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August 4, 2023

2023 Pavement Management Report

Lino Lakes, MN

PREPARED FOR: CITY OF LINO LAKES

600 TOWN CENTER PARKWAY

LINO LAKES, MN 55014

WSB PROJECT NUMBER: 022457-000

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I. Executive Summary

This Pavement Management Report includes an evaluation of the City's paved roadways and recommends a Capital Improvement Plan (CIP) and associated funding. The report gives an overview of the two budget scenarios tested for the City but is not intended to be a final document on public policy or city planning and is subject to change. A pavement analysis was performed using the PAVER program to project the future condition of the City's pavement and make maintenance recommendations. Two scenarios were designed by the City and evaluated to determine the best maintenance strategy and funding level. These recommendations and the budgets needed to achieve them are included as part of the provided 10-year Capital Improvements Program. For more information on the current condition of the City's pavement network, please refer to the Pavement Management Report published in November 2022.

A summary of the CIP analysis results is listed below:

- Using a model designed in the PAVER software, 2 scenarios were tested to determine their effects on the long-term condition of the City's pavement network.
- All assumptions for the pavement model were provided by the City, based on industry standards, or based on historical trends in the Minnesota metropolitan area.
- In August of 2022, the average PCI was 75.5 with 69.8% of the roads in Adequate condition, 23.0% of roads in Marginal condition, and 7.2% of the roads classified as being in the Problem category.
- The pavement models suggest that an additional increase in funding of approximately 15% to the overall roadway budget on top of what is already planned will be needed to achieve the City's goal of having an average Pavement Condition Index (PCI) of 73 for their road network.

The analysis included in this report aims to protect the investment already made in the network's better sections by establishing maintenance standards and prioritizing maintenance treatments. It also seeks to recommend the most cost-effective ways to improve the segments that need major repairs.

Both scenarios tested in the model examined different budgets or goals that could possibly get implemented over the next 10 years. A summary of the results is displayed in Table I.1.

Table I.1. 10-Year CIP Scenario Comparison

Scenario	Total 10-Year Budget	Average PCI Over Next 10 Years	Average PCI of Network in 2032	Spending Strategy
1: Current Proposed Budget	$29,300,000	72.1	70.1	Current Budget
2: Maintain Average PCI of 73	$33,800,000	74.6	71.2	Optimized

The City has shown the ability to manage their pavement maintenance budget well by keeping their 5-year network PCI average at 72.5. Good decision making will be crucial moving forward since the test results show implementing the currently proposed budget will cause a slight decrease in average PCI each year. A slight raise in the annual maintenance budget along with a shift towards more cost-effective pavement maintenance strategies will greatly increase the likelihood the City's pavement will remain above an average PCI of 73 for the next ten years.

II. Introduction

Developing a capital improvement program should include a systematic detailed distress survey to evaluate the condition of roads in a network followed by a cost-effective analysis of various maintenance and rehabilitation strategies. This assists decision makers in making budgets and allocating the use of available resources. This pavement management ideology, if successfully implemented, can result in improvement of the life cycle costs, performance, and service life of roads in a city. The main objectives of a CIP analysis are to maintain a high-level network, evaluate the effectiveness of different alternatives, and optimize timing of maintenance and rehabilitation activities. The data for this analysis is typically managed within a pavement management software which can manage, sort, and store the collected information. Through this software, various models can be generated that allow the user to customize maintenance protocols, run different budget scenarios, and evaluate the outcomes of each scenario.

By conducting a CIP analysis, the City is showing their willingness to continue looking for ways to improve their network of roads, extend the life of their pavement, and meet their PCI goals. On top of that, the benefits of a well-planned CIP program extend beyond helping a City improve the average condition of its pavement. Better pavement results in less wear and damage to vehicles that travel the roads. Extending the life of a road reduces the frequency of major reconstruction projects that require lengthy detours and delays to travelers. Safety is improved by giving drivers a surface that allows them to stop quickly and predictably. Achieving the maximum service life of a road is also more sustainable for the environment by reducing the amount of material and fuel that is needed when pavement needs to be completely replaced.

Overall, a capital improvement program should improve the safety for a road network’s users and the sustainability of its pavement maintenance while minimizing the costs to taxpayers. This document is designed to act as a guide to help the City manage its pavement. However, it is not the only source of information decision makers should use. It is important to also consult with maintenance staff and review other factors that cannot be accurately included a model. Circumstances unique to a specific City are hard to capture in a scientific analysis and may take precedent over the recommendations provided.

III. Pavement Condition Report Update

Pavement Lifecycle

Pavement is constructed to meet the demands of traffic and the environment for a certain design period. The Pavement Condition Index (PCI) of the roadway declines as traffic and time slowly take their toll on newly constructed pavement. Figure III.1. shows the typical life expectancy of pavement based on data obtained from the Army Corps of Engineers.

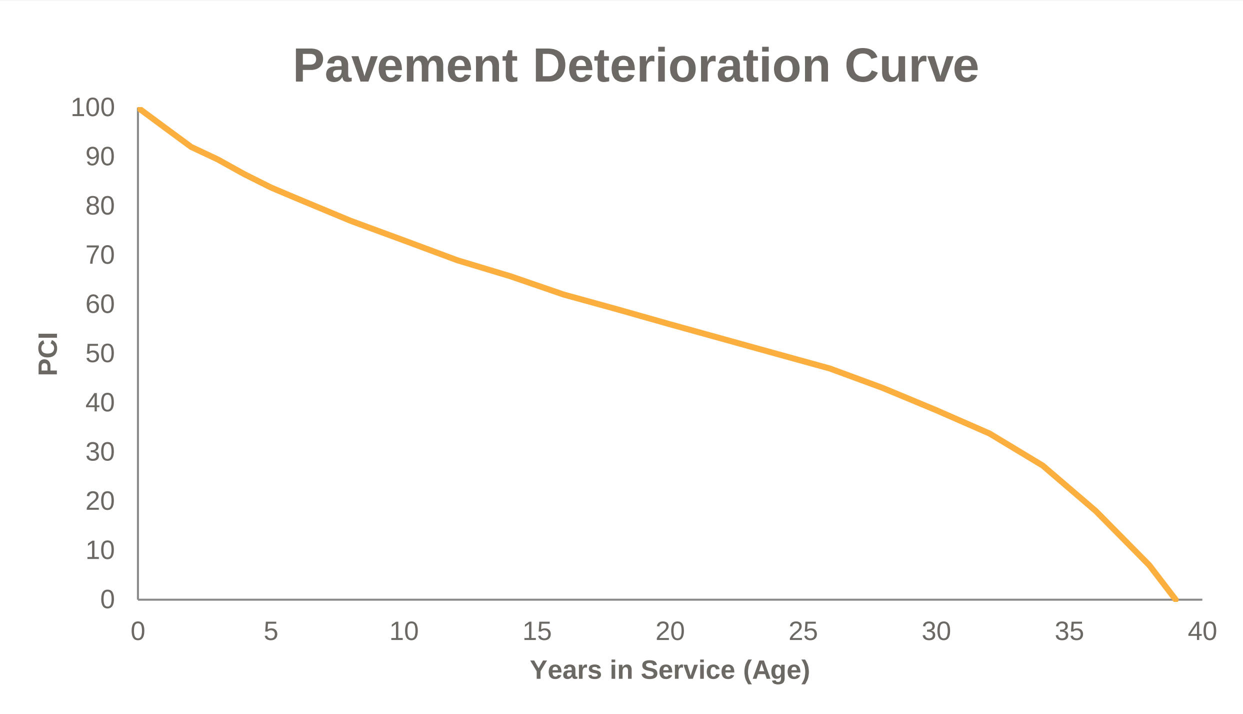

Figure III.1. Typical Pavement Deterioration Curve

This curve exhibits standard behavior when no maintenance is implemented. Each repair or preservation technique applied increases the PCI of a segment and increases its expected life by delaying degradation. The PCI values used for this CIP analysis are based on a surface inspection of the City's streets that was completed over the past 4 years with a quarter of the City's streets inspected each year. Surface inspections provide a good indication of the pavement and what riders experience when driving on the road. However, they do not capture the sub-surface of a pavement structure. Pavement forensics such as pavement coring are required to analyze the entire depth of the road. Some repairs such as patching often improve the PCI of a road but fail to address underlying issues that will continue to cause deterioration. The recommendations in this report seek to keep PCI values high but also maintain the underlying layers of pavement for each segment.

Existing Pavement Conditions

PCI values are used to evaluate pavement condition on a scale from 0 to 100 with 100 being a perfect roadway that exhibits no distress. Table III.1. displays the PCI categories that were outlined by the City's engineering staff and can be used to describe the condition of bituminous roadways. Additionally, the table also outlines the assumed repair that is used on segments of each condition category. While the recommended maintenance strategy should serve as more of a recommendation than a rule, this assumption is needed for the pavement model to determine how best to maintain each segment of road.

Table III.1. Pavement Condition Categories Based on PCI Values

Category	Pavement Condition Index (PCI)	Recommended Strategy
Adequate	70.01 – 100.00	Preventative Maintenance
Marginal	40.01 – 70.00	Mill/Overlay
Problem	0.00 – 40.00	Reconstruction

PAVER, an asset management software, was used to record and estimate the condition of each road segment. The software calculates PCI using deduct values that are based on the type, severity, and quantity of the visible pavement distresses on each road. Examples of asphalt pavement distresses include alligator cracking, longitudinal/transverse cracking, and potholes. Distress severity is classified as either low, moderate, or high. Depending on the type of distress, quantity is measured as the number of occurrences, length, or area. For segments that weren't inspected in 2022, a standard degradation curve was used to extrapolate the condition of the pavement.

The PCI values generated were based on a visual inspection and the corresponding recommended maintenance strategies should only be used as a guideline. In some cases, pavement forensics such as coring may be needed to supplement visual inspections and provide more information regarding roadway conditions.

This report shows the 2022 pavement conditions for all road segments. Most bituminous roadways at the time of inspection were in Adequate condition, but over 7% of the network was classified as a Problem. Table III.2. shows how much of the City's pavement is in each condition category.

Table III.2. 2022 City Roads by Condition Category

Pavement Condition Index	Mileage	Percent of System by Area
Adequate Category (70.01 – 100.00)	71.4	69.8 %
Marginal Category (40.01 – 70.00)	24.9	23.0 %
Problem Category (0.00 – 40.00)	8.4	7.2 %

For detailed analysis regarding the current condition of the City's pavement network or recommended maintenance strategies, see the Pavement Management Report published in November 2022.

IV. Pavement Maintenance and Rehabilitation Techniques

The information provided in this pavement management report is based on a systematic method of inspecting and rating the pavement condition of roads in the City's network, followed by an analysis of various cost-effective maintenance and rehabilitation strategies which can aid in making the best decisions on the use of available resources. It can also be used to provide updated data regarding the current capital improvement program.

Recommended Maintenance Actions

Lino Lakes has many options at their disposal for pavement rehabilitation and preventative maintenance. However, the City most frequently implements reclamations, mill and overlays, full reconstructions, and preventative maintenance to extend the life of a roadway. Each of these treatments should last several years and be cost-effective if correctly implemented at the right time. Below is a summary of what each of these treatments includes. Having a sound understanding of what each of these treatments involves is important since these are the techniques used to plan repairs in the 10-year analysis scenarios.

Preventative Maintenance

Preventative maintenance is defined as treatment to an existing road that will help preserve and protect the pavement, while also slowing future deterioration. This type of maintenance improves the condition of the system without increasing its structural capacity.

Implementing a preventative maintenance strategy is cost-effective and important since maintenance costs increase with pavement age. Preventative maintenance actions can be done at a much lower cost than preservation actions such as mill and overlays. By applying appropriate preventative maintenance before a road deteriorates, the pavement can be kept in good condition at a much lower cost. With proper preventative maintenance techniques, the life of an average paved road increases significantly with this method of maintenance.

Preventative maintenance is best performed on newer pavements prior to the appearance of significant and/or severe distresses. There are many preventative maintenance applications that seek to protect pavement from deterioration. These treatments vary in effectiveness and price. Common preventative maintenance techniques include crack sealing and rejuvenators. Patching can also be considered preventative maintenance, but it is usually implemented on small areas of severe distress. Additionally, patching a road to increase its PCI does not provide long term structural improvement. Patching may be necessary to keep roads in serviceable condition but it should not be considered routine maintenance for every road.

Crack Seal

Crack sealing is done to prevent the intrusion of water and incompressible materials into cracks. When water enters cracks in pavement, it can soften the sub-base and base layers. This leads to the development of more severe distresses and ultimately the formation of potholes. In Minnesota where extensive freeze/thaw cycles exist, the water that enters the pavement structure through cracks can also lead to frost heaving issues. Crack sealing should be completed early in the life of a new pavement or overlay. For the most effective results, it should be performed 2 to 4 years after a new surface is constructed and periodically after that as deemed necessary. This technique will not improve the structural capacity of the pavement, but it will slow down future structural deterioration. In general, crack sealing should be done in coordination with other pavement preservation and rehabilitation treatments to enhance their performance. It may also be conducted as a stand-alone practice to increase pavement life through minimizing water and incompressible ingress and damage.

Rejuvenator

Pavement rejuvenators delay pavement oxidation and reduce raveling and surface cracking. Pavement surfaces will start to have voids overtime which can hold water and deteriorate the roadway, a rejuvenator will fill the voids with a petroleum maltene to provide elasticity in the road. Rejuvenators can benefit a roadway regardless of age but are most effective earlier in the life of a road. Rejuvenators are not as effective on roads that have existing cracks as they provide no structural enhancements.

Chip Seal

The City of Lino Lakes no longer chip seals new roadways and will chip seal roadways that are older and have already been chip sealed. Chip sealing involves an application of a uniform layer of emulsified asphalt and applying a layer of cover aggregate across the pavement surface. Pre-sweeping and filling of cracks should be done prior to the chip seal application. Normally, a chip seal will last 5 to 10 years depending on the drainage of the roadway. This assumes the chip seal is protected during placement to allow proper curing time. Chip sealing does not provide any increased structural capacity so it should not be continued to be used on roads that are experiencing moderate to severe level cracking.

Thin Overlay

The City will apply a thin overlay to roadways that are in need of reconstruction and cannot be funded immediately. A thin overlay involves placing a new layer of bituminous material on top of an existing asphalt surface. This application provides a new driving surface that will last 5 to 10 years depending on conditions such as underlying soils and drainage.

Mill and Overlay

A mill and overlay requires grinding all or a portion of the in-place asphalt surface and topping the ground surface with a bituminous wearing course. This rehabilitation strategy provides a structural improvement to the roadway and re-establishes the roadway crown improving drainage. We recommend the City continue to complete pavement coring prior to a project to evaluate the subsurface conditions before implementing an overlay project. Information such as depths of pavement layers, signs of debonding, and distresses that are not visible from the road surface can be obtained through pavement coring. Applying an overlay to a pavement structure with inadequate subsurface conditions will cause the new surface to fail prematurely. When this has been the case the city has completed full depth mill and overlays or reclamations.

Reconstruction and Reclamation

The City preforms a reconstruction project every 3 years which is typically funded through street reconstruction bonds. A reconstruction project includes improving the subgrade and drainage improvements. Reconstruction projects cost significantly more however with proper maintenance these projects are estimated to last 50 to 60 years.

The City also completes full-depth reclamations (FDR) where they are cost effective. FDR involves pulverizing the full depth of bituminous and a portion of the underlying materials. That material then gets blended together and placed as a sound base for new pavement.

V. Pavement Management Analysis

To develop recommendations with the City regarding their pavement management funding and CIP planning, a model was created within the PAVER software. PAVER uses construction, inspection, and maintenance records along with a degradation curve to predict how each segment of pavement in the City's system will perform over time. This analysis utilized the Army Corps of Engineer's standard pavement degradation curve. Different scenarios and maintenance budgets can then be evaluated to see how they would perform and determine the best plan moving forward. Leveraging PAVER's ability to optimize cost-effectiveness makes sure the City's resources have the biggest impact on the roadway system.

To build an accurate model in PAVER, unit pricing for maintenance activities were developed and are listed below. The price for mill and overlays and reclamations was provided by the City. For preventative maintenance, a generic place holder price was used that should represent a wide variety of preventative maintenance options.

- Preventative Maintenance - $0.22/square foot
- Mill and Overlay - $5.00/square foot
- Reconstruction - $15.00/square foot

An inflation factor of 4% was used throughout both scenarios. Figure IV.1. demonstrates how the cost of restoring pavement increases as pavement deteriorates. This shows the importance of implementing preventative maintenance because it is exponentially cheaper. It also shows the importance of repairing roads before they reach the level where reconstruction is needed as the cost increases significantly. Once roads reach this level, the cost no longer increases and urgency to repair the road is driven solely by the need to keep roads serviceable for the traveling public. This data is reflected in the results of each scenario modeled in PAVER.

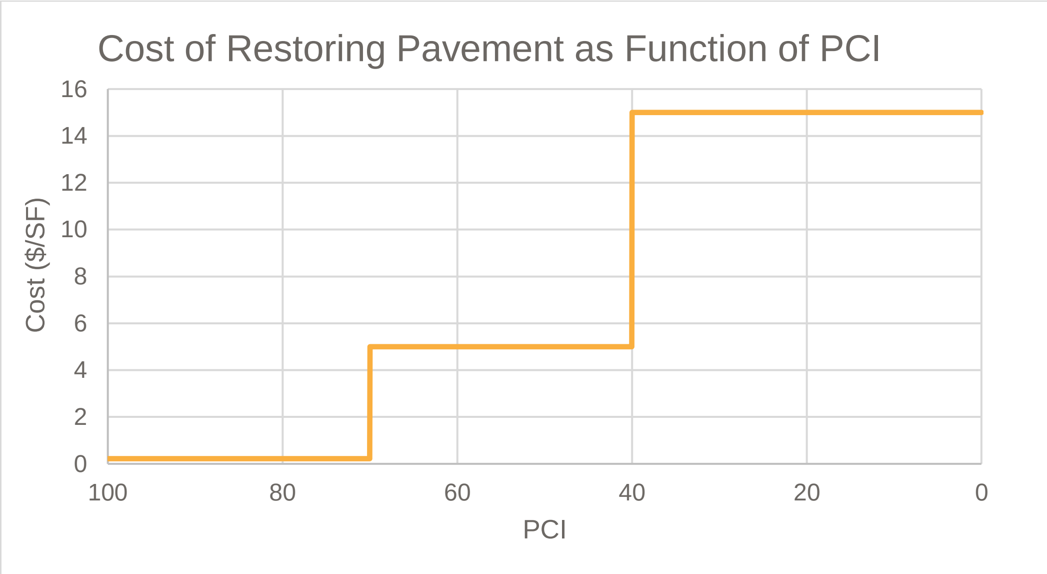

Figure V.1. Increasing Cost of Restoring Pavement

A main goal of this pavement management report is to determine how much funding is necessary to maintain the City's streets over the next ten years and how that budget should be allocated. To best determine this, two options were evaluated against the associated impacts on the overall PCI rating of the City.

In Scenario 1, it was assumed for the analysis that the mill and overlay projects for 2023, 2024, and 2025 and the reconstruction projects in 2024 and 2027 are already programmed. Those planned projects were locked in both scenarios. It was assumed that no other major projects would be implemented through 2025 but additional major projects could be added after that to use the available budget. In Scenario 2, it was assumed the only major projects already programmed were the mill and overlay projects in 2023, 2024, and 2025 so the model could freely choose how to allocate the remaining funding. The models also assumed the preventative maintenance projects have not yet been finalized and could be modified to optimize the outcome. Other assumptions used for the model can be found in Appendix A.

Scenario 1: City's Current Proposed Budget

The first scenario tested the city's current proposed budget and allocation. This budget is shown in Table V.1. In 2023, the City plans to spend approximately $50,000 on preventative maintenance, $810,000 on mill and overlays, and 4,450,000 on reconstructions every 3 years, starting in 2024. It was assumed that the preventative maintenance budget and mill/overlay budget would increase 10% each year and the reconstruction budget would increase 5% each year.

Table V.1. Anticipated Maintenance Budget and Allocation

Year	Prev Main Budget	Mill/Overlay Budget	Reconstruction Budget	Total Budget
2023	$50,000	$810,000	$0	$860,000
2024	$55,000	$891,000	$4,450,000	$5,396,000
2025	$60,500	$980,100	$0	$1,040,600
2026	$66,550	$1,078,110	$0	$1,144,660
2027	$73,205	$1,185,921	$5,151,431	$6,410,557
2028	$80,526	$1,304,513	$0	$1,385,039
2029	$88,578	$1,434,964	$0	$1,523,542
2030	$97,436	$1,578,461	$5,963,426	$7,639,322
2031	$107,179	$1,736,307	$0	$1,843,486
2032	$117,897	$1,909,938	$0	$2,027835
Total CIP Budget	**$796,871**	**$12,909,314**	**$15,564,857**	**$29,271,042**

If the expected funds are spent in the optimal way, the average PCI is projected to fall by an average of 0.39 points each year. For comparison, if no maintenance were implemented, the average PCI would fall by approximately 2.50 points each year. This means that the currently planned maintenance budget and allocation is not enough to outpace the projected degradation. While this yearly decrease is small, over the course of 10 years, it has a significant impact on the system's condition. Under this scenario, the 10-year average network PCI is 72.1 and the average PCI in 2032 is 70.1. Additionally, if at any point in the next 10 years, the budgets did not receive the annual increase outlined, the expected average PCI would be lower.

It is also important to note that the PAVER simulation only seeks to maximize the average PCI given a certain budget. This means that the segments selected for repairs are chosen solely on their condition with the worst roads in each category receiving the planned maintenance. While this approach does keep the average PCI as high as possible and maximizes the effect of each dollar spent, it does not consider that road construction projects should include a group of adjacent or nearby segments. The model also does not account for important factors such as keeping heavily trafficked roads in better condition than lesser trafficked routes. The judgement of the City is needed to decide when a road has reached the end of its serviceable life and should receive a reconstruction or reclamation. When these additional variables are included, resources need to get spent in less cost-effective ways which means the weighted average PCI will likely perform worse than projected.

The summary of results from Scenario 1 can be found in Table V.2. and Figure V.2. Note the spending for each category falls within the model's given spending tolerance for each category.

Table V.2. Yearly Average PCI for Scenario 1

Year	Average PCI
2024	74.3
2025	73.3
2026	72.0
2027	72.6
2028	71.5
2029	70.6
2030	71.7
2031	70.9
2032	70.1
Totals	-

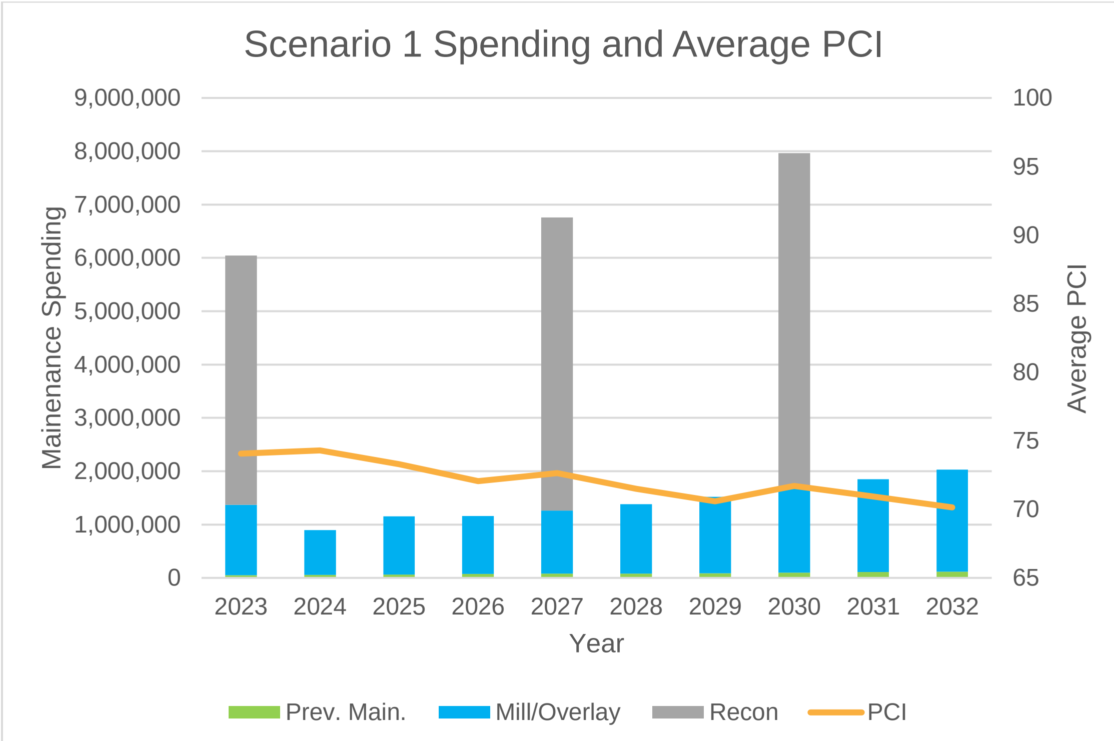

Figure V.2. PCI vs Maintenance Budget for Scenario 1

Scenario 2: Maintain Average PCI Over 73

The other scenario tested examined what budget would be needed to maintain an average PCI of 73 over the life of the CIP. The City's 5-year network average PCI is 72.5 and their target average PCI is 73. This scenario seeks to keep Lino Lakes on track with their goal and maintain their pavement in the condition that the residents are used to. The model showed that an annual budget of $3,381,000 is needed to ensure an average PCI of 73 is achieved each year until 2032. The model was given a tolerance of +/-2 PCI for this scenario since the City's PCI has fluctuated by approximately that much over the past 5 years. The final PCI value projected in this scenario is 71.2. This number is slightly lower than the target but the average condition of the network during the 10-year analysis window is 74.6 and if the analysis continued beyond 10 years, the PCI would rebound back to near 73.

Along with a larger budget, this scenario also implements a different maintenance implementation philosophy. Instead of forcing the model to spend a specified amount on each of the three major repairs implemented by the City, this scenario let the model decide the most cost-effective way to achieve the goal average PCI. This resulted in significantly more preventative maintenance funding because preventative maintenance offers the highest benefit to cost ratio of any of the three maintenance options provided. For similar reasons, mill and overlay projects were given priority over reconstruction projects. While this approach does keep the average PCI value high, it allows some roads to deteriorate beyond an acceptable point. The discretion of City decision makers will be needed to decide when the most cost-effective fix is not the best selection for the community.

The summary of results from Scenario 2 can be found in Table V.3. and Figure V.3.

Table V.3. Summary Results for Scenario 2

Year	Spent on PM ($ thousand)	Spent on M/O ($ thousand)	Spent on Recon ($ thousand)	Total Spent ($ thousand)	Average PCI
2023	1,250	1,322	0	2,572	75.9
2024	112	842	0	954	77.9
2025	222	1,090	0	1,313	75.9
2026	80	4,066	0	4,146	74.8
2027	280	3,859	0	4,139	74.5
2028	236	3,914	0	4,150	74.7
2029	70	2,050	2,004	4,124	74.5
2030	209	707	3,226	4,141	73.7
2031	0	986	3,153	4,138	72.5
2032	0	4,137	0	4,137	71.2
Totals	2,460	22,972	8,382	33,814	-

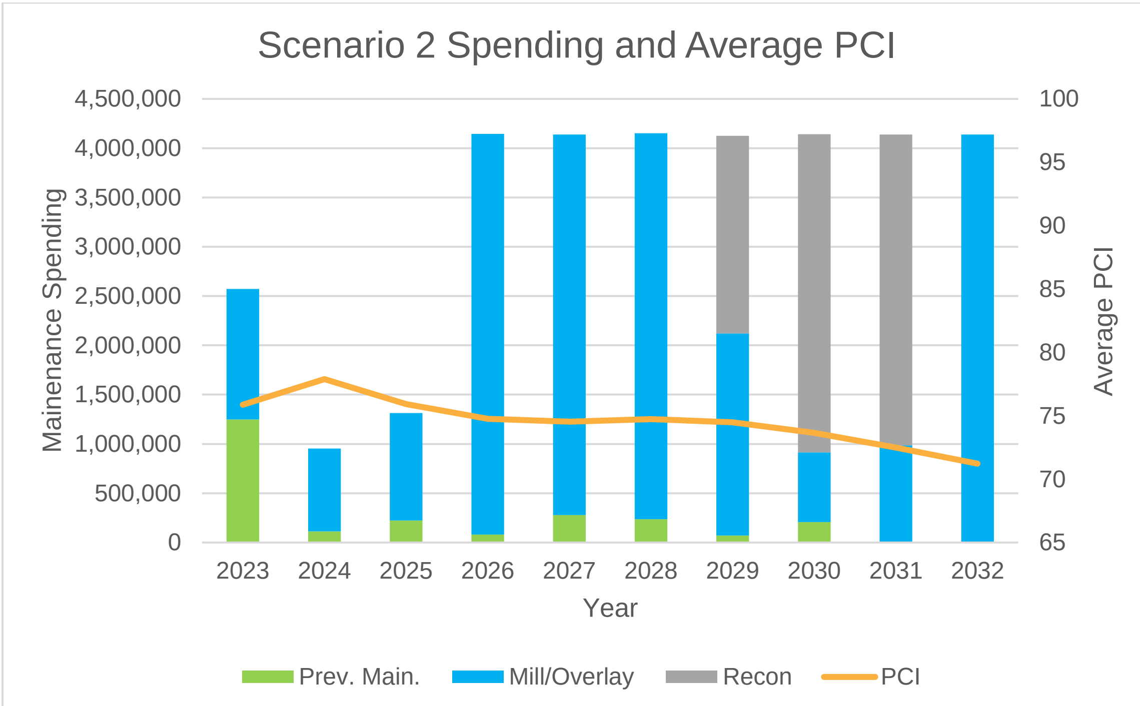

Figure V.3. PCI vs Maintenance Budget for Scenario 2

Recommendations from Spending and Maintenance Analysis

Table V.4. Compares the amount of money spent on each maintenance option in both scenarios. Figure V.4. also compares the two scenarios tested in PAVER. These results were used to notice trends and develop recommendations for the City.

Table V.4. Summary of Spending Recommendations

Average Annual Spending by Repair				
	Scenario 1		Scenario 2	
	Dollars	% of Budget	Dollars	% of Budget
Prev. Maint.	$79,687	2.7%	$245,956	7.3%
Mill/Overlay	$1,290,931	44.1%	$2,297,241	67.9%
Reclamation	$1,634,310	53.2%	$838,229	24.8%

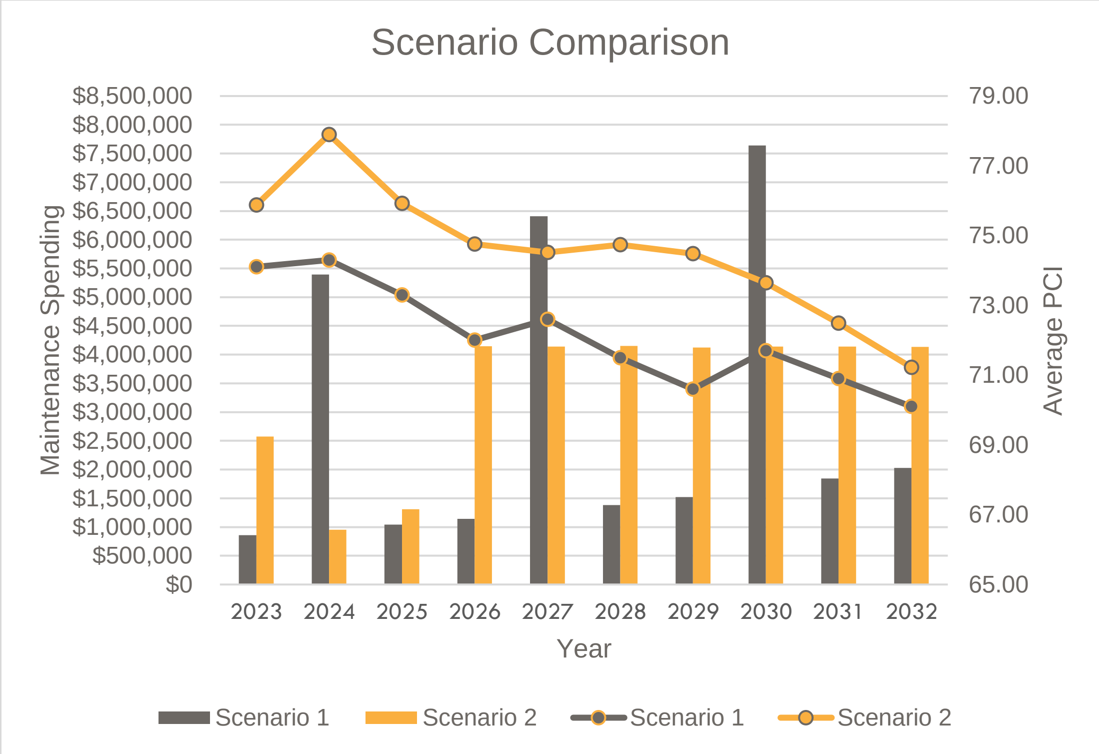

Figure V.4. Scenario Summary Comparison

Budget Recommendations

When comparing the results from the two scenarios tested, it appears that the City's proposed budget will not allow them to achieve their pavement condition goals. While the condition of roads in Lino Lakes has remained relatively steady over the past 5 years, some of this can be contributed to adding new roads to the system. If the current budget is implemented, we project the average PCI in Lino Lakes to slowly decrease each year. Scenario 2, which implements about 15% more spending on pavement over the 10-year analysis period demonstrates that at this higher level of spending, it is much more likely that the City will be able to maintain their average PCI goal of 73. Scenario 2 utilizes a fixed budget in years 2026-2032 instead of the increasing amount featured in Scenario 1. However, WSB acknowledges that committing to such a large increase in funds might be unrealistic. Implementing the yearly budget increases shown in Scenario 1 with a larger increase than originally planned should yield similar results. With the high uncertainty and inflation seen in construction pricing over the last few years, continuing to incrementally increase spending to keep up with rising costs is necessary.

Maintenance Recommendations

While the maintenance repair recommended for a segment typically aligns with its PCI score and the corresponding condition category noted above, there are a few other factors to consider when deciding which roads should receive a specific treatment. Anytime a major rehabilitation projects is needed (PCI less than 70), it is wise to do more investigation before moving ahead with a project. Spending resources investigating the pavement and base condition adds value by making sure the most cost-effective solution is applied. The cost difference between a mill/overlay and reclamation is substantial enough that pavement coring should always be implemented before moving forward with a project that has a low PCI score.

As mentioned earlier, the actual performance of the roads in the City's system will depend on how cost-effective its maintenance is. There are several strategies that can be used to protect the roads in good condition and to stretch the impact of the City's resources. To maximize the effectiveness of the available funding, we recommend prioritizing preventative maintenance. While it seems counterintuitive to focus on roads in the best condition, their preventative maintenance is relatively cheap and retaining segments with high PCI values is necessary to avoid high maintenance costs in the future. While roads will inevitably need more expensive repairs at some point, delaying those expenses and keeping roads in good condition is a best practice. Figure IV.7. illustrates this point.

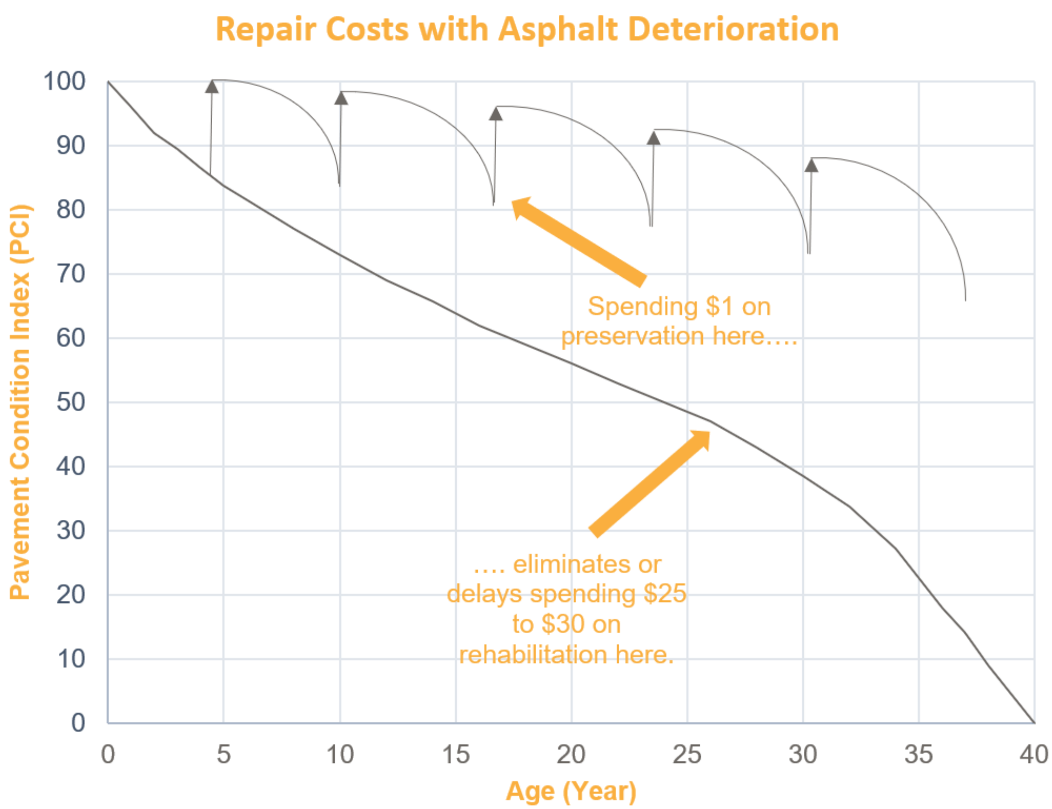

Figure V.5. Cost-Effectiveness of Preventative Maintenance Example

In Scenario 1, the funding distribution was locked at the budgets provided by the City. This distribution of spending focused significantly more resources on repairing the worst roads in the City with expensive reclamation projects. Currently, about 7% of all roads in Lino Lakes are classified as being in the Problem category. Attempting to restore all Problem segments is a task that will take several years. Instead of focusing on most of the City's spending on expensive reclamation, it is recommended more resources be allocated towards preventing roads from reaching the Problem category. With this strategy of emphasizing preventative maintenance, more cost-effective projects can be implemented and the life of the City's pavement can be further extended with the same amount of spending.

When reconstruction projects cannot be avoided, we recommend making sure the base and subbase layers have adequate thickness. Paying extra to make sure the new road is built on a sturdy and dry foundation will extend the life of the pavement and reduce the amount of resources needed for maintenance. When constructed properly, aggregate bases and subbases should not need to be replaced, even when the pavement fails.

Another important methodology to adopt is to not implement a less expensive repair on a road that requires a more expensive fix. It is tempting to try and apply cheaper fixes when facing expensive cost estimates. However, this will result in wasting precious funds. For example, applying preventative maintenance on a road that is in a Marginal or Problem condition is not effective. Instead of providing years or protection as intended, it will deteriorate quickly and not result in long-term results.

Thank you for the opportunity to assist the City of Lino Lakes with developing their Capital Improvement Program. For questions about this report or for additional analysis, please contact:

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Appendices

Appendix A: PAVER Model Assumptions

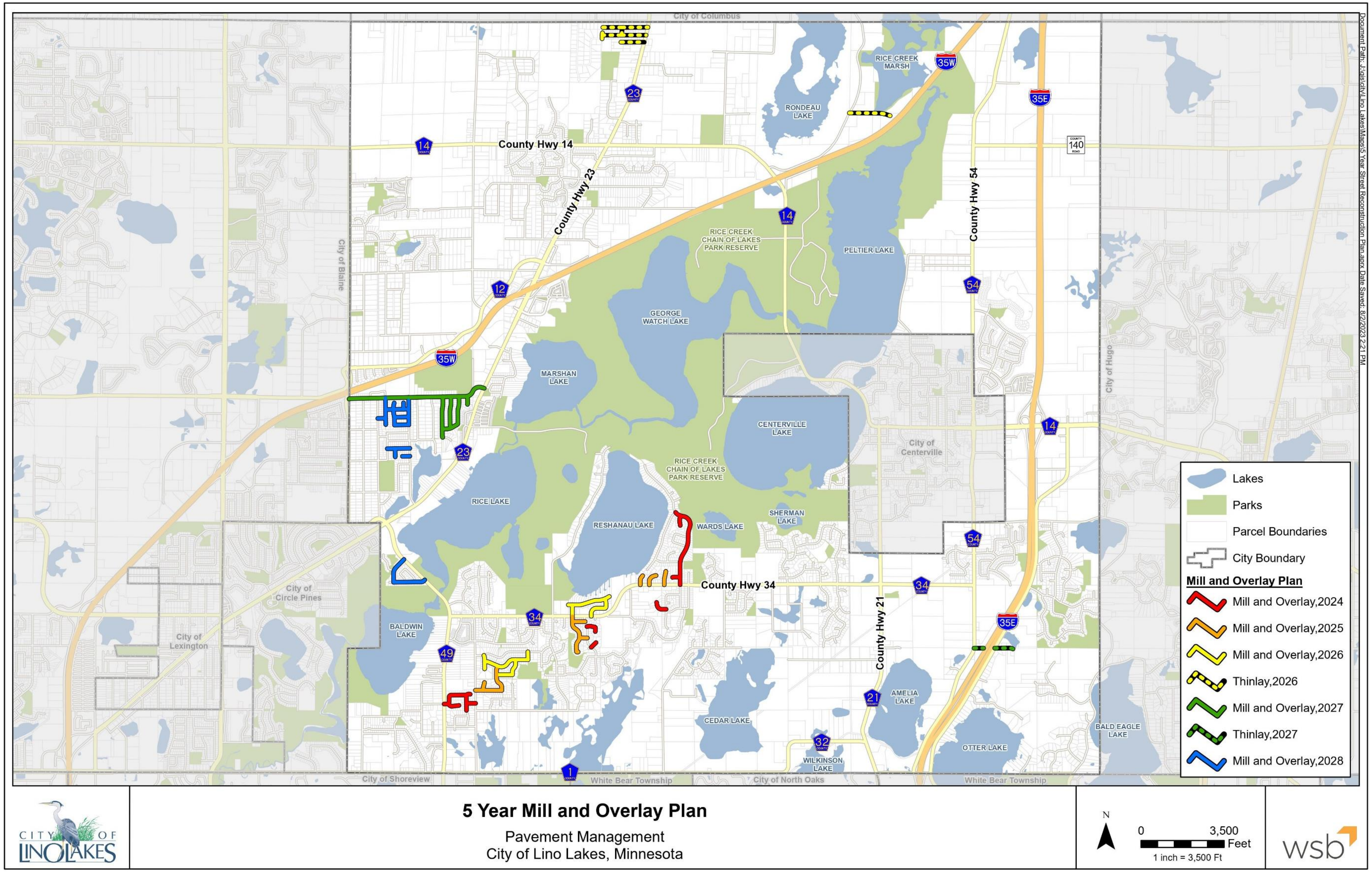
<u>Budget Scenario</u>

- Using most recent inspection data as starting point PCI values for each segment
- Budget is the budget provided by the city
- Average width of city streets is 30 ft
- Unit cost of mill and overlay and reclamation provided by the City
- Major M&R (restores PCI to 100) - Prioritized worst roads
    - Recon = $15/SF (Used on Problem category: 0.00-40.00)
        - Budget = $4,450,000 every 3 years + 5%/year
    - Mill/Overlay = $5/SF (Used of Marginal category: 40.01-70.00)
        - Budget = $810,000/year + 10%/year
- Global M&R (restores PCI of 75 to 98) = preventative maintenance
    - Preventative maintenance = $0.22/SF based on estimates and research (70.01-100.00)
        - Budget = $50,000/year + 10%/year
        - Assumed it was applied on random segments with PCI near 75
- Army Corps of Engineer Degradation Curve used for model
- Inflation rate = 4%
- Assumed 2024 and 2025 mill/overlay projects and 2024 and 2027 reconstruction projects are carried over from the previous plan and segments included for projects in those years are indicated on maps provided by the City
    - Assumed preventative maintenance could be added to those years
    - Assumed additional reconstruction could be added to those years when the current planned projects were significantly less than proposed budget.

<u>PCI Scenario</u>

- Using most recent inspection data as starting point PCI values for each segment
- Budget is TBD by the model
- Average width of city streets is 30ft
- Unit cost of mill and overlay and reclamation provided by the City
- Major M&R (restores PCI to 100) Uses costs by condition
    - Recon = $15/SF (Used on Problem category: 0.00-40.00)
    - Mill/Overlay = $5/SF (Used on Marginal category: 40.01-70.00)
- Global M&R (extends life of pavement by 6 years with 10-year application interval) = preventative maintenance
    - Preventative maintenance = $0.22/SF based on estimates and research (70.01-100.00)
- Most cost-effective repairs are recommended first to protect investments already made in pavement
- Army Corps of Engineer Degradation Curve used for model
- Inflation rate = 4%
- Assumed 2024, and 2025 projects are carried over from the previous plan and segments included for projects in those years are indicated on map provided by the City
    - Assumed only preventative maintenance could be added to those years
- Condition stabilization after 10 years at an area-weighted average PCI of 73.00 with a +/-2.00 tolerance

Appendix B: 5 Year Mill and Overlay Plan



Appendix B revised on 8/4/2023 at request of City