Minneapolis
Public Works

MMA-based Transit Priority Lane Treatment Evaluation Report

December 2025

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Executive Summary

Overview

The City of Minneapolis' Public Works Department evaluated four transit priority lanes (TPLs) installed between 2019 and 2022 that used methyl methacrylate (MMA) based paint for pavement markings. This treatment is both more durable and costly compared to the traditional water-based or thermoplastic paint.

The four TPLs included in this evaluation are:

- 7th St. S., from 1st Ave. N. to Chicago Ave.
- 3rd Ave. S. at 12th St S
- Hennepin Ave., from Franklin Ave. to Lake St. W.
- Chicago Ave., from 28th St. E. to Lake St. W.

The goals of this evaluation are to understand how the MMA treatment functions in the field to inform decisions related to using MMA paint in future projects, and to establish a methodology to evaluate the condition of the paint consistently and efficiently.

Key Findings

1. Five types of wear and tear were observed at TPLs: chipping, flaking, degradation (lane, curb edge, and dashed area), patching materials and tire staining, and pavement damage (e.g., cracks and potholes).
2. Chipping was the most prevalent type of wear observed at all four study locations while flaking was observed at three of the four study locations.
3. Dynamic curbside TPLs (where parking is allowed outside of bus only lane hours); TPLs with a higher frequency of buses; and areas with bus stops, busy driveways, and vehicle mixing areas at intersections are more likely to show increased wear and tear over time due to more frequent exposure to vehicle traffic.
4. Additional factors, such as surface pretreatment method and age of the street, can affect the longevity of the paint.
5. The type of pavement (asphalt vs concrete) and the method of paint application (spray vs hand painted) do not appear to have an impact on the longevity of the paint.

Staff Recommendations

Installation:

- Prior to MMA application, implement a full seal coat treatment along the corridor to ensure surface integrity and optimal adhesion. For installations on newly constructed roadway surfaces, assess whether a full seal coat is warranted.
- Apply a thicker layer of MMA at bus stops, driveways, and areas with mixed vehicle traffic, ensuring the thickness remains within limits to prevent damage from snowplow operations.

Monitoring and Evaluation:

- Monitor and tailor the maintenance of TPLs based on the observed condition of MMA, particularly in areas that are more exposed to friction caused by vehicles.
- If a follow-up evaluation is conducted:
    - Continue to use both images and field notes to document observations that are important in understanding how the TPL functions, the context, and the condition of the paint.
    - Schedule data collection site visits on dry/clear weather days to avoid capturing leaves, twigs, and other large debris in images. Avoid construction timelines.
    - Develop an inventory of observation sites for each corridor and a log of impacted sites to strengthen the quantitative and qualitative analysis (E.g., number of bus stop locations on X corridor and number of bus stop locations showing wear).
    - Continue to include at least one bus stop, driveway/alley/parking lot access point, and vehicle mixing zone at intersections as part of future observation site selection, depending on what is present on the corridor.
    - Track and document any changes or improvements to MMA-treated TPLs throughout their lifetime, such as installation, MMA refreshes, street repairs, and possible sources of pavement and/or paint treatment damage.

Overview

Between 2019 and 2022, the City of Minneapolis' Public Works (PW) Department, in partnership with Metro Transit, installed four transit priority lanes (TPLs) using methyl methacrylate (MMA)-based red paint across four locations in the city (Figure 1). These locations include:

- 7th St. S., from 1st Ave. N. to Chicago Ave.
- 3rd Ave. S. at 12th St S
- Hennepin Ave., from Franklin Ave. to Lake St. W.
- Chicago Ave., from 28th St. E. to Lake St. W.

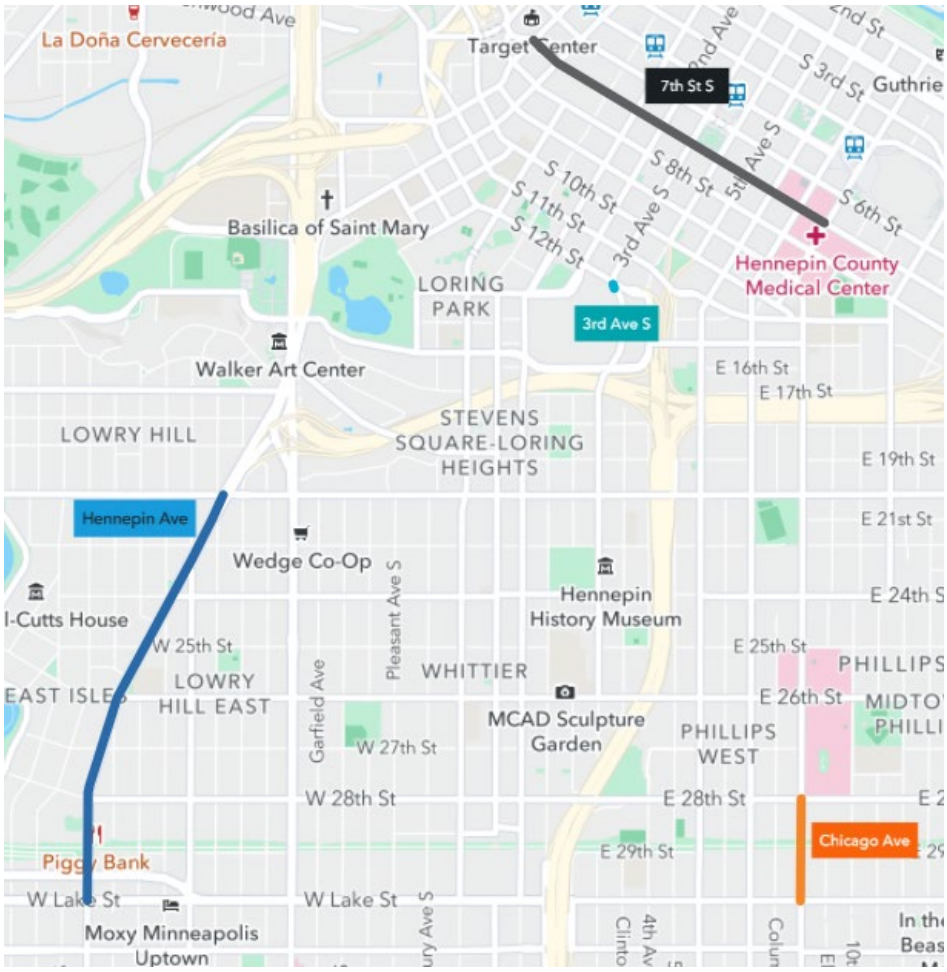

Figure 1: Study locations

Prior to 2022, the City's Traffic and Parking Services (TPS) staff installed MMA treated TPLs in the city. TPL installation since 2022 has been completed by private contractors. According to Metropolitan Council's Transit Funding Allocation Policy[1], revenue from the Metropolitan Area Transportation Sales and Use Tax may be used to maintain TPLs.[2]

This study focuses on evaluating the performance of the MMA-based treatment and identifying factors that affect its longevity. The report also includes recommendations for improving the treatment's performance over time to ensure that they remain a cost-effective investment for the City in the long run.

Evaluation Goals

The goals of this evaluation are to understand how the MMA treatment functions in the field to inform decisions related to using MMA paint in future projects, and to establish a methodology to evaluate the condition of the paint consistently and efficiently.

This evaluation focuses on determining the longevity of the MMA paint treatment under regular use conditions through interviews with the City's TPS division staff and site observations.
Staff used the following research questions as the basis of this evaluation work:

1. Which factors affect the longevity of the MMA-based treatment?
2. What steps can be taken to improve the treatment's longevity over time?
3. What are some potential methods of evaluating the condition of the paint consistently and efficiently?

The findings of this study will allow City staff to inform installation and maintenance plans for current and future TPLs.

Methodology

This study employs a qualitative approach to collect and analyze data, including interviews with TPS staff, site observations, and digital images.

Expert interviews

Evaluation program staff consulted with TPS staff three times over the course of this study: in December 2022, and in March and October of 2025. The purpose of these meetings was to learn about their experience with the process of MMA application, garner feedback on a preliminary analysis of images of the study corridors, understand details about MMA performance, and clarify maintenance procedures.

Site observations and digital imaging

Digital imaging is a powerful tool to determine the condition and longevity of roadway paint treatment[3,4]. Staff adopted a method similar to New York City Department of Transportation's *Red Bus Lane Treatment Evaluation*[5], where digital images were used to document chipping, peeling, fading and other types of wear on red bus lane treatments.

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[1] https://metrocouncil.org/Council-Meetings/Committees/Transportation-Committee/2025/August-25,-2025/2025-170-JT-attachment-1.aspx
[2] TPS staff is yet to confirm with Metropolitan Council that the Metropolitan Area Transportation Sales and Use Tax will cover costs associated with maintaining TPLs.
[3] Standard Test Method for Evaluation of Color for Thermoplastic Pavement Marking Materials – ASTM International, ASTM D4960, 2020 Edition, July 1, 2020
[4] Red Bus Lane Treatment Evaluation - Steven P. Scalici, P.E.; William Carry, Sr.; Eric Donnell, Ph.D., P.E.; Zoltan Rado, Ph.D.; and Martin R. Hartmann, P.E.T&DI Congress 2014: Planes, Trains, and Automobiles. 2014
Land Use, Zoning and Demographics (nctcog.org)
[5] Red Bus Lane Treatment Evaluation - Steven P. Scalici, P.E.; William Carry, Sr.; Eric Donnell, Ph.D., P.E.; Zoltan Rado, Ph.D.; and Martin R. Hartmann, P.E.T&DI Congress 2014: Planes, Trains, and Automobiles. 2014
Land Use, Zoning and Demographics (nctcog.org)

Evaluation program staff completed site observations in 2022, 2023, and 2024. Observations were made at intersections; alley and driveway access points; bus stops; and mid-block where no driveways, alleys, or bus stops were present. In 2024, observations were made both the day before and after spring street-sweeping was completed. This approach assumed there would be less debris on the surface after the street was swept, resulting in clearer photos of the street surface. However, at most locations, debris and rainwater were observed both before and after street sweeping, likely a result of rain and wind from the day before.

When taking photos, staff followed best practices including avoiding shadows, removing large debris from the street surface before taking photos, and capturing photos that revealed the context of the street. Photos also included curb edges and outer edges of the lane, the main lane, and dashed lines at intersections and other vehicle mixing areas to observe potential differences in the paint condition across different sections of the TPL.

Evaluation metrics

The following quantitative and qualitative metrics were studied as part of this evaluation:

- **Age of street**: to understand if the age of the street affects the performance of the paint
- **Type of pavement**: to understand if the paint performed differently on asphalt vs concrete pavements
- **TPL placement**: to understand if the condition of paint was different on curbside vs non-curbside TPLs
- **TPL use**: to understand if the number of bus routes, frequency of buses, time of operation and availability for dynamic on-street parking affect the longevity of the paint
- **Surface preparation method**: to understand if surface preparation before application affects the longevity of the paint
- **Application method**: to understand if spraying or hand-painting MMA affects its performance
- **TPL condition**: to understand what types of wear and tear are present and where

Data collection methods for each metric can be found in Table 1.

Table 1 Data collection methods for each metric

Metric	Method	Time period
Age of street	City of Minneapolis, PCI map[6]	2024
Type of pavement	City of Minneapolis, PCI map	2024
TPL placement	Evaluation program staff determination	N/A
TPL use	Metro Transit staff	Late 2024
Surface preparation method	Expert interviews	2022 and 2025
Application method	Expert interviews	2022 and 2025
TPL condition	Site observations	2022 and 2024

[6] 2022 - 2025 PCI

Study Locations

Characteristics for each study location is included in Table 2 below.

Table 2: Characteristics of the MMA-treated Transit Priority Lanes

Corridor	Length (miles)	Time of operation	TPL placement	Installation year	Number of bus routes	Weekday Trips	Type of pavement	Street construction year
7th St S, 1st Ave N to Chicago Ave	0.86	Full-time lane, westbound only	Offset lane	2021[1]	7	317	Asphalt/ Concrete	1953 (overlay in 2011)
3rd Ave S/12th St S	0.03	Full-time	Offset lane	2021	Not available[1]	Not available[1]	Asphalt	1971 (overlay in 2015)
Hennepin Ave, Franklin Ave to Lake St W	1	Time restricted (weekdays 7am-9am Northbound & weekdays 4pm-6:30pm Southbound)	Curbside, dynamic lane – parking is permitted outside of designated bus only lane hours	2019[2]	3	63	Asphalt/ Concrete	1957 (sealcoat in 2009 and chip seal in 2019)
Chicago Ave, 28th St E to Lake St W	0.23	Full-time lane, southbound only	Curbside	2019 and 2022[3]	2	118	Asphalt	2005

Notes:
[1] The number of weekday trips was not available for 3rd Ave S because it does not directly serve any bus stops. This TPL is for buses making a left turn from 3rd Ave to a contraflow bus lane on 12th St. This route is primarily used by express buses to get from the layover stop on 1st & 16th to route starting points.
[2] Information on Hennepin Ave is pre-2024/2025 reconstruction. Observations are between Franklin Ave and 26th St only and do not include the segment between 26th St and Lake St due to construction-related street closure.
[3] The TPL on Chicago Ave, as it exists today, was installed in 2022 as part of the METRO D Line construction.

Findings

The findings of this study are meant to help understand the performance of MMA, identify factors that affect its longevity, and inform installation and maintenance plans for current and future TPLs. The following findings are based on expert interviews and site observations.

Expert interviews

This section summarizes key takeaways from expert interviews.

Paint Application and Surface Preparation

According to TPS staff and informed by manufacturer specifications, the ideal temperature for installing MMA-treated lanes is above 40°F. The paint is applied in two ways: spray application (using machines) and manual application (using squeegees). Currently, the paint is installed in alternating layers of MMA and an aggregate that includes the corundum and the second layer to seal the paint. Manual application of paint is labor intensive and may result in a thicker and/or uneven layer of paint compared to spray applied paint. A higher thickness of paint

can make the paint more susceptible to damage from snowplows in the winter. While snowplows can damage the paint and the MMA can lose friction properties over time, TPS staff have not observed loss of friction that would affect the overall performance of the TPL.

Prior to 2022, MMA was installed by City staff using the spray application technique. Since 2022, MMA installations have been done by private contractors due to the scale of these projects and because contractors have machines that are more appropriate for MMA application. City equipment also became unusable as a result of corrosion caused by MMA's chemical composition. The TPL on Chicago Ave was the first contractor-applied TPL.

Figure 3: Crews applying MMA by hand on the main lane sections on Chicago Ave (September 2022)

Details about MMA application and surface preparation are summarized in Table 2.

Table 3: Details on MMA-based paint application

Location	Type of Pavement	Application Year	Application Period	Approximate Temperature During Application	Surface Preparation Method	Application Method	Estimated Paint Thickness[1]	Paint Refresh
7th St S	Asphalt	2021	Fall, nighttime	30°F	None	Spray	Lane: 40 mils, Conflict Markings: 20 mils	Yes, two blocks in September 2023 (3rd Ave S to 2nd Ave S and Hennepin Ave to 1st Ave N)
3rd Ave/12th St	Asphalt	2021	Late fall, daytime	20°F	Street sweep and blower	Hand	80 mils	No
Hennepin Ave	Asphalt	2019	Mid-summer, daytime	65°F	Full seal coat	Spray	40 mils	No
Chicago Ave	Concrete & Asphalt	2022	Fall, daytime	55°F	Full resurfacing	Hand & Spray	50 mils	No

Notes:
[1] The thickness of paint, measured in mils[7] is an estimation based on TPS' calculations of application speed and paint volume.

There was no pretreatment or surface washing done before the paint was installed on 7th St. This was a trial from

[7] *A mil (or mils) is a unit of measurement commonly used in the paint and coatings industry to express the thickness of a coating. One mil is equivalent to one-thousandth of an inch (0.001 inch) or 0.0254 millimeters. Paint thickness is often measured in mils because it is more precise than other units of measurement, such as microns or millimeters. For example, a typical coat of paint on a wall may have a thickness of 3 to 5 mils, while a coating on a metal surface may be much thicker, ranging from 10 to 20 mils or more, depending on the intended use and environmental factors. The thickness of a coating is an important component in determining the paint's performance, durability, and appearance.*

TPS staff to determine how well the paint would hold in an untreated surface. All other locations received pre-installation surface preparation, ranging from street sweeping to blowing, full seat coat, or full resurfacing. TPS staff believe that the thickness of the paint layer and surface pretreatment are important contributing factors to the longevity and performance of the paint in the long term.

Site observations

This section summarizes key findings from site visits. Staff used digital images and field notes to record their observations.

Types of wear

Staff identified five main types of wear and tear to the paint, based on their observations:

1. Chipping
2. Flaking
3. Degradation (lane, curb edge, and dashed area)
4. Patching materials and tire staining
5. Pavement damage (e.g., cracks and potholes)

A description and example of each type of wear, including possible factors that are contributing to the damage are presented in Table 3.

Table 3: Types of wear observed on MMA-treated corridors

Type of wear	Definition	Possible factors contributing to damage	Example
Chipping	• Chipping refers to small, isolated areas of paint loss.	• Weathering, chemical exposure, and heavy traffic. • Can be exacerbated by improperly applied paint treatments or improper surface preparation prior to installation.	 Figure 4: Chipping observed on the 3rd Ave S/12th St block section.
Flaking	• Flaking refers to larger sections of paint peeling away from the surface. • This can create a rough, uneven, and potentially hazardous surface.	• Weathering, chemical exposure, and heavy traffic. • Can be exacerbated by improperly applied paint treatments or improper surface preparation prior to installation.	 Figure 5: Flaking observed on Hennepin Ave.

Type of wear	Definition	Possible factors contributing to damage	Example
Lane Degradation	• Occurs when the markings on a road surface gradually deteriorate over time, effectively lowering its overall thickness and visibility. • Faded or missing markings can create a safety hazard as it could make it harder to see the intended use of the roadway.	• Exposure to various factors such as friction, heat, and chemicals. • Frequent exposure to vehicle friction next to driveways and alleys and parked vehicles.	 Figure 6: Lane degradation observed next to a driveway on Hennepin Ave.
Curb Edge Degradation	• Curb side damage or lack of curb edge retention that is observed on the edges of MMA-treated lanes next to curbs and sidewalks. • The curb side of the road deteriorates at a faster rate than the rest of the lane.	• Frequent exposure to different sources of friction such as vehicle tires, particularly at bus stops, driveways, and TPLs used for parking.	 Figure 7: Loss of paint closer to the curb on Hennepin Ave.
Dashed Area Degradation	• Wear and tear that is observed in areas painted with dashes that indicate vehicle mixing zones, particularly at intersections.	• Vehicles using the lane to turn right. • The dashed areas are painted using a lower thickness of paint than the main sections of the pavement[8].	 Figure 8: Loss of paint observed before an intersection on Hennepin Ave.
Patching Materials and Tire Staining	• Black streaks that appear on the paint both across the drive lane as well as on the wheel paths.	• The mixture used to patch the roadway surface (asphalt crack fills) permeates through the paint coating with tire rubber debris contributing to the stain.	 Figure 9: Roadway patching permeating through the MMA treatment on 7th St S.

[8] City staff have evaluated the performance of dashed areas and adjusted the method of application to match the thickness of the overall corridor treatment. The corridors this report refers to were installed before the new methods were adopted.

Type of wear	Definition	Possible factors contributing to damage	Example
Pavement Damage	• Damage to the paint due to damage to the pavement, such as potholes.	• Damage to the paint because of road surface damage in certain areas with more vehicle movements, like driveways and bus stops.	 Figure 10: Pavement damage that has affected the paint on Hennepin Ave.

Presence of wear and tear

After defining the types of wear to MMA-based paint, staff identified which type(s) of wear were generally present along each corridor. Table 4 includes a comparison of observations from 2022 and 2024.

Table 4: Summary of types of wear observed on each corridor.

Type Of Wear	7th St S		3rd Ave S/12th St		Hennepin Ave		Chicago Ave	
	2021 installation		2021 installation		2019 installation		2022 installation	
	2022	2024	2022	2024	2022	2024	2022	2024
Chipping	■	■	■	■	■	■		■
Flaking	■	■			■	■		■
Lane Degradation	■	■			■	■		
Curb Edge Degradation	■	■			■	■		
Dashed Area Degradation	■	■			■	■		
Patching Materials and Tire Staining	■	■			■	■		■
Pavement Damage					■	■		

Note: The shaded cells indicate types of wear that were observed on at least one block of the corridor and the non-shaded cells indicate that little to no wear were observed on any block of the corridor.

The most common type of wear observed across all locations was chipping. Significant flaking and lane degradation were observed on 7th St S and Hennepin Ave. In 2024, the MMA on Hennepin Ave showed all types of wear likely a result of the age of the street and TPL. The paint on the 3rd Ave/12th block section showed the least wear compared to other locations. Chicago Ave showed some wear, mostly adjacent to the bus stop.

Location of wear and tear

Generally, bus stops showed more wear and tear, including lane, curb edge, and dashed area degradation. Damage to the paint was significant at some bus stops, particularly the nearside stops at 7th St & Park on 7th St S as well as Franklin Ave & Hennepin and 24th St & Hennepin. These sections were marked by dashed lines. Some wear including flaking was present in front of the Chicago Ave & Lake St bus stop. Similar wear and tear were observed next to some busy driveway locations and at intersections where vehicles were permitted to use the TPL for right turns. Most wear to the paint was observed on Hennepin Ave compared to other locations.

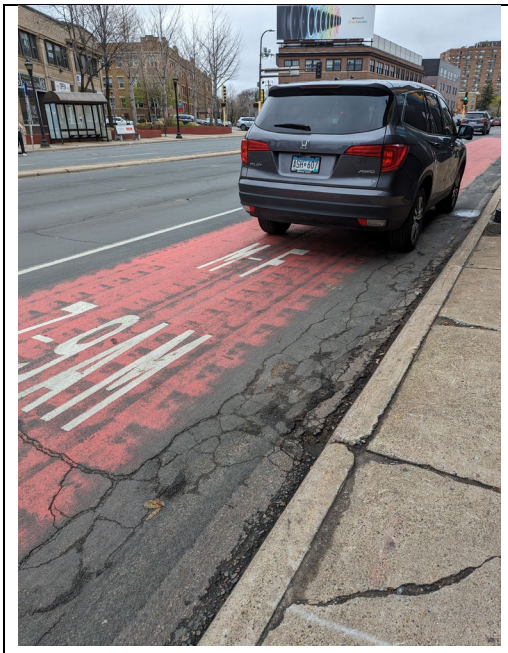


Figure 11: Lane degradation seen on Hennepin Ave where parking is allowed at limited hours

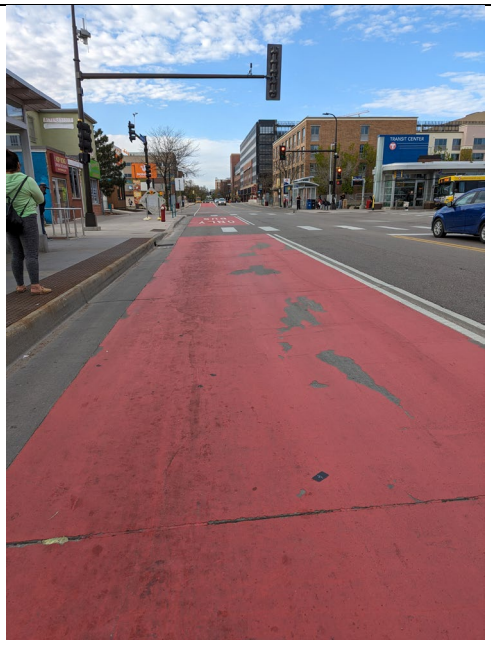


Figure 12: Flaking seen at the Chicago Ave & Lake St bus stop

Figure 13: Dashed area degradation and pavement damage seen next to the Hennepin Ave & W 24th St bus stop and adjacent driveway

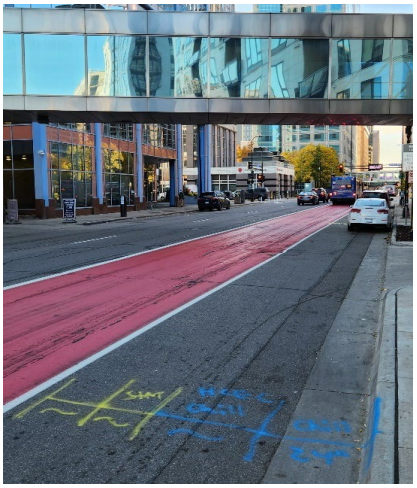
Figure 14: Dashed area degradation seen at Park & 7th bus stop on 7th St.

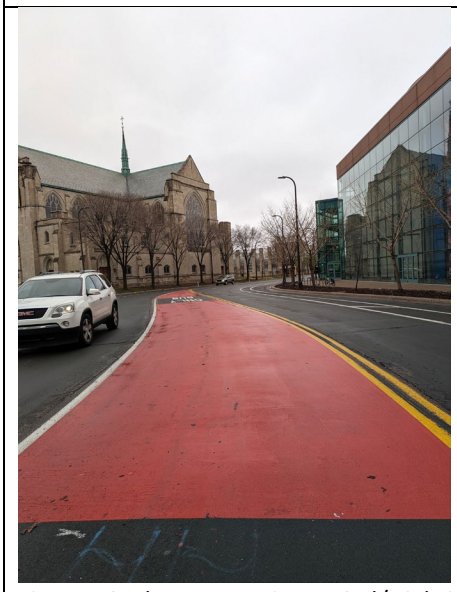
The performance of paint on one corridor cannot be compared with other corridors without considering factors such as the year of installation, time of operation, frequency of buses, post-installation maintenance, and the age of street. There are many differences across the corridors as well as across blocks along the same corridor that impact the condition of the paint. Similarly, although Table 4 indicates the presence of all types of wear to the paint along the 7th St S corridor, damage to the paint was mostly observed closer to Chicago Ave. The west end of the corridor, closer to 1st Ave N, showed significantly less wear. This might be attributed to the fact that City crews refreshed two blocks (3rd Ave S to 2nd Ave S and Hennepin Ave to 1st Ave N) in September 2023. Additionally, the presence of significant wear and tear along Hennepin Ave is likely because it was installed in 2019 and observations included in this study were made at least three years after its installation. This is also the only TPL that is used for parking outside of the designated bus only lane hours.

Location summaries

Table 5 below summarizes observations as well as contextual information against which the observed wear and tear must be understood.

Table 5: Summary of TPL context and findings

<table>
<tr><td colspan="2">7th St. S between 1st Ave. N. and Chicago Ave.</td></tr>
<tr><td> 
Figure 15: 7th St S TPL in downtown Minneapolis</td><td>Observations: Observations were made along 10 blocks (0.86 miles) on days with dry weather conditions. The two blocks between Chicago Ave and Portland Ave showed the most wear (flaking and degradation of the lane, curb edge, dashed lines), particularly at the 7th St and Park Ave bus stop. Many blocks also showed roadway patching permeating through the paint. The 3rd Ave S to 2nd Ave S and Hennepin Ave to 1st Ave N blocks showed the least amount of wear as a likely result of the paint refresh in 2023.

Context: The TPL was installed in 2021 by spraying. This is a full-time TPL in an offset lane. No surface preparation was done prior to installing the paint on the asphalt pavement. The frequency of buses using this TPL is 317 per day (7 bus routes) although general traffic also often use the bus lane even though not permitted.</td></tr>
<tr><td colspan="2">3rd Ave/12th St S</td></tr>
<tr><td> 
Figure 16: The MMA paint at 3rd/12th St S shows minor chipping</td><td>Observations: Observations were made after a day of rain (pre-and post-street sweeping). Very little wear was observed. Only some chipping was present. The MMA looked bright and in good condition overall.

Context: This TPL is located in a single block section at the 12th St S & 3rd Ave S intersection, northeast of the Minneapolis Convention Center. The TPL was installed in 2021 by hand. This is a full-time TPL in an offset lane that is 0.03 miles long. The street was swept/blown prior to installing the paint on the asphalt pavement. This TPL does not directly serve any bus stops.</td></tr>
<tr><td colspan="2">Hennepin Ave. from Franklin Ave. to Lake St. W.</td></tr>
</table>

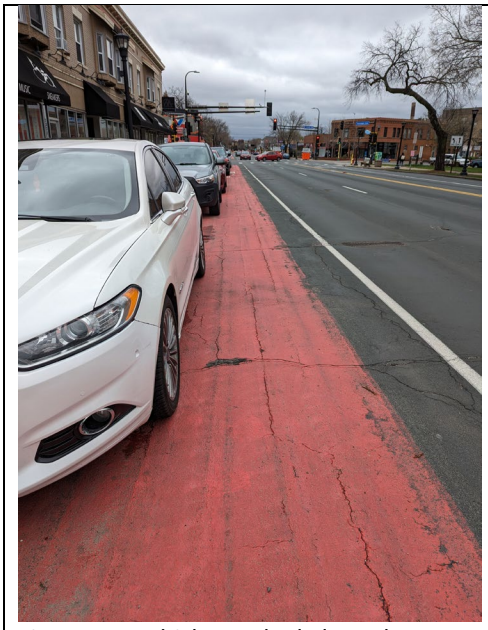


Figure 17: Vehicles parked along the TPL on Hennepin Ave

Observations: Observations were made after a day of rain (pre-and post-street sweeping). Observations are limited to the section between 26th St and Franklin Ave W (3 blocks northbound and 1 block southbound) because Lake St to 26th St was closed for construction. Both northbound and southbound sections showed significant wear -- chipping, flaking, lane and dashed line degradation, patching materials/tire staining, and pavement damages such as cracks and potholes that damaged the paint. Several vehicles were parked in the bus lane as parking is permitted outside of designated bus only lane hours. More pavement damage including potholes were observed at bus stops and in front of some driveways. Dashed area degradation was mostly present at nearside bus stops.

Context: The TPL was installed in 2019 by spraying. This is a 1-mile-long time restricted TPL with bus only hours limited to weekdays 7am-9am northbound & weekdays 4pm-6:30pm southbound. The TPL is a curbside, dynamic lane where parking is permitted outside of the designated bus only lane hours. The street received a full seal coat prior to installing the paint on the asphalt pavement. The frequency of buses using this TPL is 63 per day (3 bus routes).

Chicago Ave. from 28th St. E. to Lake St. W.

Figure 18: The paint on Chicago Ave showing some chipping and tire staining

Observations: Observations were made on days with dry weather conditions (pre- and post-street sweeping). The paint showed some chipping and flaking in some sections of the corridor. Flaking and some minor lane degradation was mostly present in front of the Chicago Ave and Lake St bus stop. The paint was bright and in good condition overall. This is likely because the paint was installed in 2022 as part of the METRO D Line construction.

Context:
The TPL was installed in 2022 by spraying and by hand. This is a curbside, 0.23-mile-long full time TPL. The street was fully resurfaced prior to installing the paint on the asphalt and concrete pavement. The frequency of buses using this TPL is 118 per day (2 bus routes).

Conclusions

Below are some key conclusions based on the findings of this evaluation:

1. Five types of wear and tear were observed at TPLs: chipping, flaking, degradation (lane, curb edge, and dashed area), patching materials and tire staining, and pavement damage (e.g., cracks and potholes).
2. Chipping was the most prevalent type of wear observed at all four study locations while flaking was observed at three of the four study locations.
3. Curbside, dynamic TPLs (where parking is allowed outside of bus only lane hours), TPLs with a higher frequency of buses, and areas with bus stops, busy driveways, and vehicle mixing areas at intersections are more likely to show increased wear and tear over time due to more frequent exposure to vehicle traffic.
4. Additional factors, such as surface pretreatment method and age of the street can affect the longevity of the paint.
5. The type of pavement (asphalt vs concrete) and the method of paint application (spray vs hand painted) do not appear to have an impact on the longevity of the paint.

Further investigation across multiple TPL locations is necessary to draw more firm conclusions around factors affecting the longevity of the paint.

Staff Recommendations

Given the findings of this evaluation, staff recommend the following steps to potentially improve the treatment's longevity over time and evaluate the condition of the paint consistently and efficiently.

Installation:

- Prior to MMA application, implement a full seal coat treatment along the corridor to ensure surface integrity and optimal adhesion. For installations on newly constructed roadway surfaces, assess whether a full seal coat is warranted.
- Apply a thicker layer of MMA at bus stops, driveways, and areas with mixed vehicle traffic, ensuring the thickness remains within limits to prevent damage from snowplow operations.

Monitoring and Evaluation:

- Monitor and tailor the maintenance of TPLs based on the observed condition of MMA, particularly in areas that are more exposed to friction caused by vehicles.
- If a follow-up evaluation is conducted:
    - Continue to use both images and field notes to document observations that are important in understanding how the TPL functions, the context, and the condition of the paint.
    - Schedule data collection site visits on dry/clear weather days to avoid capturing leaves, twigs, and other large debris in images. Avoid construction timelines.
    - Develop an inventory of observation sites for each corridor and a log of impacted sites to strengthen the quantitative and qualitative analysis (E.g., number of bus stop locations on X corridor and number of bus stop locations showing wear).
    - Continue to include at least one bus stop, driveway/alley/parking lot access point, and vehicle mixing zone at intersections as part of future observation site selection, depending on what is present on the corridor.
    - Track and document any changes or improvements to MMA-treated TPLs throughout their lifetime, such as installation, MMA refreshes, street repairs, and possible sources of pavement and/or paint treatment damage.

Appendix A – Core team

This evaluation study was conducted with a Public Works core team that involved staff from the following divisions:

- Transportation Planning & Programming: Amy Barnstorff, Leoma Van Dort
- Traffic and Parking Services: Shane Morton, Daniel Oleary, Jeff Perriera

Reviewers

- Public Works Transportation Planning &Programming Division staff
- Public Works Traffic & Parking Services Division staff
- Metro Transit staff

Appendix B – Product details

MMA

MMA is the acronym for methyl methacrylate, a chemical compound used as a bonding agent in a variety of materials. For the purposes of this evaluation, MMA is the pigmented resin to which a catalyst bonds to form the MMA-based paint material.

MMA is used as a liquid pavement marking/traffic striping tool with the capacity of chemically bonding to the surface to which it is applied. The ratio of resin to catalyst can be modified to make the bonding stronger in order to withstand friction. Thanks to this property, MMA-based materials have demonstrated excellent adhesion and durability in a variety of heavy use traffic applications, including snow-plowed streets and highways.

The chemical properties of MMA allow for its use without an extensive surface preparation, and the curing process occurs in less than 2 hours in a range of temperatures between 40-100 F, though it can be applied in more extreme temperatures as well. The typcal shorter cure time allows for shorter road closures and a more flexible application schedule.

MMA-based materials are approximately 3 times more expensive than traditional water-based paint[9], but their superior performance and longevity often make them a worthwhile investment. Applying MMA requires special equipment, unless it is painted by hand. Due to the chemical composition of the mixture, pavement marking equipment that is not designed with features such as corrosive-resistant pumps will eventually fail and render the machine unusable.

Corundum

Corundum is used by the City of Minneapolis as an anti-skid material added to MMA-based applications. Corundum is the common name for a crystalline form of aluminum oxide. Normally colorless to white, corundum is a mineral that is naturally hard and abrasive, and it is commonly used in a variety of industrial applications. In the context of anti-skid traffic materials, corundum can be added to paints, coatings, and other surface treatments to increase traction against rubber tires.

Corundum is particularly effective as an anti-skid material because of its hardness, which allows it to maintain its abrasive properties even after being subjected to heavy use. Additionally, corundum is relatively chemically inert, which means that it can be used in a variety of environments without degrading or reacting with other materials.

[9] Source: City of Minneapolis' TPS price list for paints priced by the gallon. Thermoplastics are priced by square footage; therefore, no specific price comparison was included in this study.