CITY OF SAN ANTONIO TEXAS

Bike Network Plan

Bike Facility Maintenance Cost Estimation Memorandum

November 2024

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Executive Summary

This memorandum analyzes four primary maintenance programs whose execution affects the functionality of the existing City of San Antonio (the City or COSA) bike network and may also threaten the success of the future bike network. These maintenance programs are:

- Pavement Preservation – Designing and maintaining bike facilities to resist motor vehicle impacts.
- Debris Removal- Preventing road debris from collecting and forcing cyclists out into traffic, which increases the risk of severe injury.
- Striping Re-Application – Maintaining clear, safe markings on roadways when frequent vehicle traffic and high temperatures degrade them.
- Vandalism and Crash Impacts – Maintenance and prompt replacement of bicycle facility signage and protective elements impacted by vandalism and motor vehicle crashes.

Funding to perform some of this maintenance is already a part of the City's 5-year Infrastructure Management Program (IMP), but additional funding will be needed to fully execute all of the maintenance discussed in this memorandum. A summary of the maintenance activities and anticipated additional costs above what is already allocate in the IMP is included in **Figure 1**.

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<tr><th>Facility</th><th>Pavement Preservation</th><th>Debris Removal</th><th>Striping Re-Application</th><th>Vandalism and Crash Impacts</th></tr>
<tr><td>Bike Boulevard</td><td rowspan="4">These facilities preservation is already accounted for in the City's IMP.</td><td rowspan="3">These facilities are swept through City's IMP, but bike facilities should be prioritized and problem areas should be swept more frequently.</td><td rowspan="4">Re-application on these facilities is necessary in frequent vehicle crossing areas like intersections and the outside of buffer markings</td><td rowspan="3">Includes replacement signage on all existing & tier 1 facilities</td></tr>
<tr><td>Striped Bike Lane</td></tr>
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<tr><td>Protected Raised Lane</td><td rowspan="2">These facilities' preservation is not required in a 5-year time horizon.</td><td rowspan="2">Re-application on these facilities is not required in a 5-year horizon.</td><td rowspan="2">Includes replacement signage on all existing & tier 1 facilities</td></tr>
<tr><td>Shared Use Path</td></tr>
<tr><td>Cost*</td><td>$0</td><td>$1,145,000</td><td>$11,467,500</td><td>$1,623,600</td></tr>
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Figure 1: Summary of Necessary Bicycle Facility Maintenance Activities and Anticipated Additional Costs

** Total Additional Maintenance Cost After 5 Years of Implementation*

The City's ongoing maintenance practices provide a great starting point for bike facility maintenance. With small modifications and approximately $15,000,000 over 5 years of increase (a 1.75% annual budget increase based on the 2025 IMP Budget), these maintenance practices can provide San Antonians a safer and more comfortable riding experience.

Background and Methods

An essential component of the usability of bike facilities is their maintenance and upkeep – ensuring that bike riders can use the facilities designed for them free from obstruction or unsafe conditions. The City of San Antonio (COSA or City) Bike Network Plan (BNP) places special importance on the maintenance of bike facilities planned in its Recommended Bike Network. The purpose of this technical memorandum is to perform a comparative review of the cost impacts and frequency of maintenance required for bicycle facilities, provide guidance on best practice maintenance programming, and offer cost estimates of maintenance activities in the near term (defined as a 5-year time horizon).

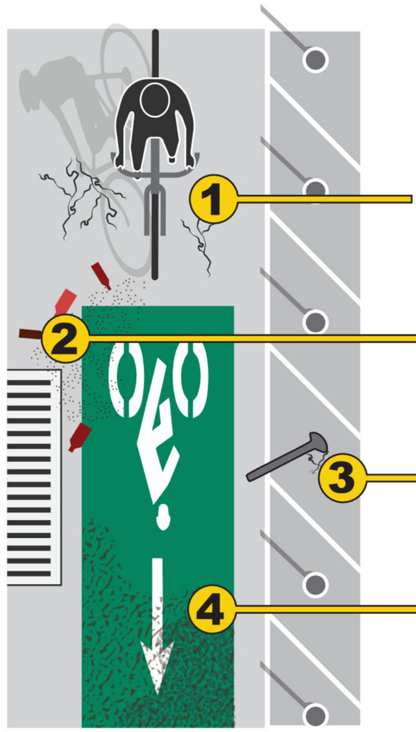

Figure 2: Bike Facility Maintenance Examples

Aside from initial construction funding, there is a continuous cost to the City to maintain any public space. The City has decades of experience maintaining spaces that require maintenance effort. However, bike facilities often sustain consistent damage from heavy traffic and crash impacts and may require more costly preservation pavement and striping. This memorandum analyzes bike facility maintenance that the City should program, including Pavement Preservation, Debris Removal, Crash Impacts, and Re-Striping shown in **Figure 2**.

Together, these four maintenance types, when programmed correctly, will ensure that the bike facilities deployed by the City remain useable transportation options over their life span. This memorandum sets context for discussions of maintenance activities by analyzing existing City maintenance programming and interviewing subject matter experts. Then analyzes and offers guidance for each of the four maintenance programs above. Finally, it summarizes recommendations, aiming to align recommendations with City programs.

Expert Interviews

To better understand best practices in maintenance procedures specific to bike facilities and the operations of existing City maintenance practices, the BNP interviewed subject matter experts that have implemented similar plans in City of Austin Transportation and Public Works Department along with experts from the City of San Antonio Parks and Recreation Department.

- The City of Austin interview was held virtually through Microsoft Teams on Tuesday, October 29, 2024 from 11:30 AM to 12:30 PM.
- The City of San Antonio interview was held virtually through Microsoft Teams on Thursday, October 31, 2024 from 3:30 PM to 4:00 PM.

Experts from Austin and San Antonio gave largely uniform guidance to the BNP team regarding the use of thermoplastic pavement markings. The City of Austin has utilized both stained concrete and thermoplastic striping extensively on their bikeway projects. In their experience, when utilized in low traffic areas, thermoplastic striping can be a long-lasting implementation. However, if it is implemented anywhere with frequent vehicle traffic, it can degrade as or more quickly than other striping treatments such as crosswalks. Furthermore, Austin staff noted that high temperatures in the area can cause the asphalt surface to secrete oils that, when carried on the tires of motor vehicles, can create a dirty appearance on pavement markings. For both of these reasons, green thermoplastic striping can be expensive to maintain and Austin staff use it minimally for bike facilities. When required, they recommend the use of pre-formed thermoplastic materials; if installed correctly, preformed thermoplastic applications perform well.

COSA Parks and Recreation staff noted that the longevity of pavement markings is determined by frequency of use and the location in relation to flood-prone areas. In their experience, thermoplastics are difficult to adhere correctly to concrete in comparison to asphalt. While thermoplastics may last only 3 years on concrete before chipping or washing off, on asphalt, thermoplastics might last 6 to 8 years before needing replacement. San Antonio staff have not yet found a long-term solution for pavement markings in areas of frequent flooding.

In comparison staff from both cities have seen greater success with stained concrete applications. City of Austin Staff have utilized a terracotta-colored concrete, to differentiate it from both motor vehicle and pedestrian facilities. In their experience this stained concrete minimizes maintenance and lasts longer – and that the darker the stain (the greater amount of stain added to the concrete mix) the more vibrant the color and the longer it lasts. The initial increased cost of installing deeply colored concrete instead of stained concrete or painted asphalt will minimize the maintenance cost of repair materials, labor, and impact to the community. And while frequent vehicle traffic does still impact the appearance of the surface – it stands up better than thermoplastic striping to motor vehicles. Similarly, In San Antonio concrete staining, etching, and paint methods work better than thermoplastics on concrete surfaces and that color add mix concrete is the best way to ensure the color is there permanently with minimal fading.

Installation methods that do not align with material specifications can result in early failures. Elements that are not located in an appropriate location can be subject to crashes and unintended wear shortening their life-cycle. For example, pavement markings are typically installed in locations outside vehicle wheel paths to minimize the friction across the paint, however, they are often placed too close to the turning movement and will wear down sections of the markings or leave them darkened.

On other maintenance costs, experts had different experiences. Regarding vandalism, San Antonio experts noted the need to create a specific graffiti removal team to provide upkeep and that vandalism does force either replacement or maintenance of signs, wayfinding, and other items often. While Austin experts noted that they do not experience a lot of graffiti or vandalism on bicycle facilities. However in Austin, driver impacts were uniquely felt on on-street facilities with vertical delineators of protected bike facilities. Drivers hitting signs and barriers has pushed Austin staff to install higher quality devices with connections that can get struck more often before breaking as well as more permanent barriers and fewer bolt down devices to reduce maintenance. The City of Austin now favors more concrete protection to prevent signage and other devices from being impacted by vehicles hitting them and to improve the safety of bike users.

COSA Maintenance Practices Analysis

Paired with these interviews, the BNP performed an analysis of the City's existing pavement preservation and striping practices to inform the recommended funding and time allotment for preservation of bike facilities. Currently, the City maintains infrastructure through its 5-year Infrastructure Management Program (IMP), which includes street maintenance, alley maintenance, drainage maintenance, sidewalks, traffic signals, and pavement markings. The BNP's analysis focused on the street maintenance and pavement markings programs using the City's 2024, 2025, and 2026 FY Planned IMP (Infrastructure Maintenance Program) GIS Datasets paired with the full 5-year scheduled IMP GIS layer. The goal of this analysis is to determine an estimate for the square feet of preservation activities the City has scheduled to complete each year, as well as an estimate for the cost of and time required to complete one foot of each preservation and rehabilitation project.

To calculate the area in square feet of COSA's planned roadway projects for 2024, 2025, and 2026, the BNP calculated the length in feet of each segment using ArcGIS Pro's Calculate Geometry tool in a new field. Once lengths were calculated, all three attribute tables were exported to an Excel document, multiplied the length in feet by the average width (*AverageWidth*) for each segment in a new field, which yielded the area in square feet of each segment. All together, this analysis showed that the City plans to perform an average of 6 million square feet of Slurry Seal (a lower impact pavement preservation method) each year.

Using the *ActualStart* and *ActualFinish* data from the COSA GIS layer showing all projects from 2024-2029 consolidated, the BNP calculated cost per day of each application and completed feet per day. Only projects that have been completed featured values in both datasets, thus all uncompleted projects were excluded from this analysis. The length in feet of each segment was calculated from the Calculate Geometry tool in ArcGIS Pro. After exporting to Excel, Excel's NETWORKDAYS function calculated the number of days in between the actual start (*ActualStart*) and end dates (*ActualFinish*) for each project, after filtering for minor occurrences of errant data. Using the newly calculated number of days that each completed project took, the cost per day and feet per day were calculated by dividing the total cost (*EstTotalCost*) and the length by the number of days. Results show rehabilitation projects to be, almost uniformly, more costly and take more time than preservation projects. Most preservation projects require around one day per project, whereas reconstruction projects require 11 days on average, shown below in **Figure 3**.

	Application	Average Total Cost Per Day	Average Completed Feet Per Day	Average Cost Per Foot	Average Days to Completion
Rehabilitation	Mill & Overlay	$ 23,997.52	240.22	$ 97.92	8.5
	Mill & Overlay	$ 24,046.64	236.37	$ 101.73	5
	Mill & Overlay - Inhouse	$ 6,044.05	156.92	$ 42.20	6.7
	Reconstruction	$ 40,854.06	146.00	$ 290.27	29.3
	Reconstruction-L	$ 134,071.86	249.53	$ 537.30	5
Preservation	Crack Seal	$ 4,436.40	1538.02	$ 2.89	1
	Crack Seal - City	$ 4,463.75	1632.32	$ 2.78	1
	Crack Seal - Contract	$ 20,682.61	3210.27	$ 6.32	1
	Micro Surface - Contract	$ 63,512.49	1450.73	$ 46.27	1.3
	Slurry Seal	$ 6,618.02	1189.93	$ 5.71	1.16
	Slurry Seal - City	$ 13,567.60	775.81	$ 15.99	1.15
	Slurry Seal - Contract	$ 26,956.96	910.49	$ 31.50	1.6

Figure 3: COSA IMP Projects Analysis Summary

Estimation by Maintenance Types

Informed by the analysis above, the BNP performed cost estimation analyses for each of the four maintenance types. The calculation of added maintenance costs is based on the assumed implementation of all Tier 1 bicycle facilities in the next five years in addition to all existing infrastructure. Many of the maintenance costs and recommendations outlined below fit within the existing COSA IMP – in those instances, the maintenance type is noted and in the recommendations section of this memo, will feature an explanation of why additional cost is not likely to be incurred to existing City practices.

Pavement Impacts and Preservation

A core component of estimated the cost of pavement preservation based on the City's ongoing maintenance activities is an understanding of the impacts of different vehicles to the roadway surface. It is intuitive that there are differential impacts to roadway surfaces of bikes and their users in comparison to motor vehicles. However, staff from COSA expressed the need to quantify this difference to better understand maintenance impacts as mode shift changes. The BNP explores here a numerical estimate for both the different impacts to the roadway surface between bikes and motor vehicles and how such a differential impact may effect on the life cycle of pavement between the two modes, as monitored by its Pavement Condition Rating (PCR).

Assumptions

To perform this analysis, several assumptions and exclusions were required to provide a reasonable estimate.

1. ***The weight of persons in San Antonio.*** For simplicity of analysis, the average male and female weight in this analysis was directly referenced from the United States Center for Disease Control (CDC) 2018 Body Measurement Estimates. This data was combined with United States American Community Survey (ACS) 2022 Data on Age and Sex in Texas. Combined, these estimates show would estimate that the average person using roadways in San Antonio weighs **185 lbs**. While this is a relatively small number in comparison to the weight of a motor vehicle, it is significantly larger than bike. A more detailed analysis to refine this information could be found by analyzing Body Mass Index Data – this was not performed due to the likely negligible impact to the roadway surface.
2. ***The number of persons per Motor Vehicle:*** According to the ACS, approximately 11.2% of Texans commute to work by carpooling. Assuming an average of 3 people per carpooling motor vehicle, the average number of people commuting in a motor vehicle is **1.22**.
3. ***The weight of an average motor vehicle:*** According to the United States Environmental Protection Agency (EPA) 2022 Automotive Trends Report, the average weight of a standard motor vehicle is 4,303 lbs. Combined with its driver and passenger(s), the average weight of the entire motor vehicle unit is **4530 lbs.** A more detailed analysis to refine this information could be found by analyzing motor vehicle consumer trends in San Antonio – this was not performed due to the unavailability of publicly accessible data.
4. ***The weight of an average bike and user:*** According to Huffy, the weight of an attainable hybrid bicycle is approximately 33 lbs. Combined with its rider, the average weight of the entire bike vehicle unit is **218 lbs**. A more detailed analysis to refine this information could be found by analyzing bike consumer trends in San Antonio – this was not performed due to the unavailability of publicly accessible data.
5. ***The roadway type and surface:*** For simplicity, the roadway analyzed in this analysis is a Major Collector featuring **10,000 motor vehicles per day** – a fairly standard roadway type to feature bike facilities in San Antonio, according to the BNP Existing Conditions Report. The assumed thickness of its most recent overlay is **3 inches**, an average for composite pavement.
6. ***The age of the pavement:*** This analysis assume **15 years** of pavement use – as this will allow for both vehicular impacts and environmental degradation.

7. ***Exclusions:*** As this analysis seeks to compare the effects of a commuting car user and a commuting bike user, the impacts of persons in buses or trucks were excluded from this analysis.

Analysis

First, to analyze the generic impact to the roadway surface, this memorandum utilizes the AASHO Road Test derived Fourth Power relationship. The Fourth Power relationship states that the stress on the road caused by a motor vehicle increases in proportion to the *fourth power of its axle load.* In both 2 axle motor vehicles and bikes, its axle load would be half of the total weight of the vehicle units. This represents a typical rule of thumb for the structural rutting and fatigue cracking range of power values in flexible pavements and is commonly used to describe how axle load influences these important mechanisms of structural pavement failure.

(Total Vehicle Weight/2)^4 = Roadway Impact

Applying this relationship to both the average motor vehicle and bike units, the results are as follows:

$$\frac{(4530/2)^4 = 26{,}312{,}955{,}907{,}851.50}{(218/2)^4 = 141850257.43} = \mathbf{\sim 185500}$$

The analysis above shows that, on average, motor vehicles cause approximately **185,500** times as much damage to a roadway surface as bikes.

Second, to translate this impact to PCR's, this memorandum utilizes a Model for Predicting Pavement Deterioration. This model estimates that for flexible pavement surfaces, the prediction of pavement condition depends on the period during which the pavement has been in service, age of the pavement (*Age*, years), the traffic volume and weight, which are expressed in terms of yearly equivalent single-axle loads (*ESAL*), and the thickness of last overlay (T) in inches. To determine the ESALs for the average motor vehicle and bike, Typical Load Equivalency Factors from AASHTO 1993 were referenced, shown in **Figure 4**.

Axle Load	Load Equivalency Factor (from AASHTO, 1993)
2,000 lbs	0.0003
10,000 lbs	0.118
14,000 lbs	0.399
18,000 lbs	1
20,000 lbs	1.4
30,000 lbs	7.9

Figure 4: AASHTO 1993 Typical Load Equivalency Factors

To project the likely ESAL for a bike, the 4th Power Relationship was applied to divide the 2000 lbs Axle Load for the equivalent Bike Axle weight of 109 lbs, yielding: **1.60899E-09.** The model for PCR prediction is shown below in **Figure 5**:

$$PCR_{(t)} = 90 - a\left[\exp\left(\frac{Age}{T}\right)^{b} - 1\right]\log\left[ESAL\right]$$

Figure 5: Pavement Condition Rating Prediction Model Formula

In applying this model to the template roadway discussed in the assumptions, the BNP finds that after 10,000 AADT use of the roadway with no bike users for 15 years, **the roadway would have a PCR of 62.2**. When adding bike users to this model at the likely rate today (from Replica Data in the ***BNP Existing Conditions Report***) of 21 bike users for every 10,000 motor vehicles, there is no change in the projected PCR.

However, when adjusting mode share for increased bike usage with new infrastructure, the PCR improves. Assuming ¼ of car users switch modes, the PCR improves to 62.9. Assuming ¾ of car users switch modes, the PCR improves to 65.5. In the extremely unlikely scenario that this roadway is entirely car-free and **used only by bikes, the PCR increases to 91.1** – meaning virtually no impact to the roadway surface. In the modest mode change scenario above (a conversion of 2500 motor vehicles to bike users, the pavement condition gains approximate 3 months before reaching the PCR of the existing mode scenario. In the entirely bike user scenario, before the PCR reached the level of the existing mode scenario, the age of the pavement would have to be at least 44 years old. In summary – any motor vehicle presence on a roadway impacts the pavement condition of that roadway severely according to the model chosen for this analysis.

The analysis above supports many assumptions that a bike user's impact on a roadway surface is negligible, and that any pavement degradation on bike-only roadways is likely due to typical roadway weathering. However, **a mode shift from motor vehicles to bike will have a small impact on the roadway surface, improving it over a solely car-oriented mode**. In the most adaptive scenario, a mode shift entirely to bikes may triple the lifespan of a roadway. However, as this is not a probable modal change in the analysis period of this memorandum (5 years), the more likely outcome is that bike infrastructure on any roadway should be designed to weather known Motor Vehicle-related impacts such as pavement deterioration and pavement marking deterioration.

In the analysis period of this memorandum, as a small mode shift only features small improvements in the lifespan of a paved surface, a slurry seal will likely be required on all projects implemented in the first 5-years of the BNP's programming (tier 1 projects and existing projects). To calculate the cost of slurry seal maintenance, the estimated average cost of all seal coat projects completed in 2024 was used. The average of the values for Slurry Seal, Slurry Seal – City, and Slurry Seal – Contract, was $17.73 per foot. This value was multiplied by the number of linear feet for each applicable facility yielding a total of approximately $12,000,000 or $2,400,000 annually. However, the cost to preserve the pavement on these roadways is already included in the City's IMP. Therefore, this estimate should not be added to the total cost of improving the bike network but rather the cost of resurfacing these roadways should be prioritized among other IMP projects.

Debris Removal and Sweeping

Clearing debris and obstructions from bike facilities through street sweeping is an essential component of bike facility maintenance. The goal of this section is to give the San Antonio Public Works Department (PWD) information on the recommended operating procedures and purchasing of bike facility specific street sweepers, in the context of its larger street sweeping operation.

Currently, in most areas of San Antonio, the City sweeps residential streets bi-annually and arterial roadways quarterly. For much of the City's bike network, this sweeping schedule is adequate for the existing infrastructure. However, for some bike facilities such as protected bike lanes and shared use paths, traditional street sweepers cannot reach the bike facility surface. Additionally, as many roadways in San Antonio are crowned in the center, with bike facilities adjacent to the curb, these facilities accumulate debris more frequently, especially at the bottom of hills or near curb gutter inlets, where water accumulates debris.

For these reasons, additional care must be given to the clearing of certain bike facilities in certain contexts. This memorandum will provide guidance and planning estimates for the safe execution of this needed clearing.

Clearing Different Bike Facility Types

In the BNP, five bike facility types exist currently and are planned for implementation around San Antonio. A summary of these facility types can be found in the BNP's Bike Facility Guidelines for Future Amendments document and the quantity can be found in the BNP's Existing Conditions Assessment. Depending on the facility, different sweeping tools are most appropriate.

On **Bike Boulevards or Bike Routes**, in which bike users share the roadway surface with motor vehicle users, traditional street sweeping in appropriate. Additionally, as bikes can operate at any part of the roadway surface on these facilities, curb-adjacent problem areas for debris accumulation are less impactful to the riding experience.

On **Bike Lanes** and **Buffered Bike Lanes**, of which the city has over 200 miles currently built, traditional street sweepers are also appropriate. There are no barriers or obstructions currently blocking sweepers from removing debris from these facilities. However, these are often the facilities where curb-adjacent problem areas for debris accumulation are most present. To correct for these problems, the City may wish to implement more frequent cleaning – as frequent as monthly – to remove debris. An additional solution for these facilities could be to employ a human-powered Bike Lane Sweeper, attachable to any bike. These sweepers have been deployed across the country and through a partnership with local bike groups such as Ghisallo Cycling, Bike San Antonio, or SATX Social Ride, could clean up debris more frequently without significant City investment.

Protected Bike Lanes are the most difficult to successfully clear of debris and feature significant variety in their deployment. These facilities separate bike users from car traffic either with flexible or concrete barriers and can be either one-way or bi-directional. While they currently only make of 10 miles of San Antonio's bike network, in the future, these facilities may make up a significant portion of the city's network as new, safer facilities are deployed. To reach these facilities around barriers, in 2024, the City purchased a Madvac LS175 Electric Mini Sweeper for $166,570. This sweeper will allow the city to reach protected bike facilities. As these facilities can accumulate significant debris from streets, but ambient car movements will not move the debris as on other roadways and the main flow of traffic pushes debris to the sides – these facilities require special cleaning attention. The City of Austin currently plans to clear its protected bike lanes twice a month to ensure a clear operating surface and has exceeded this goal every year for the past 5 years. For wider and two-way protected bike lanes, the City's Mini Sweeper can widen its cleaning path to 7 feet. Meaning it would require only two passes to clean the average 10-foot-wide protected lane. As litter vacuums and sweepers in this compact space have a cleaning speed around 3 miles per hour, the City's 10 miles of currently implemented protected bike lanes could be serviced by its Mini Sweeper twice a month with only 4 days of operating in each month.

Shared Use Paths are also difficult to clear consistently as they often are outside the roadbed entirely or in floodplains. Greenway trails are maintained by the City of San Antonio Parks Department (Parks), but other shared use paths frequently feature no clearing. For this reason, the City's Mini-sweeper could be used to clean these facilities as well. Outside of Parks's jurisdiction, but within the City, there are approximately 44 miles of Shared Use Paths for cleaning, assuming the same 2 passes to clear the 10-foot-wide surface, approximately 30 hours of operation would be required to clean these Shared Use Paths. If the city aims to clean these at the same recommended rate of twice per month, approximately 8 days of operation each month will be required.

Problem Area Identification and Cleaning

In addition to targeting specific facilities, the City must also target these maintenance practices to where San Antonians need them most. Bike facilities should always be given priority in their clearing as bike users are more sensitive to irregularities and road debris than cars due to their smaller and lighter weight tires. If there is debris requiring evasive maneuvers for bike users, they may be forced out into traffic increasing the risk of severe injury. Loose gravel or overgrown vegetation might appear insignificant to vehicles, but they pose serious hazards to bike users. Currently, the City provides spot treatment to clear debris in bike lanes as a response to demand through the City's 3-1-1 application. However, this application does not feature a bike-related reporting section. The City should modify the 3-1-1 app to provide a section specific to all bike related reporting including sweeping, repaving, and other obstructions.

Additionally, the City can anticipate the likely curb-adjacent problem areas of debris accumulation before a citizen reports to 3-1-1. By analyzing the running slope of a roadway with a bike facility for the bottom of a dip, the City can pinpoint likely areas for debris accumulation. A great place to begin is underneath rail bridges in and around Downtown San Antonio, as these roadway underpasses were often built with steep running slopes to avoid impacting the existing rail line elevation. An example of such a location is along Roosevelt Avenue, where debris often obstructs the newly implemented buffered bike lane. Other quick indicators for future areas include curb gutter inlets at the bottom of hills on roads with greater slopes, such as this location Gevers Street, at intersections where vehicles turn and change directions, such as this location on Culebra Road, and near construction zones. These areas should be identified and planned for additional sweeping outside the quarterly schedule, before a 3-1-1 request is reported.

Future Infrastructure Demands

In the next 5 years, most of the 337 miles of Tier 1 bike projects from the BNP's Cost Estimation Report will be implemented. While facility types for these projects have not been determined, many will feature protected bike lanes and shared use paths to improve bike user safety. If a goal of cleaning protected bike lanes and shared use paths twice each month is maintained, additional Mini-Sweepers will be required. The current sweeper could maintain this cleaning rate with approximately 100 miles of protected bike lanes and shared use paths, including the time required to transport the sweeper to locations across the City. In the next 5 years, 3 to 5 additional mini-sweepers may be required for purchase to maintain cleared bike facilities at an estimated total cost of up to $830,000 or approximately $170,000 annually. The cost of City staff hours to sweep those facilities that require special attention was calculated using the City's Fiscal Year 2025 pay plan for job class 7579 Maintenance Workers (an approximate hourly rate of $18.75) and the approximate hours required to sweep all existing and tier 1 shared use paths and protected bike lanes within the City's jurisdiction (including Greenway trails). In total this would require approximately 280 hours per month to sweep each twice a month costing a total of $5,250 in salary wages each month –$63,000 annually or $315,000 over the course of 5 years. If swept only monthly, the overall cost of clearing all shared use paths and protected bike lanes decreases to $31,500 – less than the lowest annual salary of a City employee. To implement this new sweeping – the PWD should partner with Parks to deploy mini-sweepers onto all applicable facilities.

Striping Re-application

The cost of individual striping applications for different bike facility types explored in the **BNP's Cost Estimation Report**. Here, to calculate pavement marking refresh cost, the BNP referred to data from the City's IMP website, which shows that the current Pavement Marking Refresh Program refreshes an estimated 1,100 miles of markings reapplied over a three-year period. Within that program, all existing facilities will feature striping reapplications in this memorandum's 5-year analysis window. However, similar to sweeping recommendations, roadways featuring bike facilities, including shared lane markings, should be prioritized within future striping reapplication programming. Furthermore, new bike facility designs may require additional pavement striping – especially at intersections. These too should be prioritized as the existing IMP restripes roadways.

As was discussed in expert interviews, striping experiencing frequent motor vehicle traffic and unique environmental circumstances will deteriorate more quickly – only the costs of these striping applications will be estimated in this memorandum. With striping applications varying by facility type, the BNP

On **Bike Boulevards or Bike Routes**, shared lane markings will feature frequent weathering from car traffic directly on the markings. The cost to refresh these markings is approximately $592 every 100 feet.

On **Bike Lanes** and **Buffered Bike Lanes**, all components of the striping, including line markings, buffer markings, bike symbols, directional arrows, and intersection crossbike markings, are open to car traffic and likely to experience car-related weathers. The cost to refresh these markings is approximately $2296 every 100 feet for bike lanes and $3896 every 100 feet for buffered bike lanes.

Protected Bike Lanes, which provide barriers to motor vehicles entering the dedicated space for bike users, will experience less car-related weathering and will only require striping reapplication on crossbike markings and car-vehicle-lane-adjacent striping. The cost to refresh these markings is approximately $725 every 100 feet.

Shared Use Paths and **Raise Protected Bike Lanes** will not feature car-related weather and will likely not require restriping in a 5-uear time horizon, instead striping reapplication should be planned on a 10-year time horizon or longer depending on the conditions. Protected raised lanes will feature stained pavement which according to interviews will not require weathering.

Combining the bike facility striping re-application maintenance estimates yields the most expensive additional maintenance cost of all programs with a total cost of $11,467,500 after 5 years of new bike facility implementation. It is important to note that not all new facilities will require striping re-applications and should respond to the condition of the roadway striping, not a pre-set plan. Additionally, the BNP recommends the City utilize more stained concrete and asphalt solutions to reduce the overall cost of this maintenance program.

Vandalism and Crash Impacts

Vandalism can be seen in various forms from graffiti or removal of signs and safety equipment. Between the crashes noted above and the passive vandalism of littering, these challenges require supplies and work force to clean graffiti, order and replace sign faces, and use various sweepers to remove foreign materials for safe use of the amenities. This cost was estimated from the **BNP's Cost Estimation Report** which noted the cost of individual signs and installation as $2000. For the purposes of simplified cost estimation – the BNP assumes that 1 in 50 or 2% of signs deployed will require replacement and that all signs will be deployed approximately every 100 feet between the many different types of signs (wayfinding, confirmation, and bike lane signs). 1 sign per 100 feet deployed along the 337 total miles of tier 1 projects and the 394 miles of existing city-maintained facilities (excluding greenway trails where signs are deployed according to different standards), yields a total signage currently or to be deployed of near 38,500, meaning approximately 770 signs will need replacement costing an aggregate of $1,540,000 in the first five years, or approximately $308,000 annually.

While interviewees noted that vandalism is a very small component of their experienced maintenance, impacts from crashes by errant vehicles can have significant impacts to the usability of bike facilities – specifically if destroying a protective barrier. Although flexible delineators are built to be resilient to impact, they will still ultimately need to be replaced if struck repeatedly by motor vehicles. For this analysis, the BNP makes two assumptions. First, that out of every 20 delineators (or 5%) will need to be replaced every five years, at a cost of $105 per delineator. The **Cost Estimation Report** states that for every 100 feet of bike facilities on both sides of the roadway, there will be approximately 28 delineators deployed, meaning that there are .28 delineators per foot. Second, all protected bike lane projects are implemented with flexible delineator posts. This second assumption is based on likely facility types though the final bike facility for any project is subject to review and not a determination by this plan. Furthermore, different protection devices will be used in different contexts. This assumption is meant only to simplify cost estimation for this memorandum.

Multiplying .28 delineators/foot by the number of feet of existing and tier 1 protected bike lanes provides the estimated number of delineators needed to implement all protected lane projects – approximately 15,900 delineators. Multiplying this number by 5% - the number of delineators in need of replacement, estimates approximately 800 delineators that will need to be replaced within 5 years, with a total estimated cost of $83,600 in the first five years.

Recommendations

Maintaining bike facilities requires a context sensitive approach, planning tailored sweeping, crash impacts, and striping programs for each type of bike facility. Not every program is applicable to every facility – bike boulevards did not have an associated debris removal activity, while protected raised lanes require pavement preservation, and only protected bike lanes have an associated barrier replacement cost.

To simplify the recommendations of this memorandum, **Figure 6** summarizes the recommended application by bike facility type and overall cost. These estimates represent the highest potential cost of maintenance. Many assumptions made in the BNP yield a likely high estimate to ensure the City can conservatively plan financial resources. It is worth noting that the two most expensive bike facilities to deploy, Protected Raised Bike Lanes and Shared Use Paths incur the least amount of recurring maintenance costs. Throughout the lifespan of those facilities, the greater upfront cost may save an equivalent or greater amount in reduced maintenance costs.

Facility	Pavement Preservation	Debris Removal & Sweeping	Striping Re-Application	Vandalism and Crash Impacts
Bike Boulevard	*$7,524,400* - but already accounted for by the IMP	$0 - Adequately swept by City's IMP, but facilities could be prioritized in future cycles	$2,512,400 - Re-applying shared lane markings on tier 1 facilities	$319,800 - Replacement signage on all existing & tier 1 facilities
Striped Bike Lane	*$1,121,800* - but already accounted for by the IMP	$0- Adequately swept by City's IMP, but facilities could be prioritized in future cycles	$1,452,700 - Re-applying bike lane markings on tier 1 facilities	$432,600 - Replacement signage on all existing & tier 1 facilities
Buffered Bike Lane	*$3,285,800* - but already accounted for by the IMP	$0- Adequately swept by City's IMP, but facilities could be prioritized in future cycles	$7,220,200 - Re-applying all buffered bike lane markings on tier 1 facilities	$128,000 - Replacement signage on all existing & tier 1 facilities
Protected Bike Lane	*$690,200* - but already accounted for by the IMP	$289,000 - Including the cost of new equipment and worker hours	$282,200 - Re-applying only the car-exposed protected lane markings on tier 1 facilities	$118,800 - Replacement signage and delineators on all existing & tier 1 facilities
Protected Raised Lane	$0 – preservation not required in a 5-year horizon	$378,000- Including the cost of new equipment and worker hours	$0– striping reapplication not required in a 5-year horizon due to minimal car impacts.	$287,500- Replacement signage on all existing & tier 1 facilities
Shared Use Path	$0– preservation not required in a 5-year horizon	$478,000- Including the cost of new equipment and worker hours	$0– striping reapplication not required in a 5-year horizon due to minimal car impacts.	$336,900- Replacement signage on all existing & tier 1 facilities
Total Additional Maintenance Cost After 5 Years of Implementation	**$0**	**$1,145,000**	**$11,467,500**	**$1,623,600**

Figure 6: Bike Facility Maintenance Cost Summary