conjunction with an overlay to retard reflection cracking.

Salvage Value – The remaining worth of the pavement at the end of the analysis period. There are generally two components of salvage value: residual value, the net value from recycling the pavement, and serviceable life, the remaining life of the pavement at the end of the analysis period.

Sand Seal – An application of asphalt material covered with fine aggregate. It may be used to improve the skid resistance of slippery pavements and to seal against air and water intrusion.

Sandwich Seal – A surface treatment that consists of application of a large aggregate, followed by a spray of asphalt emulsion that is in turn covered with an application of smaller aggregate. Sandwich seals are used to seal the surface and improve skid resistance.

Scrub Seal – Application of a polymer modified asphalt to the pavement surface followed by the broom scrubbing of the asphalt into cracks and voids, then the application of an even coat of sand or small aggregate, and finally a second brooming of the aggregate and asphalt mixture. This seal is then rolled with a pneumatic tire roller.

Slurry Seal – A mixture of slow setting emulsified asphalt, well graded fine aggregate, mineral filler, and water. It is used to fill cracks and seal areas of old pavements, to restore a uniform surface texture, to seal the surface to prevent moisture and air intrusion into the pavement, and to provide skid resistance.

Stone Mastic Asphalt Overlay – An overlay course consisting of a mix of asphalt cement, stabilizer material, mineral filler, and gap-graded aggregate. The gap-graded aggregate is similar to an open-graded material but is not quite as open.

Surface Texture – The characteristics of the pavement surface that contribute to both surface friction and noise.

User Costs – Costs incurred by highway users traveling on the facility and the excess costs incurred by those who cannot use the facility because of either agency or self-imposed detour requirements. User costs typically are comprised of vehicle operating costs (VOC), accident costs, and user delay costs.