



PAVEMENT MARKING COMPARISON STUDY – US ROUTE 302 BIKE LANE MARKINGS

Ian Anderson, Research Engineer
Vermont Agency of Transportation
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Abstract

Numerous types of bike lane markings were used in a test section of US-302 in Berlin VT as part of a road diet configuration. The bike lane pavement marking test was done as part of a larger experimental feature study on durable pavement marking tapes, in which pavement markings from various vendors were used along the course of the reconstructed roadway. Three green bike lane markings were used, Ennis-Flint PreMark preformed thermoplastic, Ennis-Flint CycleGripMMAX Methyl Methacrylate (MMA), and Transpo Color-Safe MMA. Observations of the construction, and performance after two years are documented and described.

Through visual observations, both MMA products, CycleGripMMAX and Color-Safe are outperforming the PreMark preformed thermoplastic. The majority of the green colored bike path markings remain in functioning condition, with a few skip marks in need of replacing. Based on the observed results, MMA green bike marking should be explored for future bike lane markings, when cost, time to use, and environmental factors permit.

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1. Project Overview

In an effort to gauge the real-world performance of various pavement markings, an experimental feature test section was installed on US-302 in Berlin, VT in August-October 2016. This research effort incorporated 6 High Performance and Permanent Tapes (Type A and Type B), 2 Intersection Tapes (Type C), 2 types of Preformed Thermoplastic, and 3 Green Bike Lane products. The goal of the initiative is to evaluate the overall performance of the markings including constructability, durability and retroreflective capability over time and use the results to provide recommendations regarding future usage in Vermont.

This report describes the results of the Green Bike Lane product evaluations. Green markings are approved for use in bike lanes (Interim Approval IA-14 in the MUTCD [1]) as a method for delineating bike facilities, and are being applied at intersections and in areas of high traffic.

2. Product Information

Three green pavement marking materials were used in this project. They include, Ennis-Flint PreMark and Ennis-Flint CycleGripMMAX, and Transpo Industries Color-Safe. Initial project plans included Ennis-Flint Ride-A-Way Epoxy but it was not included as there were concerns over its long cure time (12-24 hours) and number of coats needed (four).

2.1. PreMark

PreMark preformed thermoplastic is manufactured by Ennis-Flint of Thomasville, North Carolina. The manufacturer claims the product is a heavy-duty, durable intersection grade pavement marking material. It is used primarily for regulatory markings on public streets, highways, and private properties. It is claimed to have a cost-effective service life that lasts 6 to 8 times longer than paint. Under colder temperatures, 45-55 degrees, the sealer may take up to 60 minutes to cure. Retroreflective glass beads and traction aggregate are mixed throughout the material so that as the marking wears new beads and aggregate become exposed. It provides a clean and crisp appearance because the product is pre-cut and ready for use. The nominal thickness is 90 mils for both white and green colors. [2]

2.2. CycleGripMMAX

CycleGripMMAX is a colored bike lane treatment that combines Methyl Methacrylate (MMA) resin with hardwearing aggregate and premium pigment, manufactured by Ennis-Flint of Thomasville, North Carolina. It claims long-lasting color retention, friction, and extreme durability. It is suited for long lane areas with low to high vehicle traffic including cross-over points such as parking lot entries/exits along the corridor. The application thickness is 90 mils, and claims a cure time of 30-60 minutes. [3]

2.3. Color-Safe

Color-Safe MMA is an acrylic based resin system used for color pavement markings and anti-skid surfacing that is manufactured by Transpo Industries, Inc. of New Rochelle, New York. The manufacturer claims the product provides excellent color retention and durability. Color-Safe is easily applied by hand with squeegees and rollers or with automatic spray equipment. Color-Safe cures without requiring external heat sources, estimated cure time of 30 minutes at 70 degrees. It is manufactured in a variety of colors and aggregate sizes and is typically used for demarcation of crosswalks, bike and pedestrian paths, bus lanes, and other specially designated areas. It can be used as a surface coat to enhance skid-resistance for high friction surfacing on hazardous turns and high accident areas. The typical application thickness is 60-100 mils. The target in place thickness for the product in this project was as close as possible to 90 mils in place. Both green and white were used for this project, with green for the lane section and white for the Bicycle Detector Symbols located within the green bike lane. [4]

3. Installation

L&D Safety Marking Corporation was the installation contractor for this project, and each manufacturer had a representative present for the placement of their respective materials, all taking place in August-October 2016. All traffic

data cited are Peak Hourly counts from the VTrans Transportation Data Management System [5], obtained by VTrans staff during the week of May 20th 2018, diagrams of which can be found in Appendix A.

3.1. PreMark

PreMark preformed thermoplastic was installed on Aug 26-27, 2016, with ambient temperatures of 80°F. PreMark was used in three locations throughout the test. The first was between a straight and a turn lane on the North/West bound travel lanes leading to the Ames Ave, as seen in Figure 1. Cars both entering the driveway prior, and making right turns onto Ames Dr will cross over the skip marks. Traffic counts show a peak hourly count of 77 vehicles turning right onto Ames Dr, but the counts do not include the driveway use. This installation includes 22 skip marks in the convergence zone, and two solid blocks, a small block at the start of the lane, and a large block that extends the full length of the right turn lane.



Figure 1: PreMark Location 1

The second test site is at the entrance to the McDonalds, on the North/West bound side, and includes 14 skip marks across the entrance and exit of the restaurant. Traffic counts indicate a peak hourly count of 140 vehicles entering and 120 exiting across the intersection markings. The final site contains one skip mark (furthest east) on the opposite side of the intersection from the second site, on the South/East bound travel lane, across the driveway for the Burger King and adjacent office/medical complex. Traffic counts indicate a peak of 6 cars per hour making right turns, and likely to cross this final skip marks. The second and third PreMark sites can be seen in Figure 2.



Figure 2: PreMark Locations 2 and 3, and CycleGripMMAX Location 2.

Jeremy Crow, the Ennis-Flint representative, was instructing the L & D crew how to properly install the PreMark thermoplastic material. Installation included: brushing and blowing off the asphalt surface, applying an approved two-part sealer to remove unwanted moisture from the asphalt surface, and heating the symbols into place. When torch applying the material, he recommended slow and steady passes of the torch. The torch should be at a low to medium heat range, at approximately 4 to 8 inches above the material. Installation of the PreMark sections can be seen in Figure 3. If the torch is too hot or too close to the material surface, the material may burn, as seen in Figure 4. Skid resistance material, Corundum (Aluminum Oxide) was added to the PreMark, and settles into the material during heating. The PreMark thermoplastic material reaches the proper installation temperature when the heat indicators disappear. Both the skid resistance and heat indicator tabs can be seen in Figure 5. Jeremy emphasized that the edges of the material when properly installed should be rounded. For further installation instructions read the PreMark Application Instructions [6].



Figure 3: PreMark Installation



Figure 4: Burned PreMark



Figure 5: PreMark Skid Resistance (left) and Heat Indicator (right)

3.2. CycleGripMMAX

CycleGripMMAX was installed September 30, 2016, with an ambient temperature of 60°F. CycleGripMMAX was used in two locations in this study. The first installation contains 13 skip marks at the entrance and exit ways of the Vermont Shopping Center, as seen in Figure 6. Traffic studies show peak hourly counts of 165 entering and 105 exiting the shopping center. The second site coincides with the third installation of PreMark, with CycleGripMMAX constituting the other 12 skip marks, as show in Figure 2. Traffic studies show peak hourly counts of 54 vehicles entering and 51 exiting across the intersection skip markings.



Figure 6: CycleGripMMA Location 1

CycleGripMMA was installed after the specified 30-day waiting period following new paving. Prep work included masking the inlaid pavement marking tape, marking out the bike lane blocks and mixing the MMA compounds, catalyst and aggregate. MMA is applied with a squeegee, then back rolled with a coarse paint roller to add texture. Recommended mixing instructions and proportioning of the catalyst agent can be found in the manufacturer application instructions [7]. Ideal cure times for the CycleGripMMA product is between 20 – 60 minutes depending on the ambient temperature and moisture. The material cured at the Vermont Shopping Center intersection within 45 – 60 minutes, as it was cloudy, cool and the moisture was relatively high since it rained earlier in the morning. CycleGripMMA was mixed in 5-gallon kits, producing 50 ft² of finished product each, enough for five 2'x5' bike skips. Three 5-gallon kits were used to complete the 13 bike lane blocks at the Vermont Shopping Center Intersection. For the second site, the crews stretched the remaining two kits to cover 12 skip blocks, resulting in a need for Pre-Mark to be used on the remaining, 13th skip box. Figure 2 shows the second CycleGripMMA location along with the Pre-Mark 13th box. Photos from the installation of the CycleGripMMA can be seen in Figure 7.

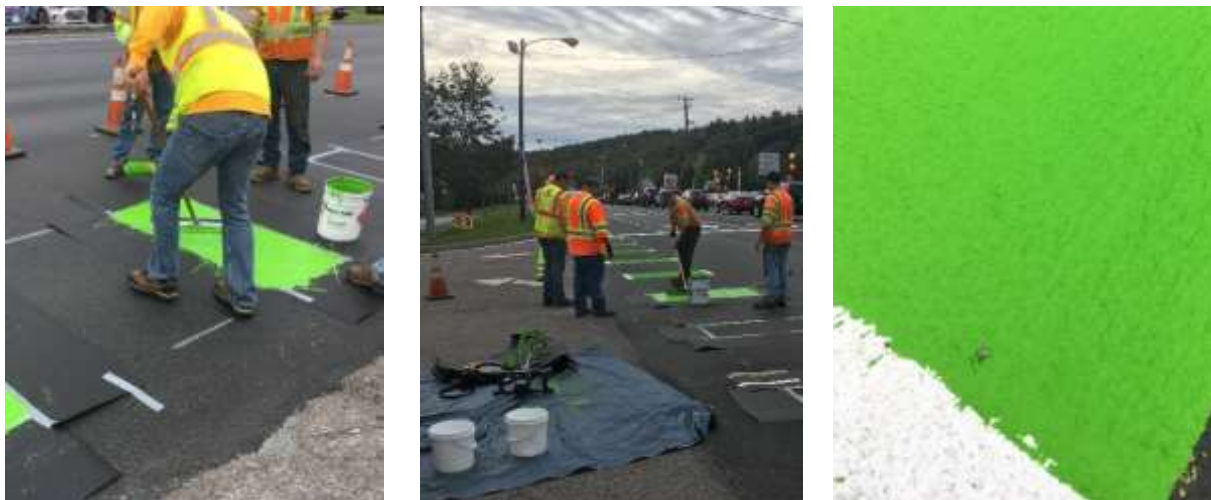


Figure 7: CycleGripMMA Installation

3.3. Color-Safe

Transpo Color-Safe MMA was installed on Oct 5, 2016, with an ambient temperature of 67 degrees. Color-Safe was used in two locations, the first being between the straight and turn lane of the North/West bound travel lane at Partridge Farm Rd, as seen in Figure 8, made up of 18 skips and a large block. Traffic studies show a peak hourly count of 20 vehicles

turning onto Partridge Farm Rd. This section includes vehicles entering the CVS Pharmacy and exiting the gas station and Sears Home Store, but are not captured in the traffic counts.



Figure 8: Color-Safe Location 1

The second location separates the turn and straight lanes of the South/East bound lane as it approaches Berlin State Hwy, shown in Figure 9. Berlin State Hwy is a heavily trafficked road, as it is the connection to I-89, and sees a large number of cars making a right turn, and crossing the bike skips frequently. Traffic studies show a peak hourly count of 193 vehicles turning right onto Berlin State Hwy. This section also includes driveways for local business offices and a car dealership lot, which are not included in the traffic counts.



Figure 9: Color-Safe Location 2

Color-safe installation is much the same as the CycleGripMMA, with masking off the skip box area, filling with a mixed MMA, squeegeeing the material into place, and back rolling to apply texture. Color-Safe was procured in a 55-gallon drum, and mixed to proportions of 2 gallons of MMA resin with 2 bags of catalyst and one bag of aggregate, based on advice from David Crowell, the Transpo representative. The amount of catalyst determines the cure time of the product and the aggregate acts as the anti-skid material. More precise mixing ratios for changing ambient temperature and other pertinent information regarding the Color-Safe bike lane material can be found on the Technical Data Sheet [8].

It took approximately 45 to 60 minutes for the Color-Safe product to cure in this location. This was due to the ambient temperature and the lack of direct sunlight. Aggregate clumps arose on two of the bike lane blocks as a result of premature curing, and were identified and removed with a chisel after curing. Installation of Color-Safe can be seen in Figure 10.



Figure 10: Color-Safe Installation

4. Performance

Observation of the Bike Lane markings occurred on October 25th, 2018. What follows below is the observed condition of each marking on a Good/Fair/Poor/Missing scale, as well as comments on the likely cause of distress.

4.1. PreMark

Observations of the first test site can be seen in Figure 11 for Good Condition, Figure 12 for PreMark in Fair Condition, and Figure 13 for Poor performing markings.



Figure 11: Location 1 PreMark in Good Condition

The first 8 skip marks and the first block are performing well and observed to be in good condition. Wear is occurring on the outside edge (nearest the traffic lane) but maintain nearly full shape. The leading edge of each is worn down, but none are chipping.



Figure 12: Location 1 PreMark in Fair Condition

The 9th through 12th, and 16th through 22nd skip marks are observed to be in fair condition, as is the beginning of the large block. Traffic wear has begun to affect the markings, with some spots of nearly full wear. No chipping is occurring, and the PreMark is well bonded to the pavement.

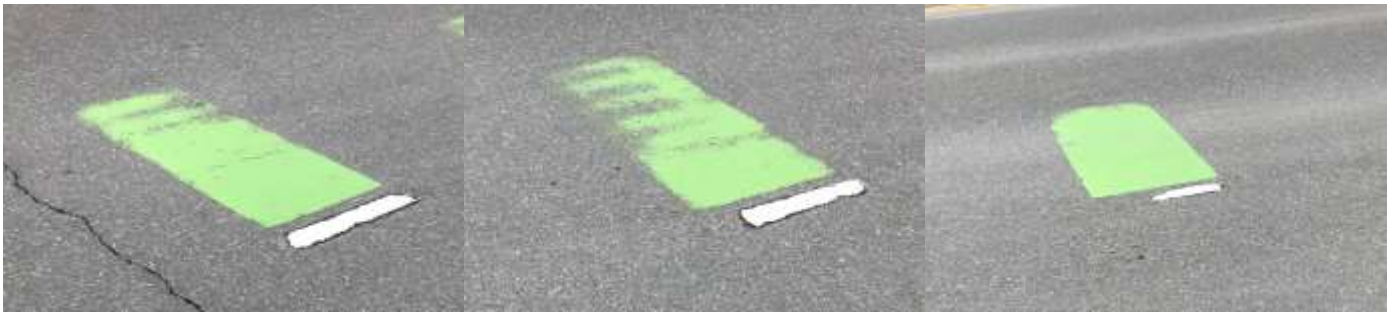


Figure 13: Location 1 PreMark in Poor Condition

The 13th through 15th skip marks are in poor condition. They have lost some coverage area, have worn fully through, and do not clearly define the bike lane. No chipping is occurring, all damage is from traffic wear.

A broader view of the first PreMark section can be seen in below. Overall, the first PreMark site is performing well, with some wear at the places with the highest cross-over traffic. The PreMark is well bonded to the pavement, and seems to have no issue with differential expansion that may result in premature failure.



Figure 14: PreMark Condition Location 1

The second installation of PreMark can be seen in Figure 15. Of the 14 skip blocks, 6 are in Good Condition (1, 2, 3, 6, 7, 8), 2 are in Fair Condition (4, 9), 5 are in Poor Condition (5, 10, 11, 12, 14), and block 13 is Missing.

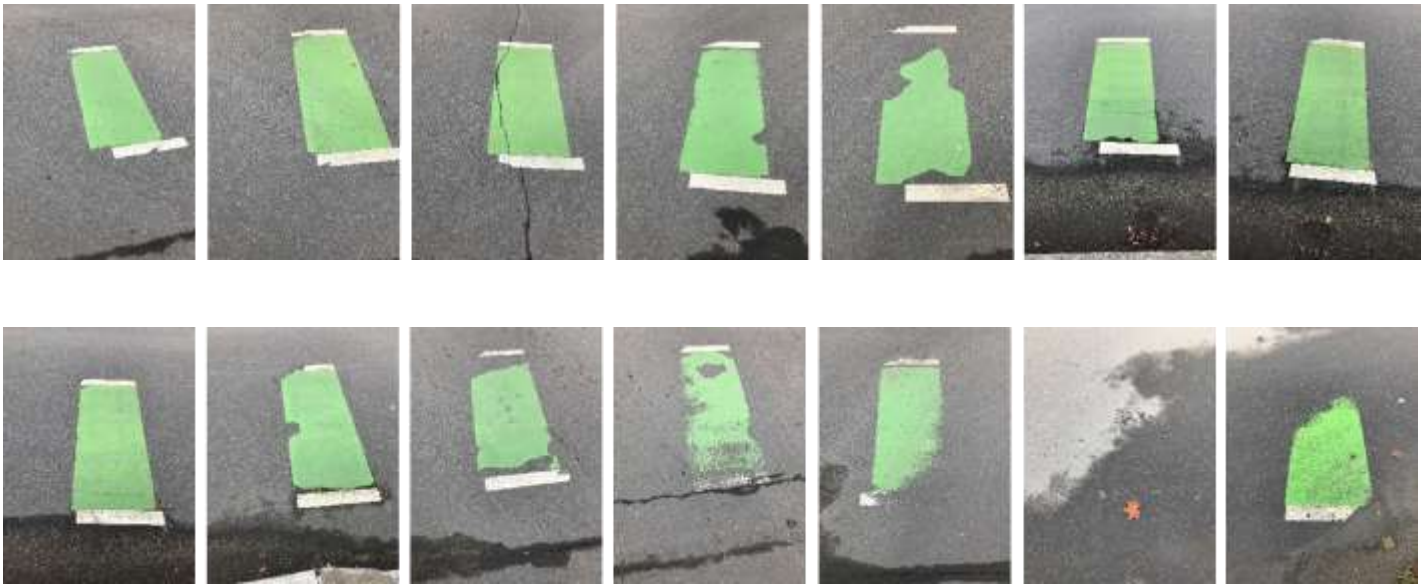


Figure 15: PreMark Condition Location 2

Several of the blocks are chipping, cracking, and delaminating, likely due to differential expansion with the pavement, and are easily removed. Several blocks show heavy wear, mainly blocks 11-14, which are located at the exit of the McDonalds, including block 13 which has been complete worn away. Overall, the PreMark installations in the second location are performing worse than the first location, and are the worst green markings in the study. Cracking and delamination are likely to rapidly deteriorate several of the blocks this winter, shown close up in Figure 16 below. The presence of moisture is indicative of a delaminating element, as the moisture in the voids is the last to evaporate post precipitation event, and further degrade the marking as freeze-thaw takes effect in the winter months.



Figure 16: PreMark Delamination

The third PreMark site, the lone skip on the opposite side of this road from the second, is performing poorly, as shown in Figure 17. The marking is very worn over its entire area, as a result of heavy turning traffic from those exiting to the right.



Figure 17: PreMark Condition Location 3

4.2. CycleGripMMAX

The first installation of CycleGripMMAX, located at the Vermont Shopping Center contains 13 skip marks. Condition observations for CycleGripMMAX include six skips in Good (3, 4, 5, 8, 9, 13), five in Fair (1, 2, 6, 10, 12), two in Poor condition (7 and 11), and none missing. Photo observation can be seen in Figure 18 below. The most worn marks, numbers 7 and 11 are located in the turn tracks of cars entering and exiting the shopping center. The damage appears to be from wear, and there is no evidence of cracking, chipping, or delamination. Overall, the markings at location 1 are in a fair condition, showing wear and reduction in covered area, but maintaining functionality on most skips.

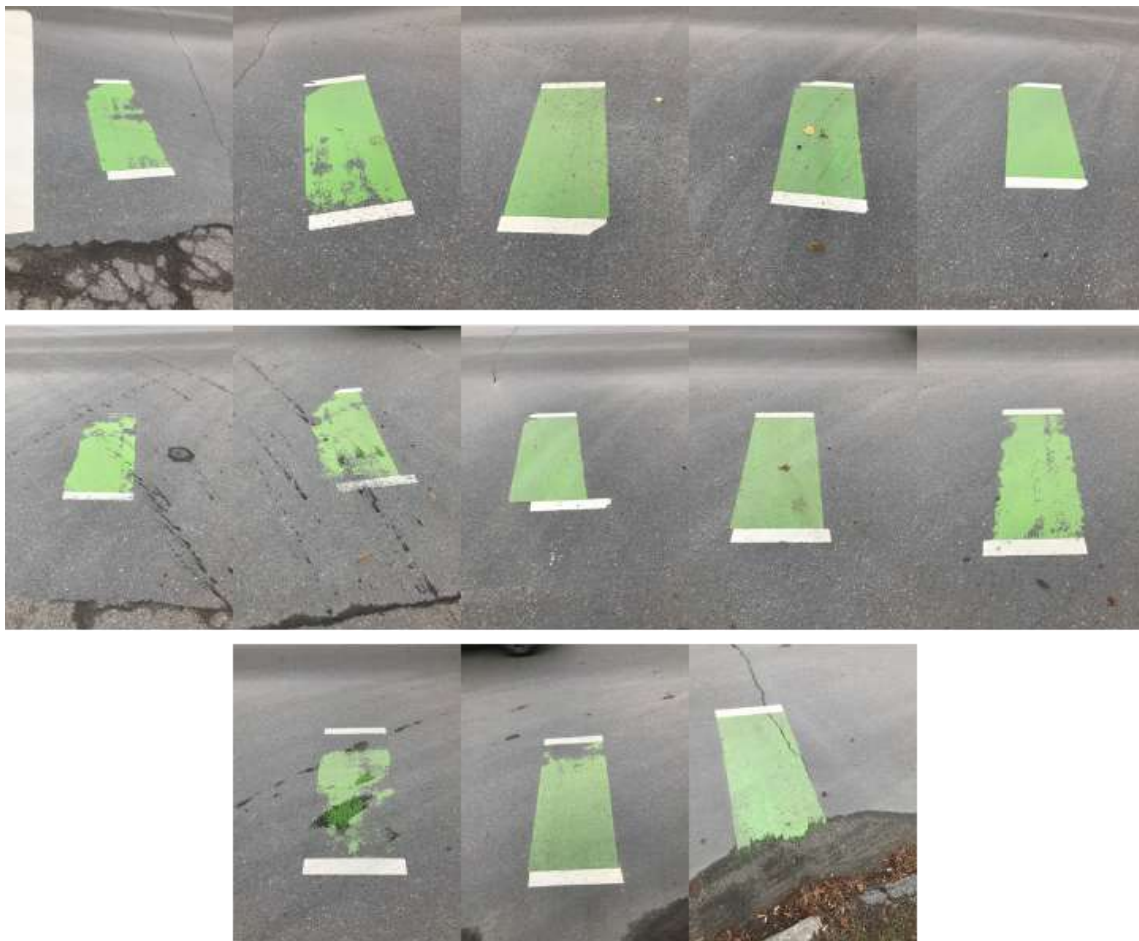


Figure 18: CycleGripMMAX Condition Location 1

CycleGripMMAX in the second location, crossing the driveway for the medical offices and Burger King, can be seen in Figure 19. Field observations show that the skip mark conditions are: seven Good (1, 2, 3, 6, 7, 8, 11), four Fair (4, 5, 10, 12), one Poor (9), and none missing. The minor damage is all from wearing, with no chipping, cracking, or delamination. The 13th skip in this location is PreMark, and performing poorly as described and shown above. Overall the CycleGripMMAX in location 2 is in Good condition, showing its durability and quality.



Figure 19: CycleGripMMAX Condition Location 2

4.3. Color-Safe

Color-Safe was used in two locations, the first utilizing 18 skip marks and a large box in front of CVS. All 18 of the skip boxes are in Good condition, as seen below in Figure 20. The large block is in good condition, with some minor wear under tire tracks, as vehicles ride the markings line, an example shown in Figure 20.

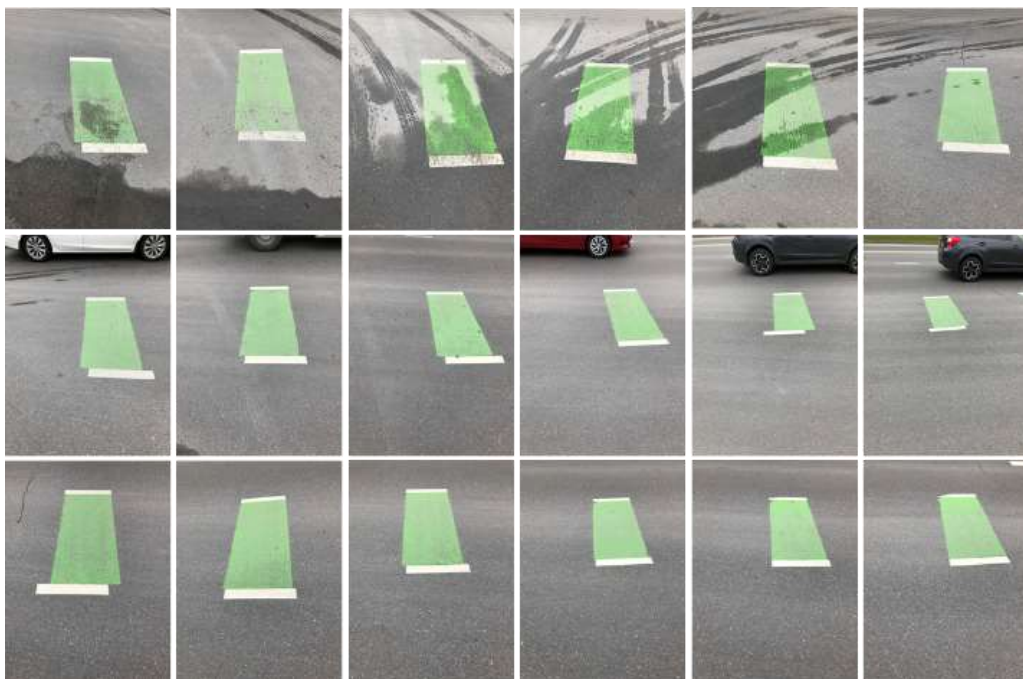


Figure 20: Color-Safe Condition Location 1



Figure 21: Color-Safe Block

The second site of Color-Safe is between the straight and turn lane approaching Berlin State Hwy, and contains 23 skip boxes. Observation shows the skip mark conditions to be: ten Good (1, 2, 3, 4, 7, 8, 9, 10, 11), with the remaining 13 in Fair condition, and can be seen in Figure 22. The Color-Safe in location 2 is performing well, and is in good and fair condition. The wear present is from heavy traffic, likely the highest of all test sites, as Berlin State Hwy leads to Interstate 89.

5. Comparison of Results

This project includes three types of Green Bike Lane markings, and observations of their condition after two years of service. The Color-Safe MMA is performing the best in both of its applications, followed by the CycleGripMMAX, and PreMark having the worst performance. PreMark is wearing faster than both MMA products, and also has shown signs of cracking, chipping, and delamination in its second location in front of McDonalds. Between the two MMA products, the CycleGripMMAX is installed in tighter turning locations, the entrance and exit of side roads and driveways; while the Color-Safe is only used to separate turn lanes, and sees fewer tight low speed turns. Perhaps as a result of this, CycleGripMMAX has shown greater wear and its condition is inferior to Color-Safe.

In situations that are similar, Color-Safe is outperforming PreMark when separating lanes approaching an intersection. This type of use sees lots of merging and lane change, but little tight turning.

In sites that cross intersections of adjacent roads and driveways, all at perpendicular alignment, CycleGripMMAX is outperforming PreMark. CycleGripMMAX has less wear, no cracking or delaminating, and maintaining its full coverage in a larger number of places.

CycleGripMMAX and Color-Safe are very similar products, follow similar application practices, and appear similar in the field. Color-Safe appears to have better outcomes so far, though the applications are different. Color-Safe has more texture remaining and retained a greater depth/thickness of material. Based on results observed, MMA green bike material should be explored for future bike lane markings, when cost, time to use, and environmental factors permit.

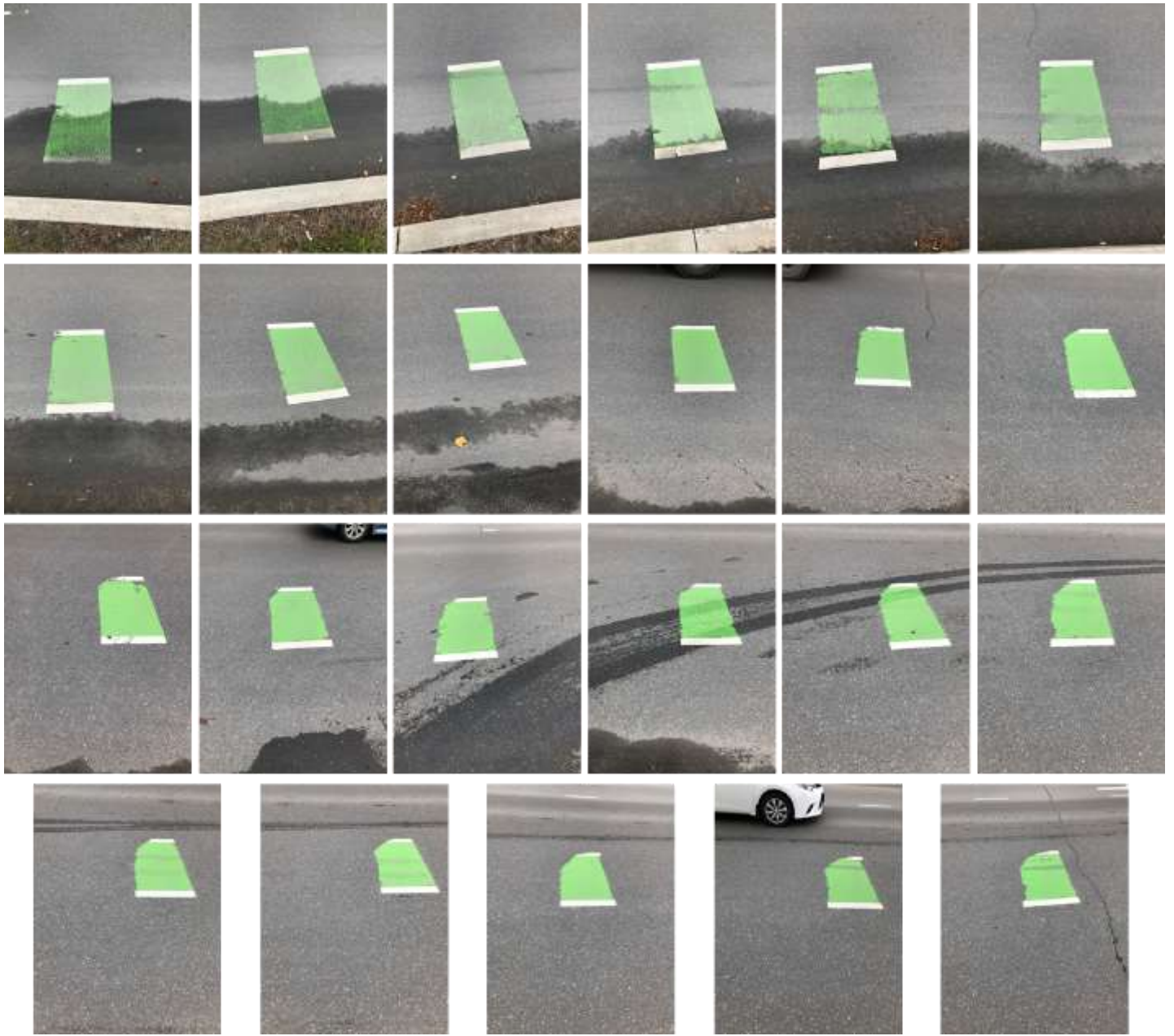


Figure 22: Color-Safe Condition Location 2

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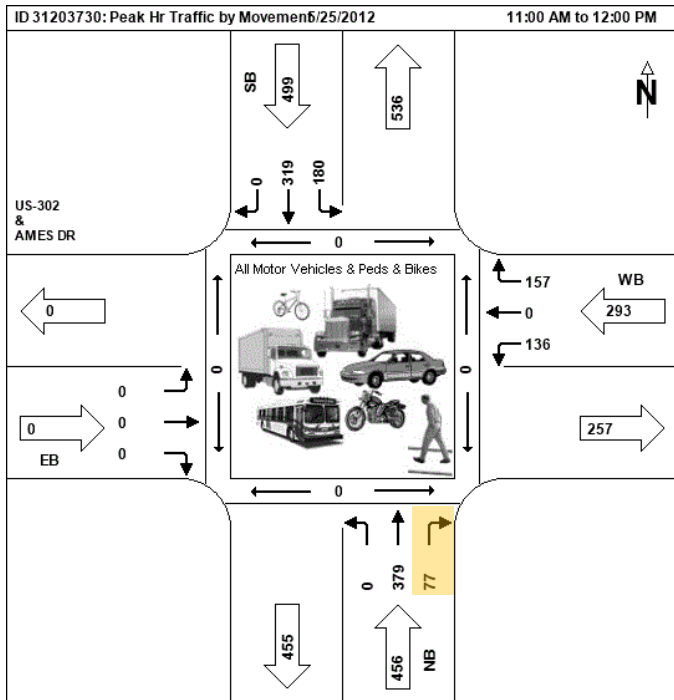
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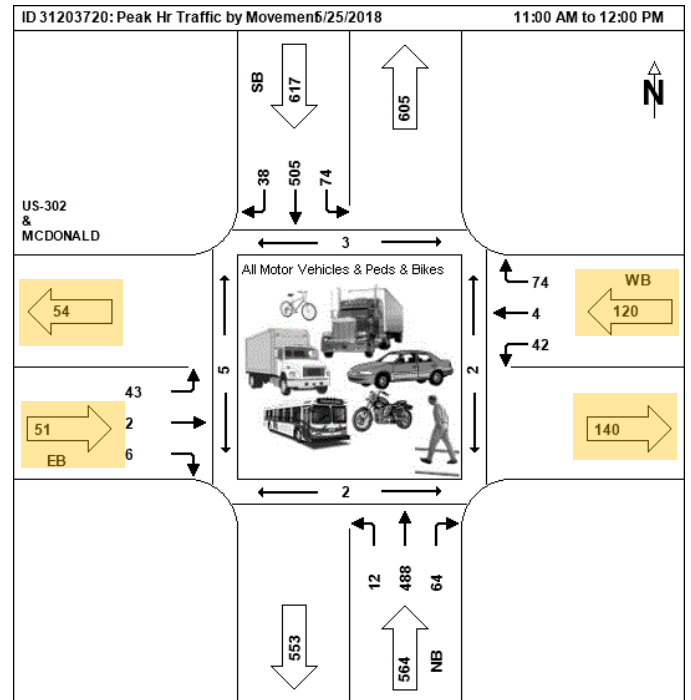
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7. Appendix A

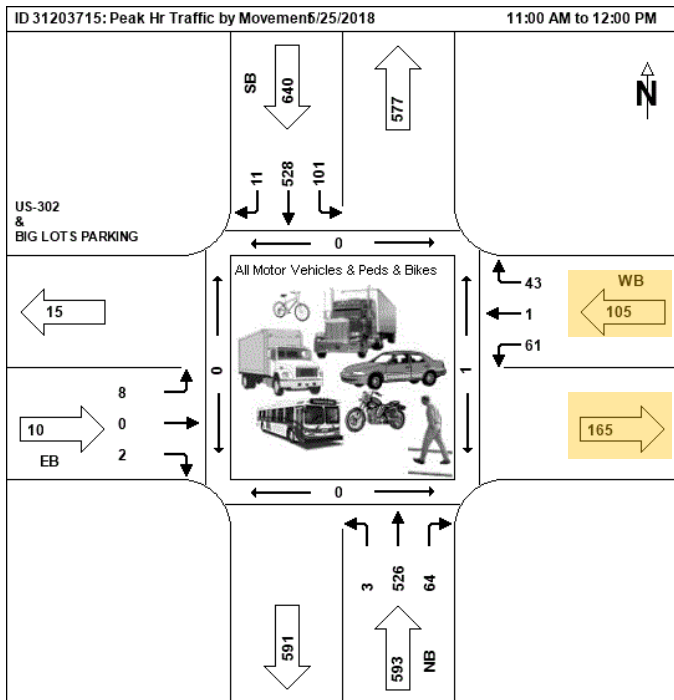
Ames Dr – PreMark Location 1



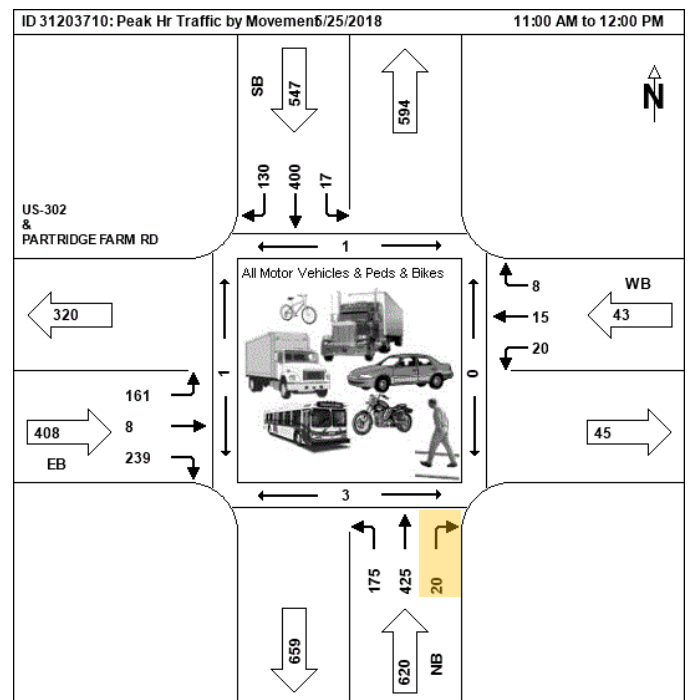
Burger King /McDonalds – PreMark Location 2 and 3 and CycleGripMMAx Location 2



Vermont Shopping Center – CycleGripMMAx Location 1



Partridge Farm Rd – Color-Safe Location 1



Berlin State Hwy – Color-Safe Location 2

