Council Meeting Date: February 1, 1999 **Agenda Item: 6(a)**

CITY COUNCIL AGENDA ITEM

CITY OF SHORELINE, WASHINGTON

AGENDA TITLE:	Pavement Maintenance and Rehabilitation Plan for Shoreline's Road System
DEPARTMENT:	Public Works
PRESENTED BY:	Douglas W. Mattoon, Director DM Gail Perkins, Operations Manager GP

EXECUTIVE / COUNCIL SUMMARY

At your Council meeting on April 27, 1998, Public Works staff introduced the use and concept of Pavement Management Systems. There were also pavement and asset management discussions at your 1999 budget retreat. At that meeting the City Manager shared the fact that we are not setting aside adequate funds on a yearly basis to protect our most valuable physical asset, our roadway network. Following that meeting, staff began the process of developing a long-term pavement maintenance rehabilitation and repair plan for the City's $380 million asset, our roadway network. The current budget adopted by your Council provides $400,000 annually to maintain this multi million-dollar asset. A pavement management system will enable us to optimize our available funds, get more work done with limited funds and improve the overall condition of our pavement networks.

In order to develop a pavement management program staff:

- Collected data (via King County staff) on all pavement surfaces throughout the City
- Performed modeling on the roads to predict future performance
- Defined maintenance rehabilitation strategies
- Developed procedures for the implementation of these strategies, and
- Developed a model that includes cost estimates and the overall performance of the pavement network

The purpose of this report is to provide information on overall maintenance and rehabilitation strategies and to provide options for maintaining the integrity of the pavement condition. This report will review the condition of Shoreline's roadway network and help to assess the capacity of our funds to meet the maintenance needs recommended by the pavement management program. It will also help in getting a maximum return for expenditures by implementing a multi-year street rehabilitation and maintenance program, and selecting the most cost-effective options.

Staff has performed an extensive data analysis of the condition of pavement surfaces within Shoreline, and has included in this report three application alternatives to pavement rehabilitation and repair. They are as follows:

Status Quo: (Reactive not planned) Reflects the City's current pavement maintenance practices and funding levels.
Cost: $400,000 annually (Arterial $271,000, Residential $129,000)
Result: Decline in pavement condition would occur from a fair condition to poor.
Deferred Maintenance: A dramatic increase of deferred maintenance and the need for large capital investments would occur in the long-term with the continuation of this program.

All Overlays: (Uses more aggressive overlay strategies of various thickness values) This method depicts an increase in funding levels with no alternative treatment options.
Cost: $590,000 annually (Arterial $400,000, Residential $190,000)
Result: The roadway network would remain in the fair with a minimal decrease over 10 years. This is an improvement over the Status Quo Program.
Deferred Maintenance: Would "flatten" out over a 10-year period and decrease the need for massive capital expenditures in the future. This is not optimal but is an enhancement over our current practices.

Mix Method: (Uses overlays and seal treatments) This is staff's preferred alternative. It utilizes the same funding level as the All Overlay option. A mix of treatment alternatives were considered in this program
Cost: $590,000 annually (Arterial $400,000, Residential $190,000)
Result: This maintenance strategy provides the best level of pavement condition, and the lowest deferred maintenance cost. The use of overlays on major arterial and high traffic areas and seal coats on low traffic non-curb and gutter areas provides a balance of the overall condition of the pavement network.
Deferred Maintenance: Costs are reduced and a balance of the overall condition of the pavement network is achieved.

Based on this analysis staff is recommending the "Mix Method" pavement maintenance program. This maintenance strategy provides the best level of pavement condition, and the lowest deferred maintenance cost. The program will require a budget amendment before this option is implemented from the current $400,000 to $590,000 budgeted annually for overlays.

RECOMMENDATION

Staff is requesting consensus from your Council that the recommended "Mixed Method" pavement management program is the preferred option. With Council concurrence, staff would return to Council with necessary budget amendments.

Approved By: City Manager LB City Attorney N/A

BACKGROUND

As part of the 1998 Overlay Work Plan presented to your Council on April 27, 1998, Public Works staff introduced the use and concept of pavement management systems. These concepts and how they apply to asset management were also briefly discussed at your 1999 budget retreat. At that time the City Manager discussed the need to increase our overlay budget from our current $400,000 per year spending level to $500- $700,000 annually. This recommendation was made to bring road conditions to an appropriately maintained service level. Staff committed to return with a detailed review of our pavement management needs. This report is intended to fulfill that commitment by presenting an overview of pavement management, an analysis of the City's pavement network and a recommended pavement management program.

The City of Shoreline has approximately 380 lane miles of paved surfaces with an estimated replacement value of $380 million. Investing in a pavement management program is critical to protecting this asset. Pavement management is best described as an organized and systematic process for applying a series of preventive maintenance treatments over the life of the pavement to maximize the use of limited funds and extend the life of the pavement. An optimal pavement management program uses a variety of preventive maintenance methods to reduce the need for more expensive road reconstruction in the future. Research indicates that applying preventive maintenance treatments at appropriate times during a pavement's life is less costly than reconstructing the surface at the end of a pavement's life. These treatments range from seal coating the roadway, costing $1.20 per square yard, to thick asphalt overlay, costing $12.30 per square yard (Table 1). When a road fails and can not be effectively repaired using preventive maintenance or overlays, the cost of reconstruction is $35.00 per square yard. As you can see, applying preventive maintenance treatments at the appropriate time in a road's life cycle will be two to three times cheaper than to wait until road failure occurs and replacement is required. The implementation of a sound routine maintenance program also expands life expectancy, reduces deferred maintenance costs and minimizes capital vs. maintenance expenses.

In order to develop a pavement management program, pavement management automated systems are developed to monitor and manage pavement surface conditions. These systems also assist in selecting the various routine preventive maintenance treatments such as "seal coating" and "overlays" of varying thickness, and the timing of their application from year to year. The performance of preventive maintenance treatments depends on many factors including:

- The condition of the pavement prior to the application of treatment
- Environmental factors such as traffic conditions, volume or type of vehicle usage
- Drainage and shoulder conditions
- Type of previous preventive maintenance performed, criteria and the materials used
- Quality of the maintenance application
- Weather conditions and the time of year when the treatment is applied

By analyzing and improving pavement surface conditions, the City could benefit from improved safety, reduced liability and claims and reduced operating costs. Creating a pavement management system involves conducting detailed visual surveys of pavement conditions. The process generally consists of walking and visually inspecting the pavement surface condition.

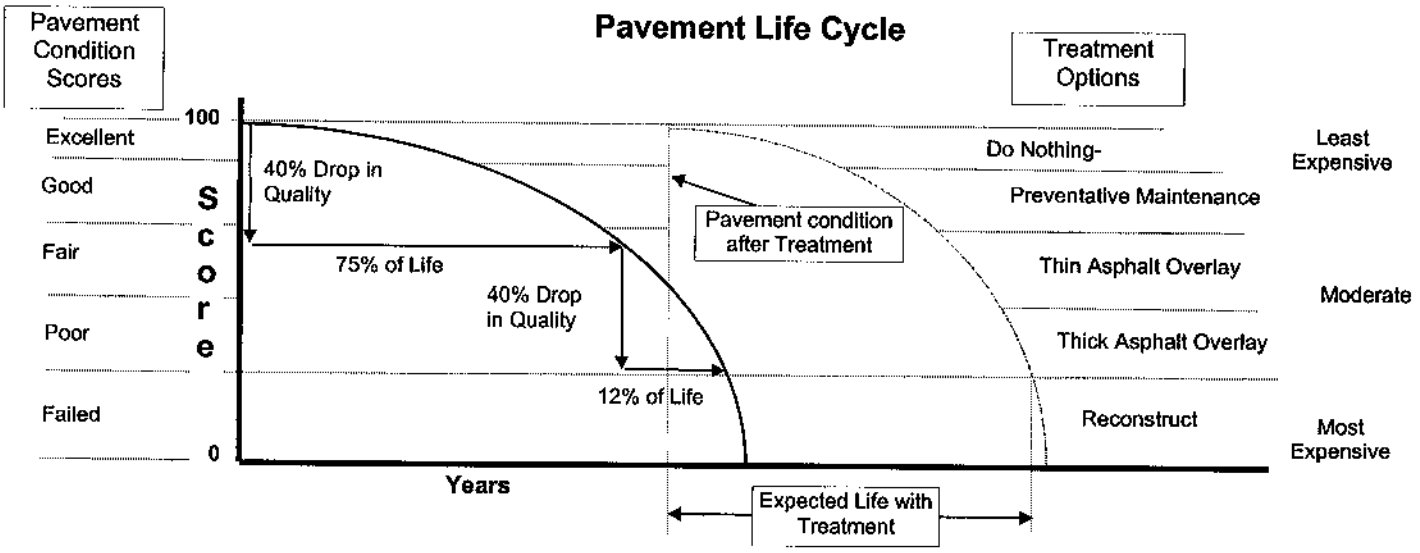
This inspection process identifies the severity of different types of cracking, the amount of loose rock, rutting and potholes. Data is collected utilizing a rating system. The condition is rated using a scale from 0-100 with 0 being the worst condition and 100 being the best. Ideally, a pavement condition should not fall below a rating of 65. Pavement conditions rated below 65 fail 6 times faster that those rated above 65. One advantage of using pavement management systems is the ability to predict the life of a pavement surface and evaluate methods to extend its life.

There are five basic steps required to maintain a professional pavement management system:

- Regular collection of pavement condition data on individual roadway sections
- Modeling or predicting the future performance of these individual pavement sections
- Defining maintenance strategies
- Developing procedures for the implementation of these strategies
- Developing a model including cost estimates of the overall performance of the pavement network

Pavement management systems most commonly use surface distress data to rate the pavement condition. The pavement surface shows different types of distress that give clues about what is occurring to the road structure. A numerical rating is assigned based upon the type, severity and size of the distress. An example would be the measurement of cracks: cracks smaller than 0.5 inch is slight, but 0.5 inch to 1-inch cracks is moderate. Severe cracks are over 1 inch. In addition to cracks, other distress types (i.e. rutting, loose rock and aggregate loss, etc.) are also evaluated. Other considerations include structural characteristics of the pavement layers and actual traffic volumes. This data helps to define the current and likely future condition of a given section of pavement using computer modeling.

Once the ratings are assembled, the scores are fit into mathematical formulas to produce a performance curve that reflects an expected life span of a given section of pavement. An example of the result is the graph on the following page titled "Pavement Lifecycle, expressed as a curve showing the relationship between pavement condition deterioration rate and the expected life of a given of section pavement. This curve also demonstrates when pavement conditions fall below a score of 65, there is accelerated deterioration that occurs compared to those with scores above 65. This model further plots the pavement life expectancy based on various pavement treatments.



A number of variables can define the specific maintenance strategy needs of any given section of pavement and its life expectancy. These variable include:

- The pavement surface condition rating
- Last maintenance, rehabilitation or re-construction
- The expected life of pavement
- Existing age of pavement
- Remaining life of pavement
- The type of applied maintenance: thin overlay, chip seal etc.(see Table 1)
- The pavement life cycle between typical maintenance and repair actions

As you can see by the model curves, the less costly preventive maintenance options (crack seal and patching at $1.20 to thin overlays at $7.50) are available in the earliest stages of a pavement's life cycle. As the pavement life and condition drop to poor and below, the only maintenance options are extremely expensive (thick overlay at $12.30 or complete reconstruction at $35.00). For costs of all treatment alternatives see Table 1 of this report on the following page.

Roadway network systems typically have pavement in all these categories. Thus, a mix of maintenance treatments is required to improve pavement conditions and to extend pavement life.

After modeling the future performance of the pavement, maintenance strategies can be identified that will prolong the life of the roadway surface. The range of options available is based on the condition of the roadway surface. The following table illustrates this in better detail.

Table 1

Treatment Descriptions	Suitable Option when condition is	Unit Cost Per square Yard
Crack sealing and patching	Excellent	$1.20
Chip, slurry or other seal coats	Good	$1.50
Thin Overlay - Residential	Fair	$4.50
Thin Overlay + Fabric	Fair	$7.50
Structural Overlay	Fair- Poor	$7.50
Thick Overlay	Poor	$12.30
Reconstruct ACP with New Base	Failed	$35.00

A seal coat consists of a sprayed application of asphalt binder followed by a layer of aggregate. Seal coats can be applied at a cost of $1.50 per square yard with a projected 8-year life cycle. They can be placed in either single or multiple layers, providing several benefits such as providing a new wearing surface, waterproofing the surface, sealing small cracks, protecting the original surface from solar radiation, and improving surface friction. A pavement needs to be structurally sound before considering a seal coat as a preventive maintenance treatment as a seal coat does not increase the structural capacity of the pavement. Thus, this cheaper approach is only available for roads that are in better shape.

The thick overlay is essential to the pavement network and is the preferred method of maintenance and repair programs for areas that receive high volumes of traffic such as a major arterial. This is due to its 15-year life cycle. Also, it is the only available method where road conditions are failing and cannot be effectively repaired using other treatment options. It is also one of the most expensive to apply at $12.30 per square yard.

Alternative methods of application have become viable due to new seal coat applications techniques and materials. The use of overlays on the major arterial and high traffic areas, and seal coats on low traffic non-curb and gutter areas, provides a balanced alternative to maintaining the overall condition of the pavement network at a given budget. By preserving this balance, deferred maintenance costs are reduced.

Analysis of pavement condition scores, data models of the future performance and maintenance treatment strategies will define the most economical use of funds. Optimal programs result in spreading all costs evenly over a period of time to minimize deterioration of the pavement network, reduce deferred maintenance costs (deferred maintenance is the measurement of unfinished work that still exists within the total pavement network) and provide for predictable annual budgeting funds. For the City of Shoreline, this will require adjusting current budget levels and using various maintenance treatments to optimize the effectiveness of a pavement management program.

ANALYSIS

The process of developing a Pavement Management Program for the City of Shoreline began with an analysis of our own pavement network. All City streets were visually surveyed in 1997 using a manual pavement distress survey procedure. This process involved King County staff walking the streets and measuring the pavement surface distresses as we previously described

in this report. It is important to mention that King County measured a sampling of our pavement condition and then extrapolated the overall condition of the road from that sampling. Until we acquire our own staff and system, the City is relying upon on the accuracy of King County data and staff. This information serves as the foundation for this analysis.

In order to understand our roadway system, we have broken it out into two major categories; these categories are also required by the State for allocating designated gas tax funding sources. This table (Table 2) indicates the specific road classification and total lane miles within the City.

Table 2

Road Classification by Lane Miles		
Classification	Lane Miles	Percent of Total
Arterial Streets	109.80	19.7
Residential	228.30	80.3
Totals	338.10	100

(Aurora pavement surfaces are managed by the State DOT and are not included in the total lane miles)

The overall summary (Table 3, following page) of the City's pavement conditions indicated our pavement network is in fair condition. The Rating Category and the Road Classification dictate, which option is preferable to maintain a particular road.

The data in this table is used to calculate the projected life cycle of a given section of pavement and select the appropriate treatment method. Arterial streets have a higher volume of traffic compared to residential, which results in increased wear. A thick overlay treatment would be the preferred method of maintenance due to its 15-year life cycle as previously mentioned.

The Pavement Conditions Summary (Table 3) depicts the pavement distress survey data.

Table 3

Pavement Condition Summary			
	Rating	Percent Range Based on Total Lane Miles	
Ranges	Category	Arterial	Residential
100-85	Excellent	21.6	29.6
85-70	Good	31.7	16.3
70-55	Fair	19.3	19.2
55-40	Poor	14.1	15.3
40-25	Very Poor	6.0	8.0
25-10	Part Failed	5.4	7.6
10-0	Failed	1.9	4.0
Total		100	100

(Aurora pavement surfaces are managed by the State DOT and are not included in the total lane miles)

By employing the pavement distress survey data and evaluating a variety of treatment strategies, a number of maintenance programs were modeled over a ten-year period. Funding levels were input for each strategy considered. This analysis includes annual routine maintenance to demonstrate the entire costs of managing the City's pavement network. Routine maintenance is funded independently of the city's annual overlay program. The model projected long term deferred maintenance costs and future weighted pavement condition scores. The following analysis looks at 3 different repair options and points of interest. "Status Quo" reflects the city's current pavement maintenance practices and funding levels. "All Overlay" depicts an increase in funding levels from $400,000 per year to $590,000, with no alternative treatments such as chip or slurry coats. The "Mix Methods" option utilizes the same funding level as "All Overlays" and optimizes a mix of treatment alternatives. Table 4 summarizes the impacts of these three pavement management strategies.

Table 4

10 Year Pavement Management Model							
	Annual Budgets			Results			
Options	Arterial	Residential	Routine Maintenance	Deferred Rehabilitation Costs		Pavement Scores	
				Arterial and Residential	Routine Maintenance	Beg.	End
Status Quo	$271,000	$129,000	$27,000	$11,880,000	$5,030,000	65	52
All Overlays	$400,000	$190,000	$40,000	$8,306,000	$2,221,000	65	64
Mix Methods	$400,000	$190,000	$40,000	$5,127,000	$1,368,000	65	72

(Using current dollars)

Status Quo

This option assumes $271,000 per year on overlays for arterial streets, $129,000 for overlays on residential streets, based on overlays of various pavement thickness values and $27,000 for routine maintenance. The deferred maintenance and rehabilitation costs increase at the end of the 10-year period total $11.8 million for rehabilitation of arterial and residential and $5 million for routine maintenance. This indicates a decline would occur in the condition of the pavement network system from a weighted average score of 65 to 52, which takes the system from a "fair" to a "poor" rating category (Table 3). Long-term modeling of the deferred maintenance and

rehabilitation costs is shown in Attachments A and B. As you can see, by looking at the "Status Quo" option last line, this strategy dramatically increases deferred maintenance and rehabilitation costs. Also, upon reviewing Attachment C, you see that the Weight Scores for the overall system drops from 65 to 52. For this reason, this is not our preferred option.

All Overlay

This option assumes $400,000 per year on overlays for arterial streets, $190,000 for overlays on residential streets a total of $590,000 for the overly program and $40,000 for routine maintenance. This option uses a more aggressive overlay strategy using various pavement thickness values. This is a typical repair strategy used by most cities in this region. The annual budget for this option would increase from $400,000 to $590,000. The deferred maintenance and rehabilitation costs, which are the most important indicators of a maintenance system, are $8,306,000 and $2,221,000 respectively (see Table 4). The Deferred Maintenance Costs (Attachment B) show that these costs "flatten out" until the year 2006 and then begin to increase. At that time an increase in funds or maintenance would be required. This is a better-deferred cost method curve, as costs remain constant for some time. The beginning pavement scores from 1998 are just above 65. After ten years of utilizing this method the total weighted average score is approximately 64. See the Pavement Network Average Weighted Scores in Attachment B.

Mixed Methods

This option assumes $400,000 per year on overlays for arterial streets, $190,000 for a mix of seal coats and overlays of varying thickness on residential streets, and $40,000 for routine maintenance. This option is an optimized repair strategy using overlays on the arterial streets and a seal coat on residential streets were appropriate. This maintenance strategy provides the best level of pavement condition, and the lowest deferred maintenance cost. Remember that seal coats can be applied at a cost of $1.50 per square yard vs. the $12.30 overlay. The use of overlays on major arterial and high traffic areas and seal coats on low traffic non-curb and gutter areas provides a balance of the overall condition and a mix of application on residential streets (seal coats and overlays) of the pavement network; deferred maintenance costs are reduced. The annual budget for this strategy is $590,000. As previously stated, this provides a balanced alternative to maintaining the overall condition of the pavement network. By utilizing the same level of funds as "All Overlays", there is a decline in deferred maintenance costs (see Attachment A, and B). Also, per Attachment C, the pavement scores go from 65 1997 to 72 in 2007. For these reasons, this is our recommended pavement management program.

SUMMARY

Pavement management systems are an important tool for the implementation of an effective pavement management program. Used consistently and applied in a timely manner, preventive maintenance treatments can improve the quality of the pavement network and extend pavement service life. The use of a pavement management system has provided detailed information on maintenance needs, the type of maintenance treatments that are appropriate, and an estimate of the quantity and cost of the work to be performed.

Staff recommends a pavement management program that maintains pavement-rating scores in the 60-70 range (fair rating), and keeps deferred maintenance costs steady from year to year. This level would ensure that the City wouldn't face costly repairs in the future due to deferred maintenance. This investment would increase the overall condition of the City's street

infrastructure and reduce total costs over the long term. Data collected will provide insight into which maintenance techniques and materials perform well and under specific conditions.

Staff could obviously add additional pavement management funding options for your consideration. For example, we know that in order to reach the overall pavement rating of "excellent", the City would have to increase the overlay budget from $400,000 to over a $1 million. Given the competing needs in other infrastructure categories of the City this is simply unrealistic. Instead, we feel that more pragmatic target should be a weighted average road condition of 70 plus. The "Mixed Methods" option gets us to 72. If you desire a higher score, A general rule of thumb would be that an additional $100.000 investment in the overlay program would get us an approximately six-point increase in the overall score.

Implementing this pavement maintenance program would require the current overlay budget of $400,000 per year increase annually to $590,000. This concurs with the recommendation made by the city manager late last year. This recommendation will bring road conditions to an appropriately maintained service level.

Budget Implications

Considering that your Council has reviewed two major changes to the Public Works Department budget, this item and the previous approved Three Year Transition Plan of the King County contracts, staff will come back to you with a budget amendment. We believe the cost increases from these two programs can be funded by newly increased revenue.

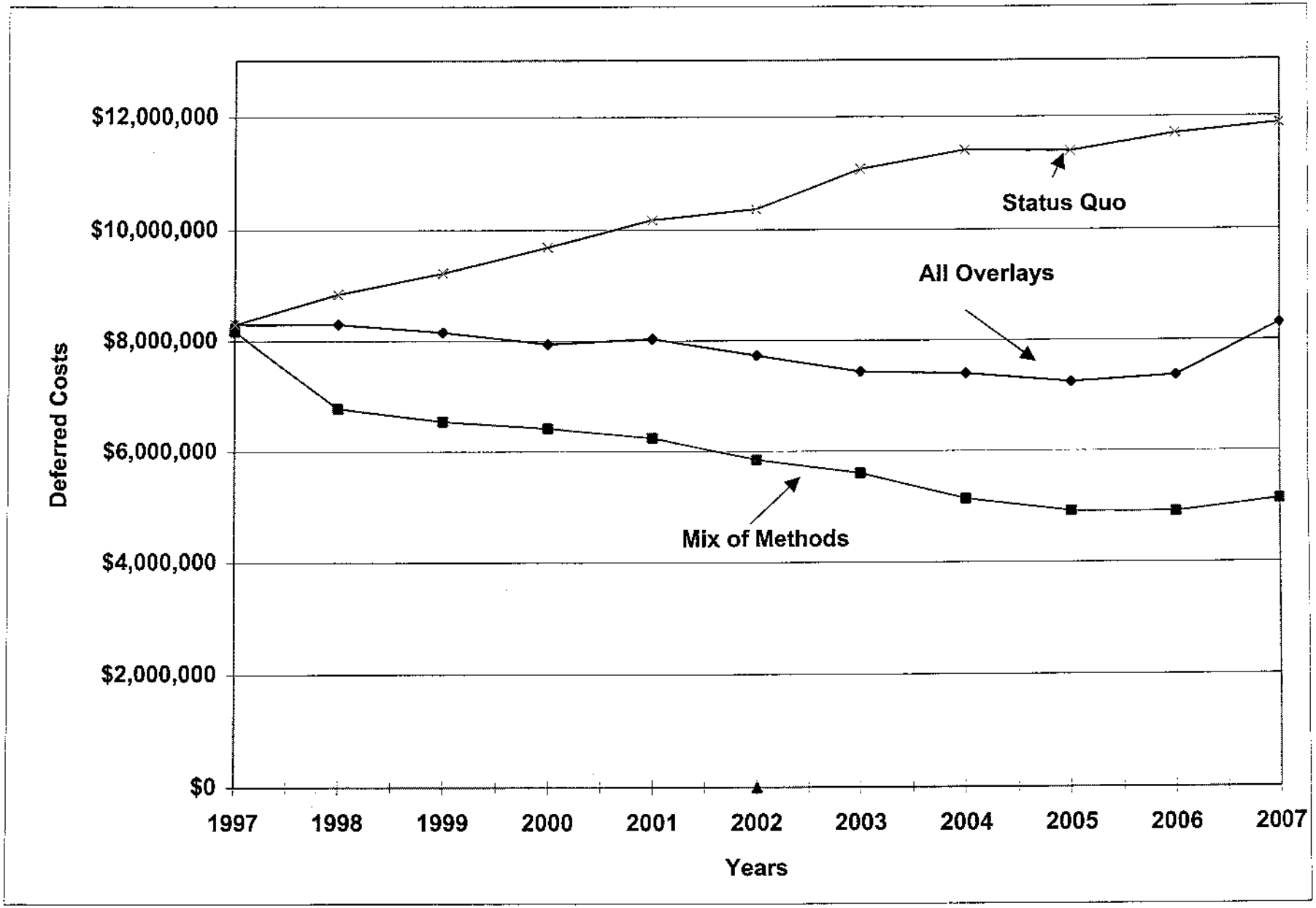
RECOMMENDATION

Staff is requesting consensus from your Council that the recommended "Mixed Method" pavement management program is the preferred option. With Council concurrence, staff would return to Council with necessary budget amendments.

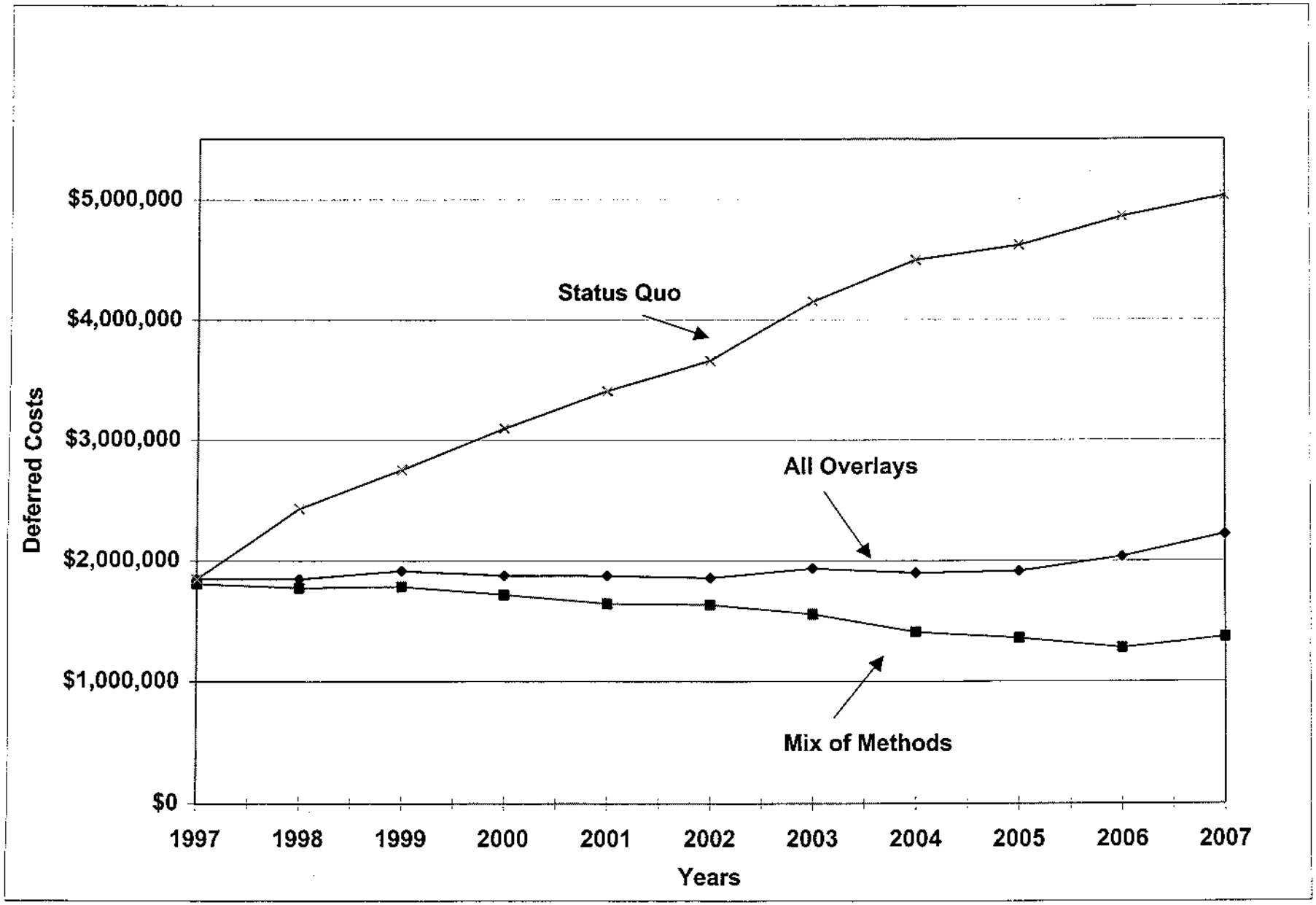
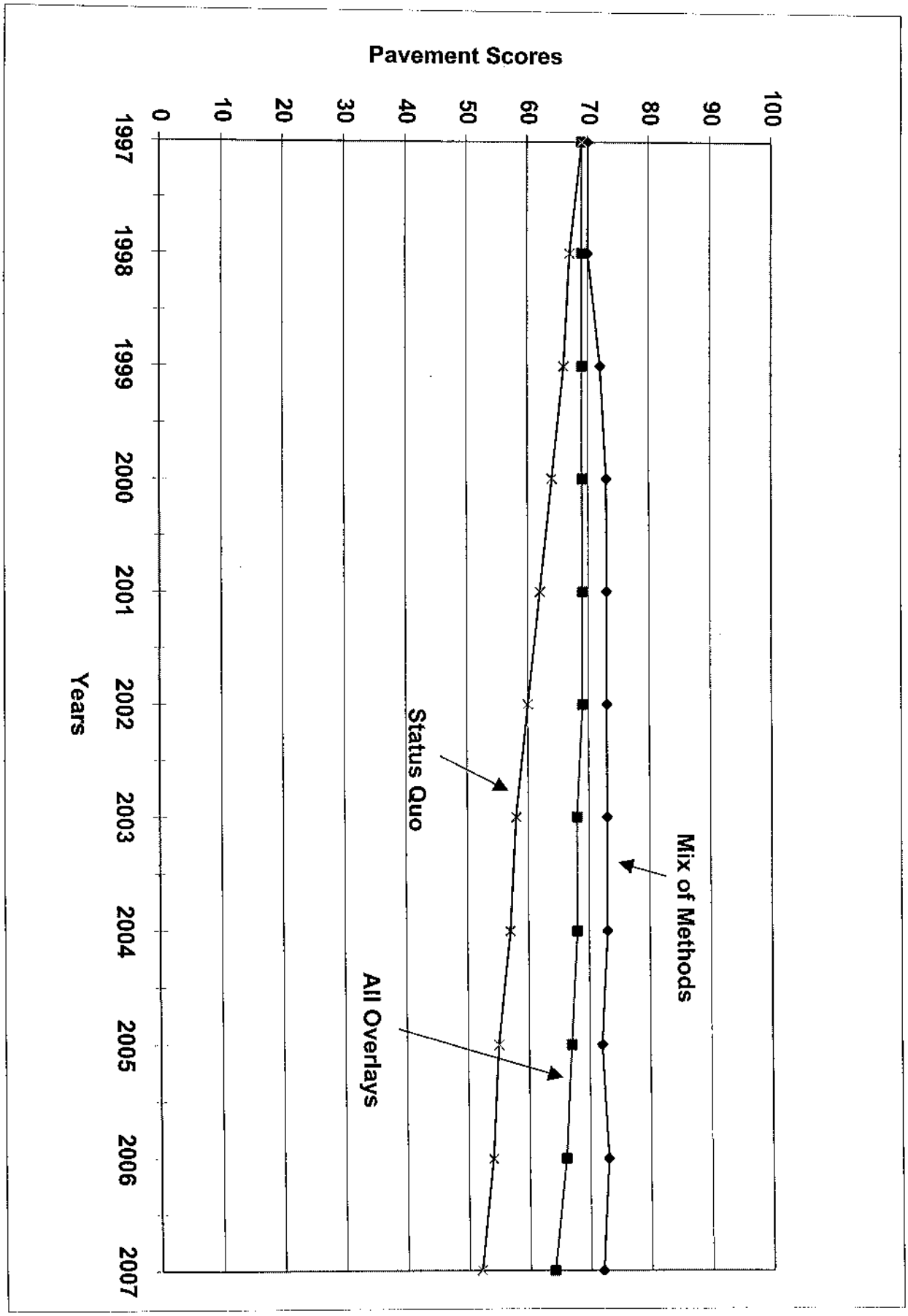
ATTACHMENTS

Attachment A: Pavement Network Deferred Rehabilitation Costs for Arterial and Residential
B: Deferred Network Pavement Rehabilitation Costs for Routine Maintenance
C: Pavement Network Weighted Average Scores

Attachment A: Pavement Network Deferred Rehabilitation Costs for Arterial and Residential



Attachment B: Pavement Network Deferred Rehabilitation Costs for Routine Maintenance



Attachment C: Pavement Network Weighted Average Scores