Chapter 10 - MAINTENANCE AND OPERATIONS PLAN

Transportation systems require maintenance, repair, rehabilitation, updating, and replacement to maintain serviceability, reliability, safety, and to protect the public's investment. The City's transportation infrastructure is comprised primarily of streets with pavements, sidewalks, illumination, and traffic control, including traffic signals, signs, and pavement marking. In recent years, pavement rehabilitation and traffic signal upgrade projects programmed in the yearly 6-Year Transportation Improvement Program (TIP) accounted for over seventy-five percent of the total expenditures. This demonstrates the City's strong commitment to preserving its transportation infrastructure.

THE PUBLIC WORKS DEPARTMENT

Mountlake Terrace's Public Works Department's mission is to guard the health, safety and welfare of the citizens by operating and maintaining the water, sewer, street and storm systems in accordance with applicable codes, policies and laws established by the City, County, State and Federal Government.

The City operates separate water, sewer and storm utilities funded through service fees for each utility. Work on surface roads, signalized intersections, streetlights and all improved rights of way is performed by street division personnel through a General Revenue Street Fund. The department consists of the following six divisions: Engineering Services, Streets, Stormwater, Sewer, Water and Equipment Rental. The Engineering Service, Streets and Stormwater divisions have a direct or peripheral role in maintaining and operating the transportation infrastructure and are briefly discussed below

ENGINEERING SERVICES

The Engineering Service's group are located at City Hall. They are responsible for planning, constructing and rehabilitating the City's streets, traffic control systems, water, sanitary sewer, and storm drainage infrastructure.

Maintaining street systems and traffic control for pedestrians and drivers is also a responsibility of Engineering Services. In order to increase safety and reduce traffic congestion, the Engineering Services Department manages the City's streets by adjusting traffic signals, modifying traffic signs and updating lane markings. The department also coordinates the use of the right of way enabling private and public utilities and telecommunication providers to bring the services citizens need and enjoy.

Typical projects include pavement overlays, street reconstruction with curbs and sidewalks, new traffic signals, street lighting, water main and sewer main replacements, and installing new storm drainage facilities.

The remaining five divisions operate out of the Public Works Operation and Maintenance Facility located at 6204 215th St. SW.

STORMWATER

Storm water is rain and snowmelt that runs off impervious surfaces such as rooftops, paved streets, highways, and parking lots. As it runs off, it picks up pollutants like oil, fertilizers, pesticides, soil, trash, and pet waste and is either soaked into the ground or conveyed through the City's storm water networks. First, along a roadway's curb and gutter and into catch basins. Then it enters the storm water drainage system and eventually is dispersed into one of the four watersheds in Mountlake Terrace. Storm water runoff is the leading threat to Washington's urban waters, streambeds, banks, and habitats.

This group is in charge of maintaining Mountlake Terrace's stormwater network and managing spills that enter the storm water system to minimize the negative impacts to fish, wildlife, pets and people.

STREETS

The Street's Division preserves the City's streets, traffic signals, street signs, street shoulders, streetlights, sidewalks and walkways to help provide a safe and pleasing environment for citizens. Their responsibilities include:

- Managing the constructed street surface within the right-of-way with roadway crack sealing, paving, chip sealing, pothole patching, and snow and ice control
- Maintaining traffic-related roadway amenities including 16 signalized intersections, 76 miles of surface streets (pavement markings and striping and signs), 503 City-owned street lights (street lights mounted on metal or concrete poles), 946 SnoPUD –owned streetlight) 3,335 signs, 70 miles of sidewalk, curb ramps, bicycle route signing and striping, and landscaping maintenance of 25 miles of planting strips and brush control

SEWER

The mission of the Sewer Division of the Public Works Department is to guard the health, safety, and welfare of its citizens by operating and maintaining the sanitary sewer system in accordance with applicable codes, policies, and laws established by the City, County, State, and Federal statutes.

Approximately 80% of the sewage from Mountlake Terrace is collected and pumped to the City of Edmonds for primary and secondary treatment. The remaining 20% flows through Brier and Lake Forest Park and is treated by King County Metro at the West Point Treatment Plant near Discovery Park in Seattle. Mountlake Terrace has sewer agreements with the City of Edmonds, the City of Brier and the Ronald Wastewater District for disposal of sanitary sewer flow. The City has purchased sufficient capacity in the Edmonds Treatment Facility to accommodate growth as outlined in the City's Comprehensive Plan.

WATER

The Water Division of the Public Works Department maintains the city water infrastructure to provide drinking water for home use, commercial use, and for fire protection. The City purchases potable water for distribution from the Alderwood Water District.

EQUIPMENT RENTAL

The Equipment Rental Division provides for routine maintenance, the setup for new vehicles and repair for the nearly 60 vehicles and 40 pieces of equipment owned and operated by the City of Mountlake Terrace.

EXISTING MAINTENANCE AND OPERATION PROGRAM

MAINTENANCE

Maintenance of the City's transportation infrastructure is provided primarily by the City's Public Works Department. Activities include pavement patching, crack sealing, sign cleaning and replacement, minor sidewalk repairs and replacement, right of way mowing and other vegetation control, cross walk painting, and street and traffic signal light replacement. Street sweeping and catch basin cleaning is also performed by the Public Works staff as part of the stormwater quality and maintenance program. Additional assistance for signal maintenance and repair is provided by the City's Traffic Engineer and by an on-call contract with the City of Lynnwood. Other types of maintenance performed by contract includes street re-striping (by private contractor), slab jacking of sidewalks, spraying for weed control, and milling of abrupt edges of concrete sidewalks to eliminate potential tripping hazards.

PRESERVATION

The City roadways are paved almost entirely with asphalt concrete. Preservation of these roadway pavements are guided by the Multi-Year Pavement Maintenance and Rehabilitation Plan, which was drafted in 2005, while coordinating with other City capital improvement projects for the water, sewer, and storm utilities. Based on the conclusions of the report and financial considerations, the strategy consists of using a mixture of bituminous surface treatments (chip seals) and pavement overlays.

CHIP SEALS

The predominate form of chip seal applied by the City is comprised of a fog seal with one or two layers of rock. The City has a long history of relying on this pavement treatment. Chip seals are generally expected to have a service life of about seven years.

ASPHALT CONCRETE PAVEMENT OVERLAYS

In recent years, the City has had few pavement overlay maintenance projects. The projects have included spot repairs of failed pavement, full surface and taper grinding of pavement, curbing and sidewalk repairs, ADA compliant sidewalk ramps where none existed and replacement ramps where they did not meet ADA design requirement, and minor storm water system modifications. The projects have also incorporated traffic calming measures. In coordination with this transportation plan, future projects may include delineating bike lanes and other bike route improvements. Selection of projects includes reviewing the capital improvement plans for water, sewer, and storm to determine if utility improvements are programmed within the roadway segment under consideration. If there are, the projects schedules are coordinated. As part of the design of the overlay project, existing City sewer and storm systems are remotely inspected with video to locate repairs needed in advance of the overlay.

Water services are also evaluated to determine if they too should be replaced. This effort will greatly reduce the likelihood of needing to dig into the new pavement overlays to repair leaks or other utility failures, and thereby prolong the integrity and lifespan of the pavement and the City's investment.

Utility Improvement Project Effects on Pavement Condition

Another strategy to preserve the City's roadway pavements is the City's pavement restoration standards. With the City's commitment to overlay projects there was growing concern about the impact of future utility cuts in the newly repaved streets. This led to new requirements for pavement restoration over trenches. The goal was to adopt requirements that better balanced the need to prolong the life of roadway pavement with the cost to developers, residents, utility companies, and the City when implementing those requirements.

Saw cutting, removing and replacing asphalt pavement shortens its life. Regardless of how well the pavement is restored (patched), cuts in pavement create seams of weakness that contribute to early deterioration and failure. The problem is acute in streets where the seams are subjected to wheel loading from high traffic volumes, which occur, on arterials and collectors. The strategy to reduce this effect is to locate seams away from areas of the pavement subject to loading, i.e., the wheel tracks, and to reduce the number of seams. Pavement patching also decreases the smoothness and "ride" along the street. This results when too much or too little asphalt is placed in a narrow trench, resulting in a narrow bump or dip. Wider patches are typically smoother. To address these issues, the adopted pavement restoration standards for arterials and collectors require longitudinal (along the direction of travel) patches to extend to the edges of the travel or parking lanes. Transverse patches must be a minimum of 10 feet wide.

Traffic Signal Upgrades

Nearly all of the traffic signals in the City were constructed more than two decades ago. Vehicles detected by induction loops installed in the roadway pavement actuated signal phases and determined cycle length. The controllers receiving the actuations and operating the signals are comprised of many types and many manufactures. Most are old, have limited functionality, and are becoming difficult to maintain. Likewise, most of the controller cabinets are outdated and are not configured to accommodate modern traffic control equipment.

In 2004, 220th Street SW, from SR 5 to SR 99, was reconstructed to increase capacity along that corridor. The project included a fiber optic signal interconnect system to synchronize the operation of the signals. Video vehicle detection replaced the induction loops due to the ability of the video system to operate after the pavement was removed during the construction phase, as opposed to the loops, which could not. This was the first use of video vehicle detection in the City. In 2005, a program to update the controllers and cabinets was initiated. In the future, the installation of video detection will be added to the controller and cabinet replacement program.

The schedule of these upgrades will continue to be coordinated with street overlays, construction projects undergrounding overhead utilities that affect the existing loop detection systems, and equipment failures. This program is anticipated to be completed in 2015.

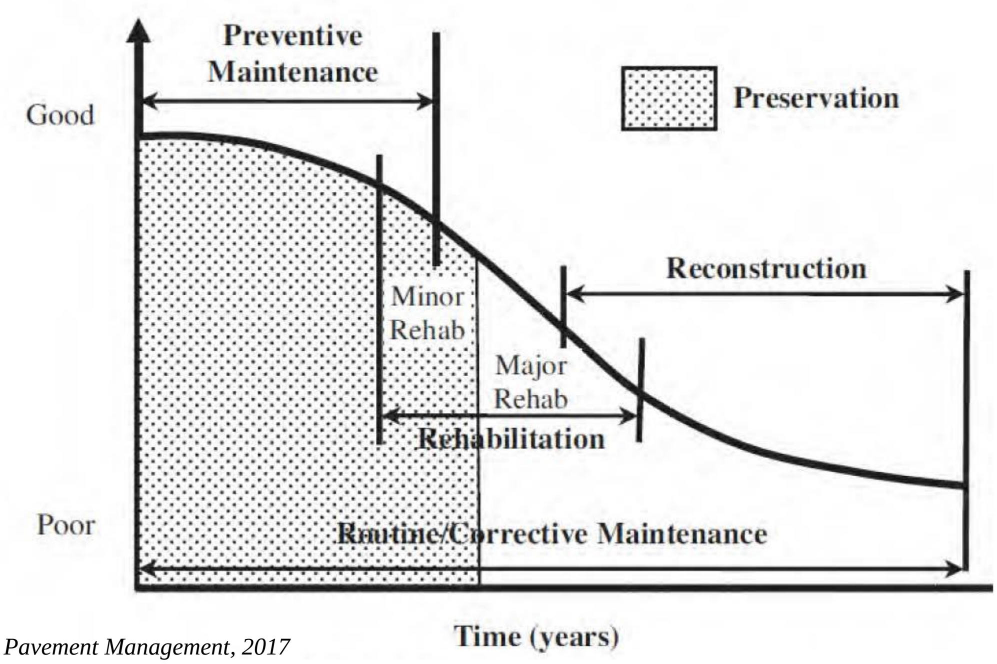
In 2006, the Citywide Signal Modification Project was completed, which was comprised primarily of replacing incandescent bulbs in the signals with energy efficient light emitting diode (LED) lighting units. A signal upgrade at 56th and 236th was also part of the project, which included installing video detection in advance of a pavement overlay project that included paving that intersection.

The phase I of the Main Street project was completed in 2020. Maintenance-related improvements that occurred as part of the project included:

- Signal Cabinet and Controller upgrades at the intersections of 236th St. SW with 56th Ave. W.
- Constructed a new traffic signal at Van Ry Blvd. with 236th St. SW.
- Asphalt overlay on 236th St. SW between Interstate 5 and 56th Ave. W.

The Importance of Creating a New Pavement Maintenance Program

A pavement management program [PMP] is a maintenance document that protects this community asset and maximizes the life of it. In general terms, a PMP regularly evaluates pavement conditions and determines the most cost-effective methods to extend pavement life and improve the driving surface. When streets begin to fail, pavement deterioration occurs quickly and the costs to repair them begin to increase. A generalized pavement life curve, shown Figure 10 – 1 below, illustrates this point. Pavement may appear to be in good condition for a long time. However, when it fails, it fails quickly and repair costs increase dramatically. Therefore, it is best to monitor pavement condition citywide and utilize a variety of maintenance resources to extend the life of each roadway on a rolling basis.



FHWA, *Pavement Management, 2017*

Figure 10-1 – Pavement Deterioration – vs – Time Chart

The PMP effectively uses these resources to maximize pavement condition citywide while minimizing maintenance costs. The overall goal of a pavement inventory is to develop a pavement condition index (PCI) and assign a PCI score to individual roadway segments throughout the City, which eventually allows individual roadway maintenance improvement projects to be identified and prioritized.

An effective PMP will address pavements while they are still in good condition and before the onset of serious damage. A properly structured PMP can help pay for itself through reduced repair costs and optimized maintenance. The development of a PMP takes the following three step:

- Perform a city-wide pavement condition inventory;
- Create a prioritized list of pavement maintenance improvement projects; and
- Develop a pavement maintenance funding program based on the prioritized list of maintenance projects.

These three steps are described in detail below.

PERFORM A CITY-WIDE PAVEMENT CONDITION INVENTORY

Time, traffic and weather take their toll on all pavement surfaces. Repeated loads of travelling vehicles and trucks, moisture from rain and snowmelt, temperature fluctuations causing cyclic freeze and thaw of moisture that has penetrated the pavement contribute to the deterioration of pavement over time. The PMP provides a structured maintenance schedule to ensure the pavement condition is maintained to provide safe driving conditions and extends the life of our streets.

The two types of pavement maintenance that the City has used in the past are slurry seals and asphalt overlays. These treatments preserve and replace the street surface. Both extend the life of the roadway and appear similar when completed.

The inventory can be completed in a variety of methods or a combination of them; they vary in complexity and cost. Two conventional methods of conducting a pavement management condition inventory include an annual visual inventory and a more detailed pavement attribute measurement analysis.

ANNUAL VISUAL INVENTORY

Observing all pavement surfaces on an annual basis is useful to identify and catalogue surface distress problem areas. Pavement surface distress is any indication of poor or unfavorable pavement performance or signs of impending failure. Surface distress modes can be broadly classified into the following three groups:

- **Fracturing** – Fracturing is in the form of pavement cracking or chipping/fraying at joints or cracks resulting from such things as excessive loading, fatigue, thermal changes, moisture damage, material slippage or contraction.
- **Distortion** – Distortion is in the form of deformation (rutting and rippling), which can result from such things as excessive loading, creep, densification, consolidation, swelling, or freeze/thaw cycles.
- **Disintegration** – Disintegration is in the form of stripping, raveling or potholing, which can result from such things as poor or aging emulsifier bonding, chemical reactivity, traffic-related abrasion, aggregate degradation or poor consolidation/compaction.

A visual inspection of the surface of the pavement can also provide valuable indicators of base-failure or base-deficient strength and sub-base or soil inefficiencies present in the area.

PAVEMENT ATTRIBUTE MEASUREMENT ANALYSIS

This method uses a team of professional pavement technicians that drive along the jurisdictions roadways on a "pavement condition van" that uses electronic vehicle-mounted sensors and cameras to measure the attributes. The cameras are used to identify pavement surface distress conditions described above. The vehicle-mounted sensors collect pavement condition attributes that include the following:

- **Pavement Roughness** – Pavement roughness is an expression of irregularities in the pavement surface that adversely affect a vehicle's ride quality. Roughness is an important pavement characteristic because it affects not only ride quality but also vehicle operating costs, fuel consumption and maintenance costs. It was developed to distinguish the trade-off between pavement condition and user cost The International Roughness Index [IRI] is used to quantify roughness. Mathematically, the IRI is the accumulated suspension of a vehicle (inches) divided by the distance traveled by the vehicle during the measurement (miles).
- **Skid Resistance** – Skid resistance is the force developed when a tire that is prevented from rotating slides along the pavement surface. Skid resistance is an important pavement evaluation safety parameter for the following reasons:
  - Inadequate skid resistance can lead to higher incidences of skid related accidents.
  - Most agencies have an obligation to provide users with a roadway that is "reasonably" safe.
- **Pavement Deflection** – The magnitude and shape of pavement deflection is a function of traffic (vehicular type and volume), pavement structural section and the temperature and moisture content affecting the pavement structure. Thus, many characteristics of a HMA pavement can be determined by measuring its deflection in response to loading and what protective measures can be taken to maintain it in the future. Surface deflection is measured as a pavement surface's vertical deflected distance because of an applied (either static or dynamic) load.

CREATE A PRIORITIZED LIST OF PAVEMENT MAINTENANCE IMPROVEMENT PROJECTS

The Pavement Condition Index [PCI] is a numerical rating of the pavement condition based on the type of pavement condition inventory method used. The PCI value of the pavement condition is represented by a numerical index between 0 and 100, where zero is the worst possible condition and 100 is the best possible condition.

In addition, the PCI history of a pavement section can help establish its rate of deterioration and identify future rehabilitation needs. Consequently, the PCI values are also used in prioritizing, funding and executing maintenance and preservation of pavement segments that are continuous, share similar deterioration characteristics and comprise a sensible distinct pavement rehabilitation project.

If the *Annual Visual Inventory* method is used, the PCI calculation is based on the surface distresses observed during pavement condition inspections. This information is used to establish a pavement condition rating system that identifies deduction points that reflect specific distress type, severity, and extent combinations. These points can then be summed and subtracted from the upper limit of 100 points to give an overall rating of a pavement section's structural condition. The equations that describe the conversion of the severity and extent of a certain distress type to a PCI score, vary among jurisdictions and can be rather complex.

When a *Pavement Attribute measurement analysis* method is utilized, the PCI calculation is based not only on the pavement surface distress conditions discussed above, but also on the electronically captured attributes collected from the sensor-equipped vans taking the survey of the roadway network. These attribute measurements include ***roughness***, ***skid resistance*** and ***deflection*** described above. The PCI equation becomes more complex by adding these parameters, but will provide a more comprehensive review of the conditions that may be causing the pavement to deteriorate.

Once the PCI is calculated for each street segments, a pavement maintenance schedule can be created. There are several ways to implement pavement rehabilitation based on the PCI-generated prioritized list. However, there basic steps are mostly consistent and include the following components:

I. **Creating a trigger treatment PCI point threshold** – For instance, once a pavement segment's PCI reaches a certain level, it will be added to a list of pavement maintenance or rehabilitation needs list;

II. **Determine the extent and cost of repair** – A pavement condition score is a numerical representation of a pavement's overall condition and can thus be used to estimate the extent of repair work, the likely repair cost and its relative prioritization.

III. **Establish a maximum network condition index** – By combining PCI's for individual roadway segments for an entire road network, a single score can be obtained that gives a goal the City can use to monitor the roadway network condition as a whole.

The PMP schedule must also consider where individual pavement sections are on the Pavement Deterioration – vs – Time Chart shown in Figure 10 – 1. The City must determine whether a street has reached a level beyond the point where preventive maintenance or a minor pavement rehabilitation method can be used to extend the pavements life at significantly less cost. On the other side of the spectrum, an evaluation has to be made to schedule pavement segments that are approaching widespread failure so that roadway safety and discomfort while using them are not sacrificed.

This process is also complex since its primary goal is to create a strategy that maximizes pavement condition and minimizes maintenance costs. Therefore, the development of a PMP schedule involves balancing pavement maintenance costs with a list of maintenance needs and the appropriate method for pavement preservation and its serviceability life extensions.

A life-cycle cost analysis of pavement rehabilitation strategy alternatives, when done correctly, permits the identification of the strategy which yields the best value, by providing the desired performance at the lowest cost over the analysis period. Ideally, a comprehensive life-cycle cost analysis would consider quantitatively all of the costs incurred by both the agency and the users over the analysis period.

Pavement maintenance can be broadly classified into three primary categories – Preventive, Corrective and Critical. The cost of each of these types of projects are less significant as the severity of deficiencies decline. For instance, overlays consists of Hot Mix Asphalt (HMA) over an existing pavement structure with minor to major structural repair. Overlays are less costly than Reconstruction, which is typically, required when there is substantial damage to the existing pavement structure. The various methods of pavement maintenance procedures are summarized in Table 10 – 1 below.

TABLE 10-1 – PAVEMENT MAINTENANCE PROCEDURES

Pavement Procedure Type	Process	Life Extension without Preventive Maintenan	Cost	Comments
Critical – Reconstruction or Overlays with Significant Structural Work				
Reconstruction	Reconstruction a roadway is the process of a complete replacement of the pavement structure.	30 – Asphalt 40 – Concrete		The entire pavement structure is removed and replaced with a new aggregate base and wearing surface.
Major Overlay with Significant Structural Repair	Major Overlay with Significant Structural Repair is the process where the old surface is milled or ground off. The structural deficiencies are repaired and a new wearing surface is applied.	15 – 20		The structural deficiencies are significant
Corrective – Overlays with Minor Structural Work or Standard AC Overlay				
Minor Overlay with Minor Structural Repair	Minor Overlays with Minor Structural Repair is the process where the old surface is milled or ground off. The structural deficiencies repaired and a new wearing surface is applied	15 – 20		The structural deficiencies are sporadic
Standard Hot Mix Asphalt [HMA] Overlay	Standard AC Overlay is the process where the old surface is milled or ground off and a new wearing surface is applied	10 – 15		
Preventive – A variety of preventive pavement procedures are available				
Crack/Joint Filling	Crack filling is the process of placing lower quality bituminous filler materials into non-working cracks to substantially reduce the infiltration of water and to reinforce the adjacent pavement.	2 – 4		Once the Crack Filling finishes curing, a thin overlay or other maintenance surface application
Crack/Joint Sealing	Crack/joint sealing is the process of placing higher-quality thermosetting and thermoplastic material into "working" cracks (i.e., those that open and close with changes in temperature) and construction joints in order to reduce water infiltration into a pavement.	2 – 8		In contrast to crack "filling," crack sealing requires crack routing and uses higher quality sealant materials.
Chip Seal	Asphalt emulsion is applied directly to the pavement surface followed by the application of aggregate chips, which are then immediately rolled to imbed chips. Application rates depend upon aggregate gradation and maximum size.	4 – 8 Dependent on the number of layers applied.		This treatment can be applied in multiple and in combination with other surface treatments. For sections with ADT > 1,000, a fog seal shall be included with the treatment.
Pavement Surface Sealing	Various pavement surface sealing methods are available to improved worn surfaces, prevent water intrusion into or below asphalt pavement, with some also capable of improving structural strength. This may include slurry seals, fog seals, micro surfacing, cape seal, or others.	4-15		Life extension is dependent on the location specific treatment needs and method.

There are numerous other pavement maintenance strategies that are emerging and provide local jurisdiction a variety of choices to add to their toolbox for pavement preservation.

Another major consideration is the ability to coordinate needed pavement maintenance with other street, water, sewer and underground utility improvements. Most major streets receive additional engineering analysis to further evaluate their conditions both in the pavement and the public infrastructure underneath. After all factors have been considered, the candidates are reviewed and a final prioritized project list is developed for a PMP.

DEVELOP A 6 – YEAR FUNDING PROGRAM BASED ON PRIORITIZATION LIST

The Pavement Management Program seeks to balance preservation with replacement of existing surfaces. The most cost-efficient way to correct any street surface problem is to address issues when they first appear. That is why maintenance funds are targeted at streets rated in fair-to-good condition. Without this preventative maintenance, these streets would quickly deteriorate and be much more costly to fix. Monitoring the pavement condition and creating a six – year PMP will save the City a substantial sum of maintenance costs in the future.

In addition to lowering transportation infrastructure improvement costs over time, other advantages of a PMP include: more predictable funding needs, fewer premature pavement failures, safer road conditions and reduced time spent in traffic due to construction. The Pavement management Program is also a component for issuing permits to franchise utilities such as cable, phone, electricity and gas since the permitting process seeks to find alternatives to cutting existing streets.

Without additional funding sources, the current citywide pavement condition level cannot be maintained effectively to keep up with annual deterioration of the street infrastructure. Proactive maintenance in the early years of a street lifecycle, such as repairing cracks and seal coating, is recommended as a cost effective maintenance practice.

By protecting the road subgrade from the negative effects of water intrusion with crack sealing, pavement patching, and seal coating, additional cost savings can be realized in future lower cost pavement rehabilitation methods. If the preventative time frames are missed, the pavement deteriorates quickly and the cost of repairs increases substantially. For example, utilizing pavement maintenance costs and their respective life extension facets, shows that spending $100,000 in a given PMP life-cycle year to slurry seal streets can prevent the expenditure of $600,000 5 to 10 years later for pavement rehabilitation projects or $2,000,000 for pavement reconstruction projects 15 – 20 years later.

Proactively maintaining the City’s streets is a wise investment. The City should perform a physical survey of every road in the City to recalibrate the PCI index every 6 years. In the years that surveys are not done, the PCI should be updated using a computer model with observations from a visual survey of the current arterial and collector street conditions.

Significant reduction in street maintenance funding has occurred in the past couple of decades. There have been reductions in both State and Federal funding through the sale of gasoline resulting in less revenues from gas taxes available for maintenance needs. Federal funding from current and future Federal transportation acts are no longer available for local street maintenance.

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