

EXPERIMENTAL PROJECTS CONSTRUCTION AND EVALUATION REPORT

Evaluation of Durable Traffic Pavement Marking Tape (PMT)

Location: Lewis & Clark County, Helena; Great Falls District:
Highway 12 (N-8) – Intersections of Euclid/West Lyndale-
West Benton Ave. and Last Chance Gulch (North Main) &
West Lyndale

Project Name: Lyndale Intersections

Project Number: 311172

Experimental Project: MT-14-02

Type of Project: Pavement Markings Application

Principal Investigator: Craig Abernathy: Experimental Project Manager (ExPM)

Technical Contact: Doug McBroom: MDT Maintenance Operations

Contractor: Highmark Traffic Services Inc.

Date of Installation: June 2014

Description

Keeping pavement markings sustainable on concrete pavement intersections in the state of Montana is a challenge in areas of high traffic. Typically epoxy markings will start to degrade within two months, with total failure occurring between 14-18 months. Waterborne paint performs even worse, typically only getting about three months of life.

This shortened lifespan costs the Department time resources and money. The Maintenance Division initiated the installation two types of pavement marking tapes on two portland cement concrete pavement (PCCP) intersections to determine their durability; Lyndale Ave. and Last Chance Gulch with a 2012 average annual daily traffic (AADT) of 21,000, and Lyndale Ave/Euclid. and West Benton Ave. which has an AADT of 24,700.

Experimental Design

Tape applications will include longitudinal markings; centerline, turn lanes, arrows, and

legends etc. for each intersection.

The chosen products are the Swarco Director 35 Intersection Grade Permanent Pavement Marking Tape and 3M's Stamark Pavement Marking Tape (the 3M product 380-5IES will be used for the skip lines; N380 will be used for transverse lines; and for all others, 380IES will be used for long lines, symbols and legends).

The Lyndale and Benton intersection; designated as test site 1 (TS1), will receive the Director 35 treatment. The Lyndale and Last Chance Gulch intersection; designated as test site 2 (TS2), will receive the 3M treatment.

The tape pavement surface configurations will receive a groove depth of 100 mils (+/- 10 mils).

Evaluation Procedures

Installation Documentation: The Research Section, in consultation with Maintenance staff on site, will document the installation phases involving preparation of the sites, equipment used, PMT placement, specification conformance etc.,

The markings shall be applied in accordance with the manufacturer's installation instructions. Marking configurations shall be in accordance with the "Manual on Uniform Traffic Control Devices (MUTCD)."

Post Documentation: The Research Section will conduct site visits from mid-June to October to inspect markings integrity; after that, monthly inspections will be conducted for the next three months. Semi-annual inspections will then be in place. Additional site inspections will be added as needed.

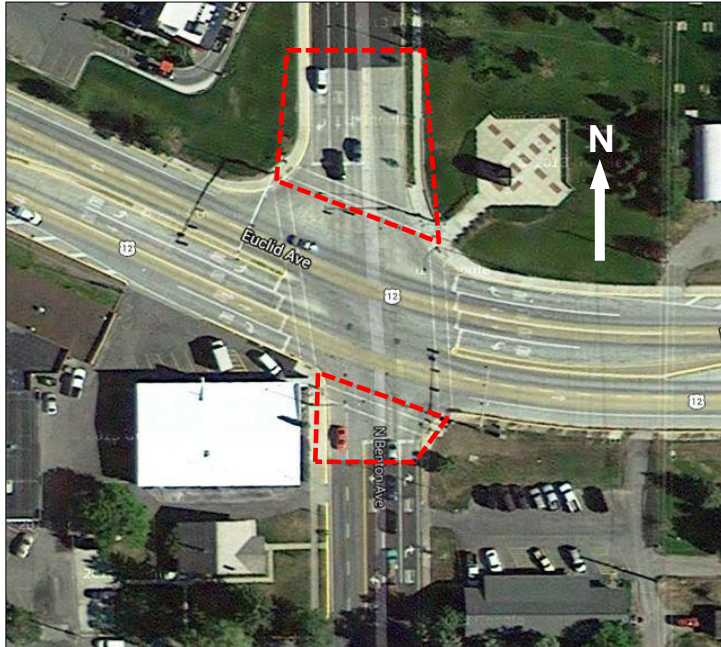
The Maintenance Division will be responsible for the compilation of retro-reflectivity readings of the applied tape at initial placement and at a post-sampling of 3, 6, 9, 18, 24, 36, 48, and 60 months for inclusion into the annual and final reports.

Evaluation Schedule

Research will monitor and report on performance for a period up to five years annually. This is in accordance with the Department's "Experimental Project Procedures". Delivery of a construction/installation report, interim, annual or semi-annual reports is required as well as a final project report (responsibility of Research). A web page will be dedicated to display all reporting from the project.

2014:	Installation Report
2015-2018:	Semi-Annual Inspections/ Annual Evaluation Reports
2019:	Final Evaluation/Final Report

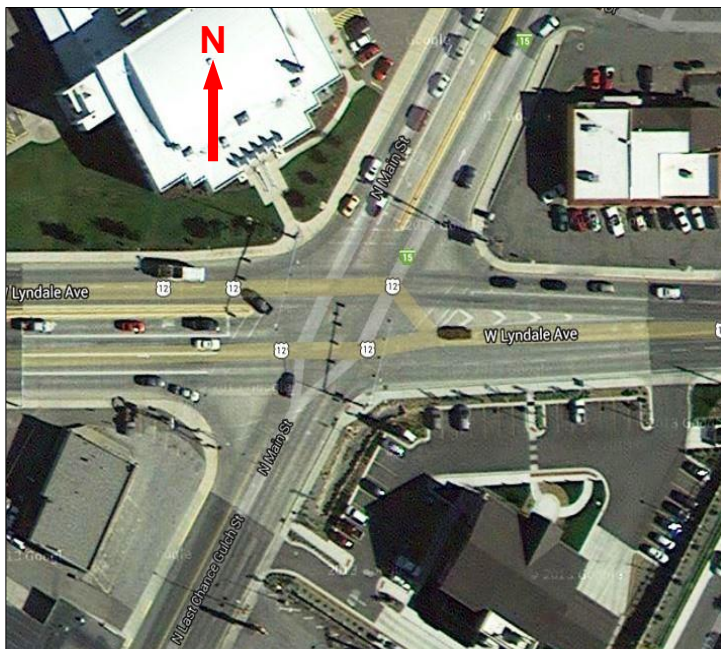
Project Location: Lewis & Clark County – Helena Montana



← Overview view of the Euclid/Lyndale & North Benton Ave. Intersection (TS1).

This site received the Swarco Director 35 tape application installed on June 10.

Note the areas of the N. Benton Ave. intersection denoted by the red dash received the 3M Stamark pavement tape approximately one month after the Swarco installation.



← Overview view of the Lyndale & Last Chance Gulch Intersection (TS2).

This site received the 3M Stamark tape application installed on June 3.

Project Information

The purpose of an experimental projects report is to document the phases and events of any given experimental feature to provide the reader with an understanding of the specific activities required to install or incorporate the research element into an active construction or maintenance project.

This report also establishes a baseline for defining performance for any given feature under actual service conditions to determine its relative merits.

Input from MDT staff and contractor during the installation of the 3M and Swarco products reported the project went well with no significant construction issues occurred during placement that may affect tape performance. The contractor followed the manufacturers tape application instructions for each installation. The Swarco installation did have an issue with a noncompliant MUTCD standard regarding a legend which was modified in the field.

Several site visits were conducted within a week after placement with both products. During these informal inspections minor tearing and delamination were evident. The first formal documentation of the project occurred on June 18, with eight additional site inspections, the last being on October 15.

Several weeks after installation, turning movements involving heavy or long trailered vehicles seemed to initiate the first sign of distress (stretching/tearing and delamination of tape to pavement surface) to the pedestrian lines first documented on the 3M site then approximately a week later at the Swarco installation.

Secondly tearing (or shearing) and delamination of the tape(s) appeared to happen upon sudden braking from direct contact of vehicle wheel to tape. Upon successive site inspections this type of distress progressed over time as represented in this report.

Retroreflectivity readings will be added to this report as they become available.

Pavement marking durability is affected by material characteristics, traffic volumes, weather, and location geometrics. The information presented in this report will attempt to show current performance for both products over the duration of the analysis.

Pages 5-16: Represents the general examples of the application practice involved with the 3M and Swarco tape installations.

Pages 17-18: Description of tape performance to date.

Pages 19-31: Visual examples of tape distress since installation of June 2014 to April 2016.

Pages 32 & 33: Overview maps showing frequency and location of documented distress from installation to March 2015. These descriptions are strictly for reference and are not to scale.

3M's Stamark Pavement Marking Tape: Lyndale and Last Chance Gulch – 06/03/2014



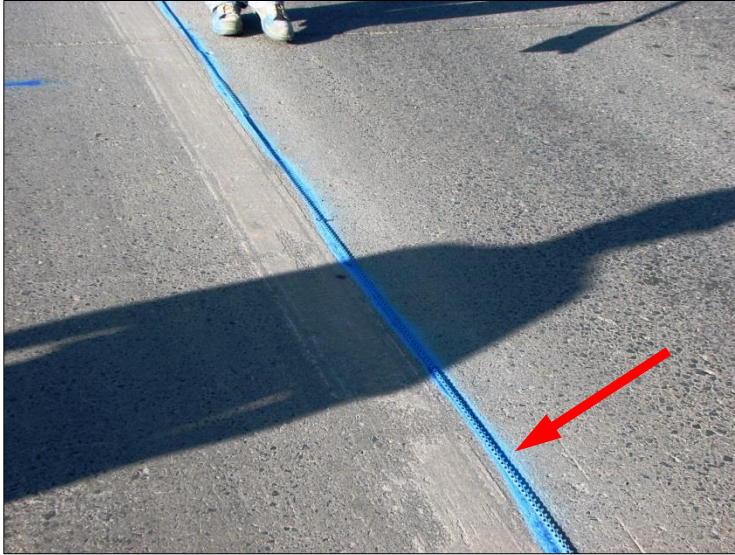
← A rubber template is placed on the pavement surface for the arrow (as well as symbols) application.



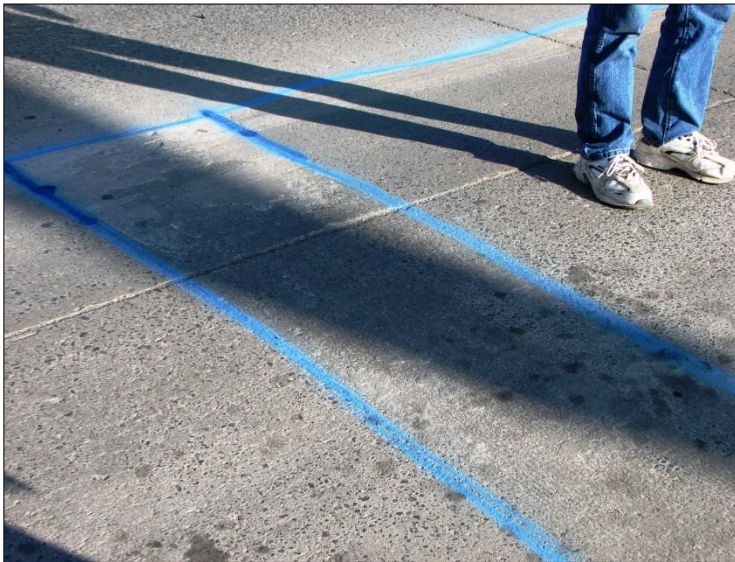
← Paint is used to outline the template on the pavement surface.



← With the outline complete the arrow is ready for the grinding application.



← ↓ For linear or straight lines, a chain is used to direct where the paint outline is to be applied (red arrow).



← A stop bar outlined for grooving.

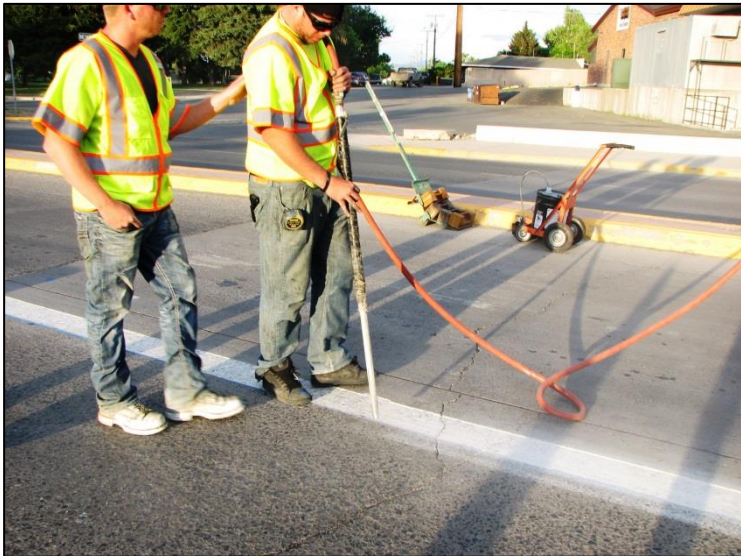


← The contractor used a groover calibrated to cut the appropriate depth (100 mils, +/- 10 mils) for all arrows and legends on the project.

This equipment also vacuums and collects the concrete dust during grinding.



← Representative image of the grooved surface approximately 7" (17.78cm) in width.



← Compressed air is used to further clean grooved surfaces.



← Here the grooving machine starts the grinding of the arrow.



← In areas where the grooving machine deposited oil on the surface of the grind; the contractor used spray solvent to remove the oil prior to the application of the Stamark Contact Cement E-44T.



← Contact cement is applied with 1-2" overlap using a spray applicator cart.

The cement may also be applied using a conventional paint roller.



← The contact cement is left to set and determined ready by the contractor when the cement exhibits no visible stringing when touch by a fingertip.



← The arrow symbols (as seen in the image) and word legends are separated precut panels which have a backing that is peeled away prior to placement on the prepared surface.

The contractor seats the sections of tape and tamps the seams as tight as possible.



← Those seams which may overlap are trimmed with a utility knife for a tighter fit.



← Rectilinear tape (lane dividers, stop bars, etc.) are spooled directly off a roll and cut to length.

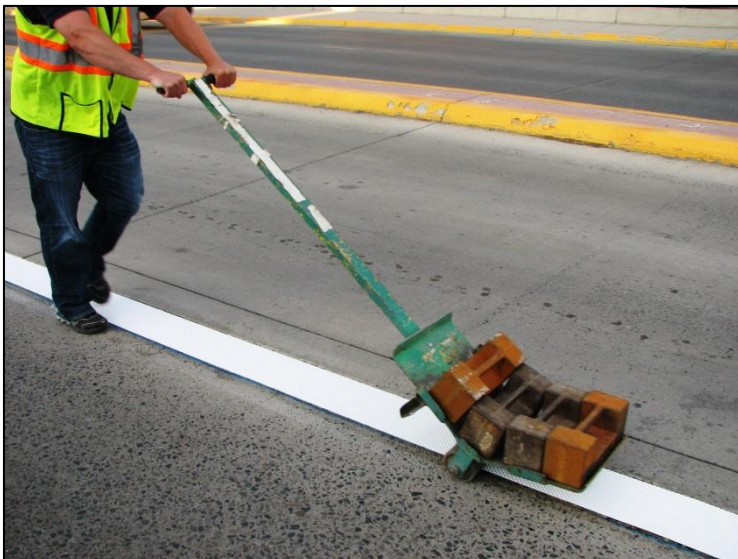


← Example application of a stop bar placement.



← Those markings positioned over pavement joints are cut roughly 1" on either side of the joint (red dash lines).

This procedure was also used on the Swarco Director 35 application.



← A roller tamping cart with a 200lb. load is used to firmly set the tape to the roadway surface. Care is taken not to twist or turn the cart during tamping.

Back and forth passes from a frequency 3 to 6 based on the width and type of tape being tamped.



← An example of the weighted roller cart tamping an arrow.



← Bordered contrast broken line markers were included on the site as lane dividers.

Swarco Director 25 Marking Tape: Euclid & W. Lyndale – 06/10/2014



← In this image the intersection stop bars are grooved with the same equipment used for the 3M application.



← Example of a completed grooved ONLY legend.



← Sample image of a completed grooved arrow.



← Note that the cross hatch lines (eastbound/west side Euclid) were not placed directly to the curb but at halfway (red arrows).



← Prior to the application of the contact cement the grooved surfaces are air-blasted of dust and debris.



← A workman, in the background, applies the (CC-4S) contact cement to an ONLY legend while segmented tape sections are being laid out for placement.



← Legend segments have a peel off backing and then place approximately on the grooved prepared surface.



← The ONLY legends did not meet the Manual on Uniform Traffic Control Devices (MUTCD) requirements and had to be modified in the field.

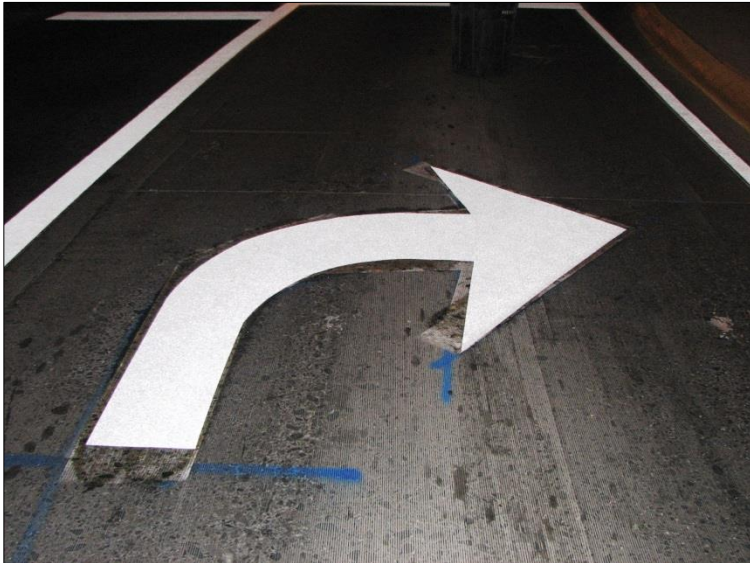
Here you can see the gap in the letters needed to make the legend in compliance.



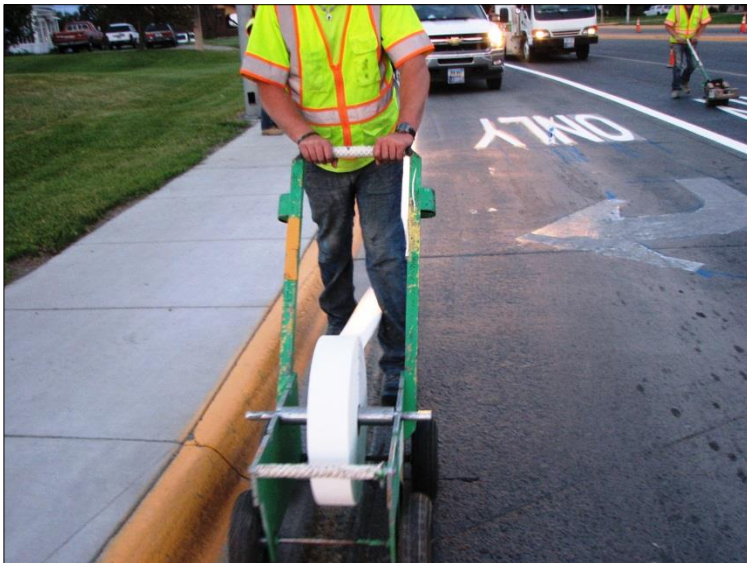
← A cut and paste approach was used to modify the markings.



← Example of an arrow legend positioning.



← Completed arrow placement.



← A tape applicator cart was used for some of the long lines.



← For other long lines they were rolled out by hand.



← All marking applications were tamped with a 200 lb. roller cart.

It was observed while during tamping the cart would track up reflective beads on the roller.



← Note that the contractor elected to install a section of Methyl Methacrylate (MMA) at the eastside pedestrian crosswalk marking, westbound West Lyndale Ave. and North Benton Ave.

The length of MMA runs approximately 37' of the pedestrian line.

Material Performance to date: October 2014

Pages 19-24 represents general examples of tape distress for both product locations. Images presented in this section will not document every area on the intersections that exhibit distress but will show examples of the type of damage taking place since installation and up to October 15.

This report will include an overview map denoting documented areas of tape distress to give the reader a general knowledge of the frequency and location of tape damage. The map does not represent severity or type of tape distress, and is strictly for reference.

As stated earlier in the report, tape damage first appeared at areas of turning movement, and then progressed to sections such as pedestrian lines, stop bars and legends.

Material Performance to date: March 2015

Pages 25-26 have several examples of the general condition of the two test products since the mid-October documentation.

Transverse markings (including word and symbol markings, arrows, stop bars, crosswalk bars, etc.) are most affected by tire to tape contact at turning movements within the intersection. Friction deterioration also affects the integrity of the tape due to stop and start actions of the vehicles.

With the Swarco Director 35 tape, once delamination begins due to cyclic stresses the deterioration appears continuous. The 3M Stamark tape seems to be less prone to delamination distress, but is susceptible to excessive wear at areas where the frequency of contact with tire to tape is pronounced.

Areas of the intersection (for both test products) which have the least documented distress are the edge and skip lines located away from the general intersections where vehicle contact to the tape is at a minimum.

Material Performance to date: May 2016

Pages 27-31 represent the general condition of the PMT sections since installation in 2014. As in earlier inspections, vehicle traffic patterns affect the durability of the tape where frequency of tire to tape contact has a direct effect on tape durability.

The Swarco Director 25 product appears to have the greatest tendency for adhesion failure to direct delamination (or debonding) from the pavement as well as vehicle tires wearing down of the tape surface to the base pavement. As noted in this report, the Swarco product was applied correctly with no installation issue that may have affected the efficacy of the performance.

For the most part the 3M Stamark tape does not suffer from delamination issues, and the main cause of tape failure appears to be uneven wear of direct impact by vehicles tires.

During observations at night with dry conditions, both test sections exhibit a greater radiance than the adjacent conventional pavement markings. During nighttime wet

conditions the difference of radiance of the test and adjacent markings are indistinguishable.

As stated in the report those pavement markings such as white lines and center skip lines away from the general intersections are in good condition. The 3M bordered contrast tape (white with black border) is also in good condition.

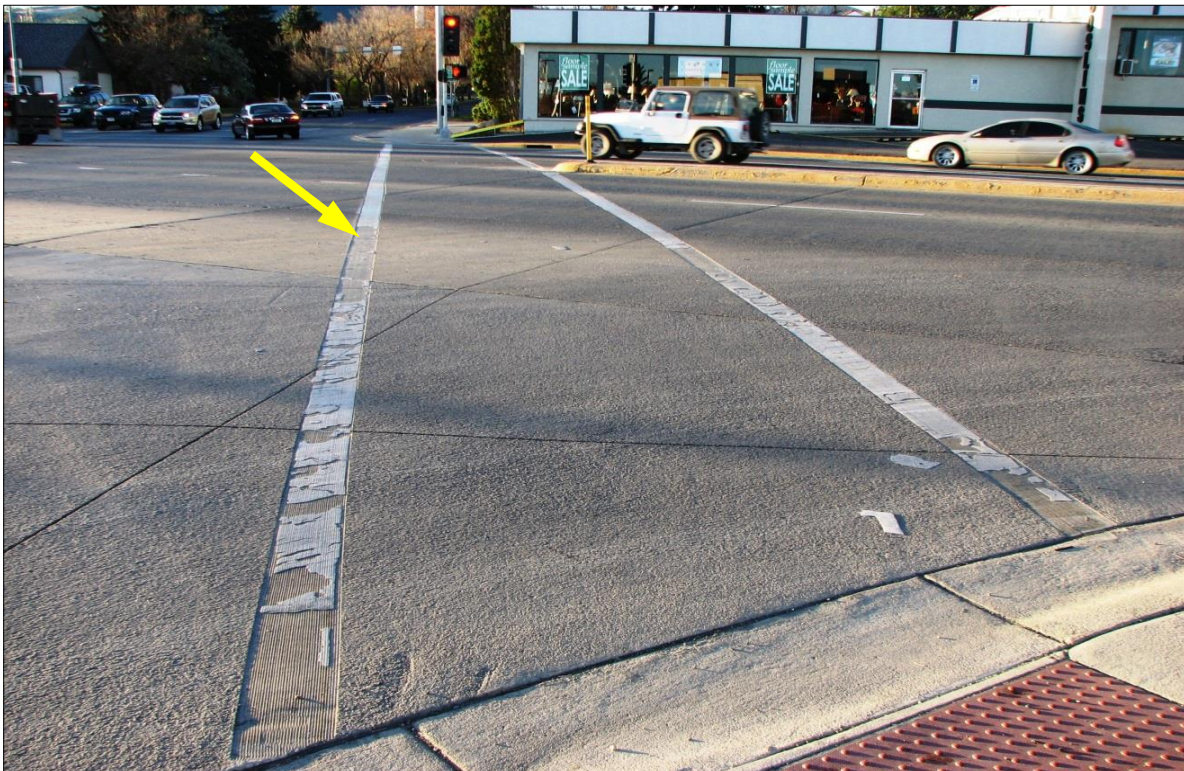
To date; the 3M Stamark tape appears to be a more durable than the Swarco product with the issue of tape delamination (or debonding) from the pavement surface.

Swarco Director 25: Euclid Ave. & West Lyndale Ave. – October 2014



↑ Image of Euclid Ave: westbound, west side pedestrian lines shortly after installation.

↓ Same location approximately 4 months after installation. Initial tearing and delamination began in the travel lane (yellow arrow) and progressed to the curb.



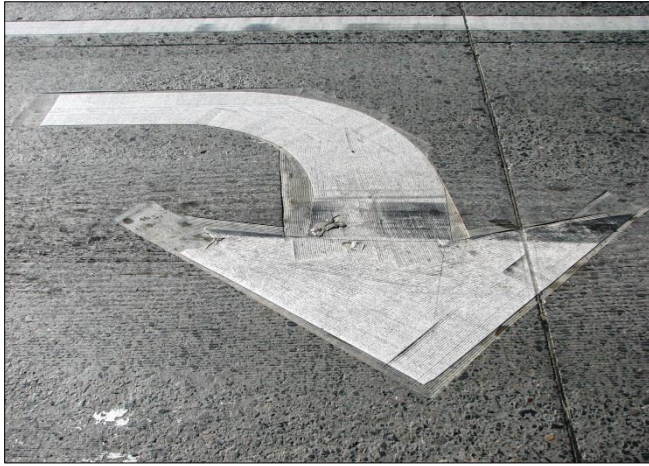


← A closer view of the pedestrian line tape damage.

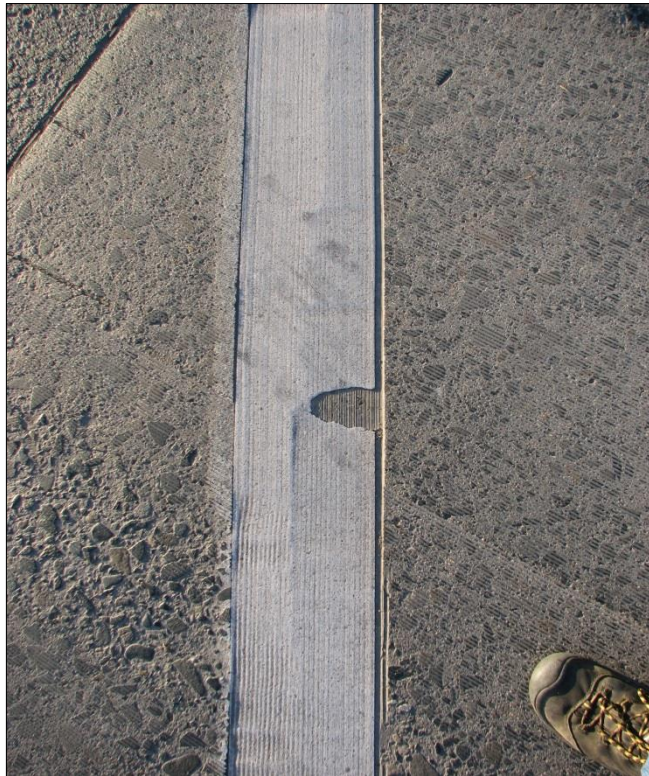
Once the tape cracked or tore continuous vehicle traffic would eventually cause the tape to separate from the grooved pavement.



← An example of a torn section of tape on an edge line.



↩️⬇️ More examples of the type of tape distress with the Swarco project.



3M Stamark: W. Lyndale Ave. & Last Chance Gulch (North Main St.) – October 2014



↑ Image of West Lyndale: westbound, west side pedestrian lines shortly after installation.

↓ Right turn from West Lyndale onto Last Chance Gulch: Turning movements are stretching and tearing the pedestrian lines.





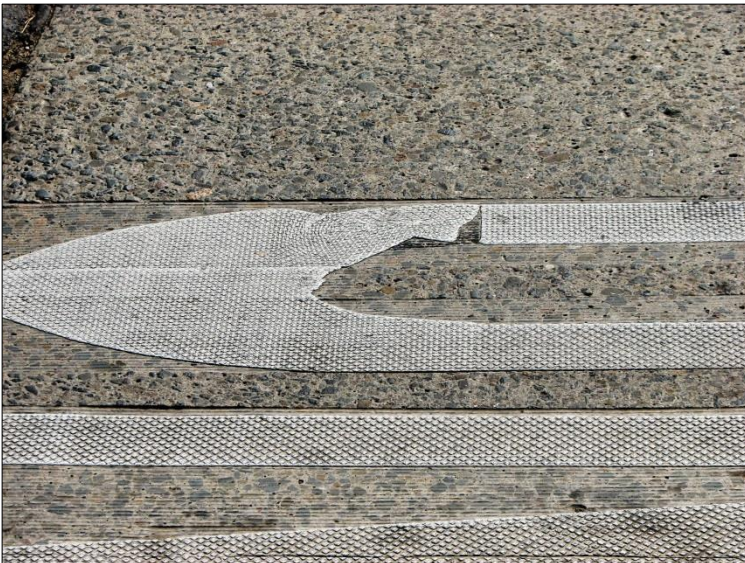
← Sample image of a friction tear most likely caused by sudden braking of a vehicle.



← Damaged caused by sudden braking by a vehicle is apparent in this image.



↙ More examples of the type of tape distress with the 3M Stamark project.



Swarco Director 25: Euclid Ave. & West Lyndale Ave. – March 2015



← ↑ As seen in earlier inspections, the pavement tape continues to degrade especially in areas with the most direct tire to tape contact.

3M Stamark: W. Lyndale Ave. & Last Chance Gulch (North Main St.) – March 2015



← ↑ General representation of continued pavement tape deterioration.

Swarco Director 25: Euclid Ave. & West Lyndale Ave. – April 2016



← General visual examples of the condition of the pavement marking at various areas of the intersection since installation in the summer of 2014.

Debonding (or delamination) of material is the most prevalent form of distress, secondary would be uneven tape wear.

← Euclid Ave., eastbound – west end of intersection.



← West Lyndale Ave., westbound – east end of intersection.



← Euclid Ave., westbound – west end of intersection.

3M Stamark: W. Lyndale Ave. & Last Chance Gulch (North Main St.) – April 2016



← General visual examples of the condition of the pavement marking at various areas of the intersection since installation in the summer of 2014.

The main distress feature is direct wearing of the tape due to vehicle traffic.

← N. Last Chance Gulch, northbound – south end of intersection.



← W. Lyndale Ave., eastbound – west end of intersection.

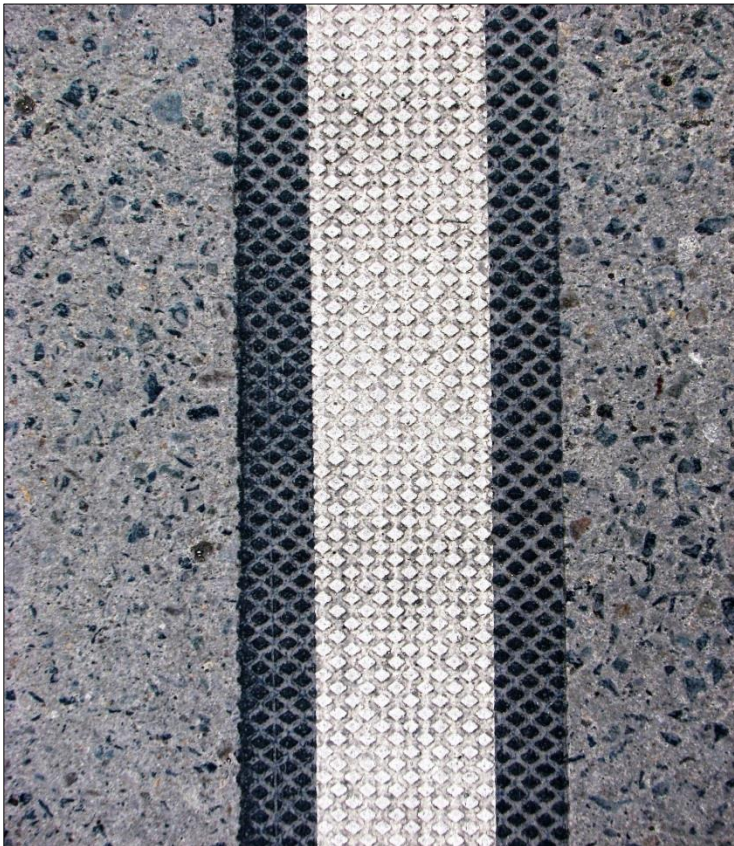


← W. Lyndale Ave., westbound – east end of intersection.

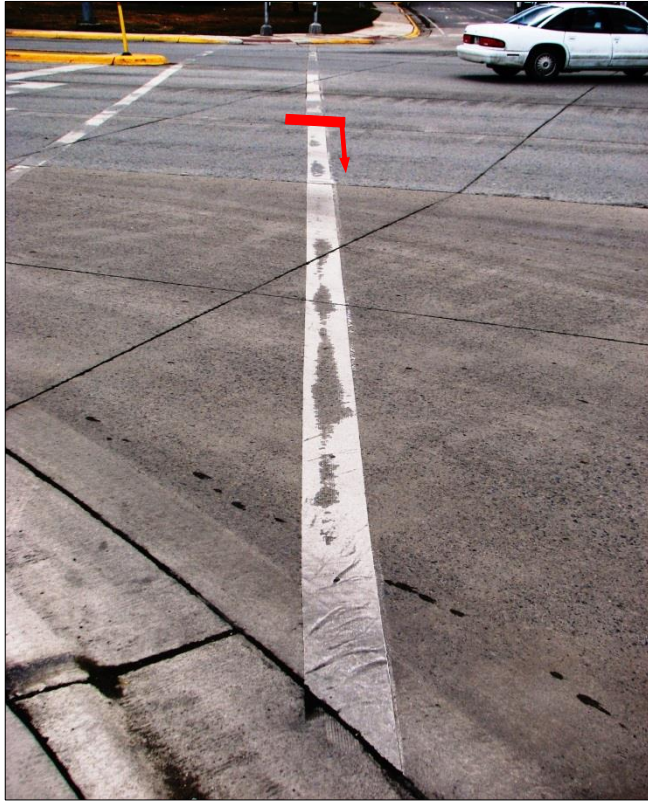
Supplemental



↙↘ 3M's contrast striping skip lines (or dotted lines) are in good condition since applied in the summer of 2014.



Supplemental



↙ West Lyndale Ave. – westbound,
east end of intersection:

During the Swarco installation the contractor elected to apply a section of Methyl Methacrylate (MMA) to the crosswalk bar.

The image below was taken in the summer of 2014. The image to the left was taken in the spring of 2016.



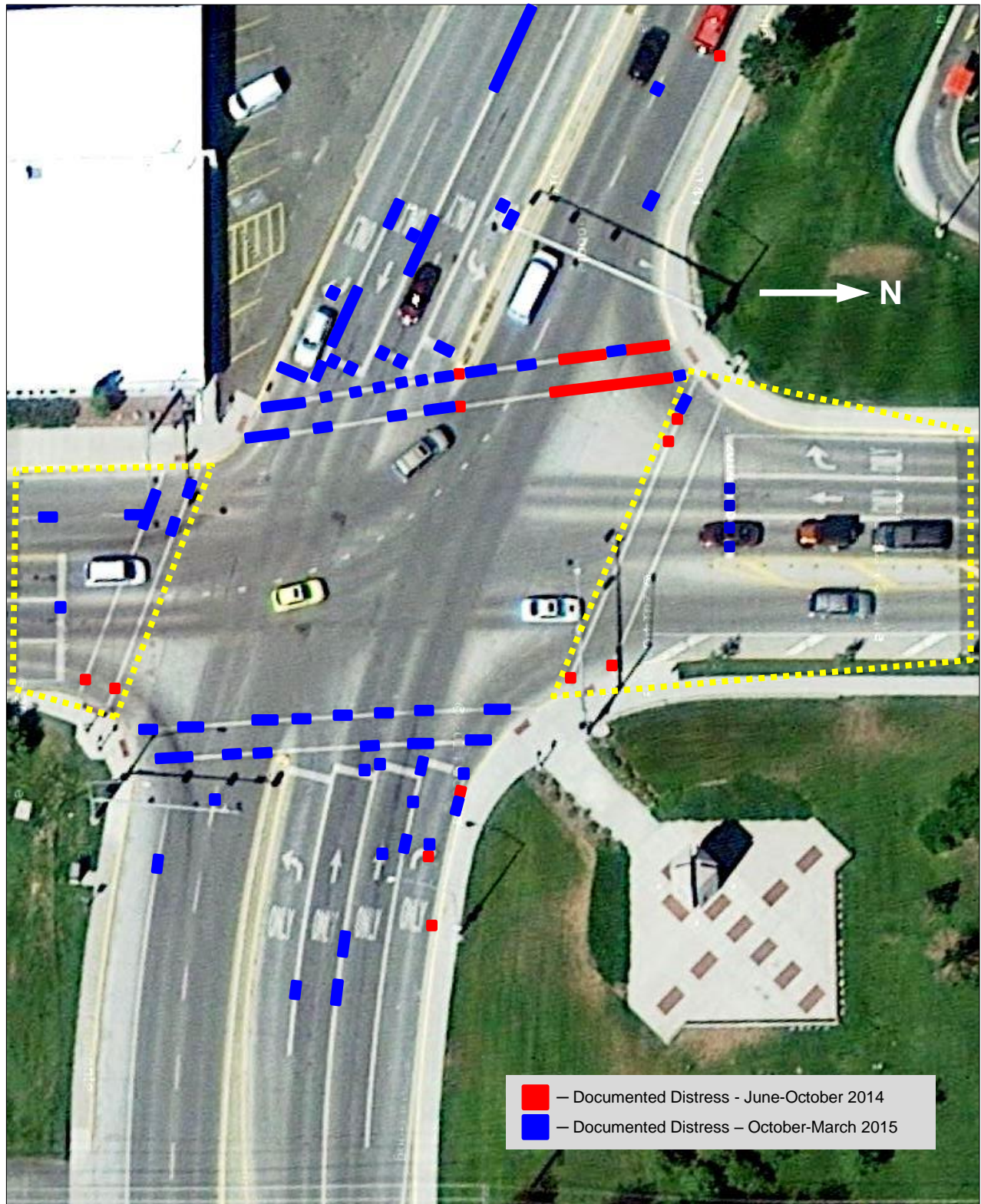
Supplemental

Pavement lines such as the example below of the 4" white edge line/broken lines Swarco tape (and as applicable with the 3M Stamark) where tire to tape contact is at a minimum, or not subjected to stop and start friction as related to the transverse markings; are generally in good condition at both project sites since installation in 2014.



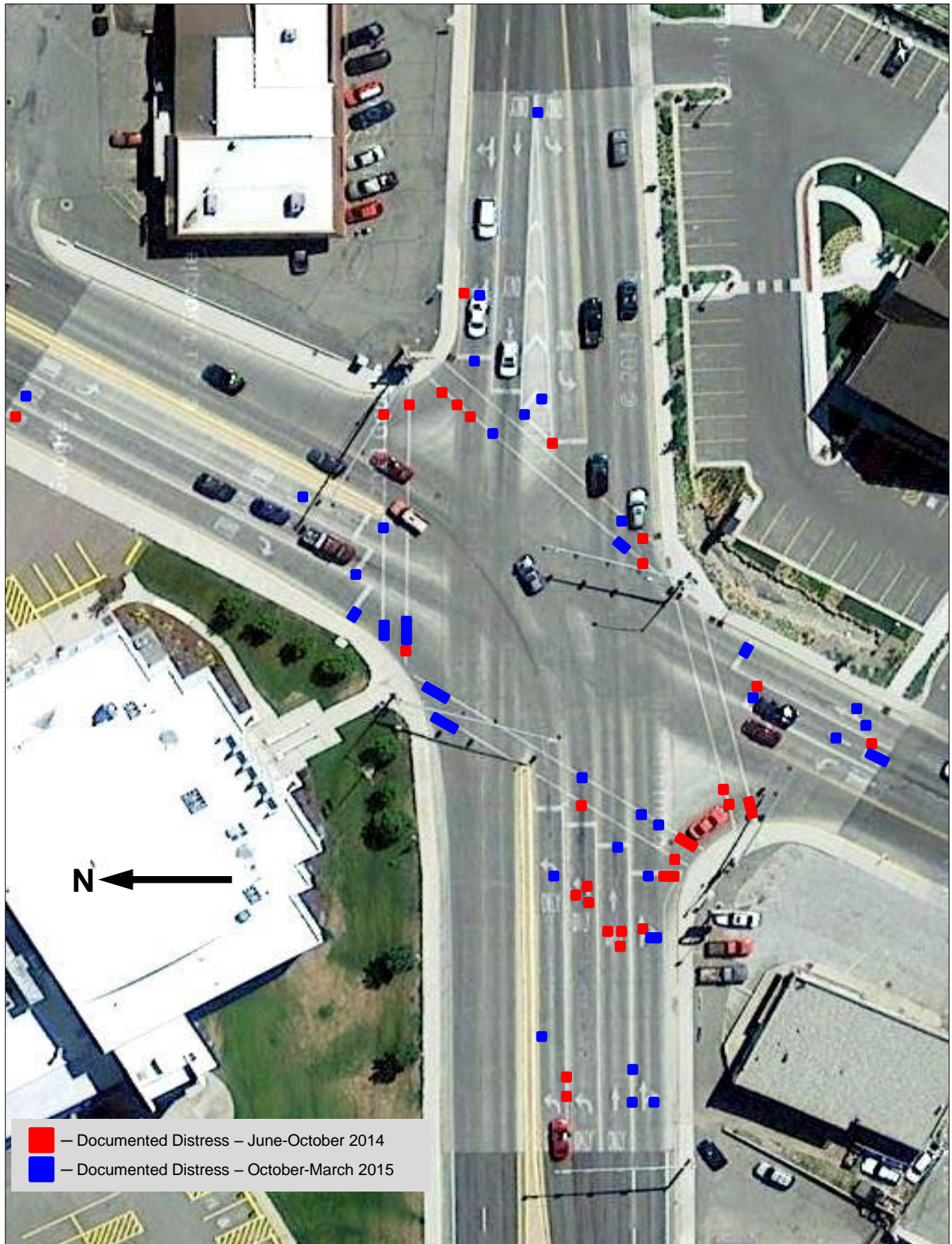
Swarco Director 25 Pavement Tape Defect Locations: West Lyndale & Euclid

Overview indicating areas where tape distress has been documented to date. Note the intersection area outlined in **yellow** (North Benton) received the 3M Stamark pavement tape. Locations are strictly for reference. This map is not to scale.



3M Stamark Pavement Tape Defect Locations: West Lyndale & Last Chance Gulch

Overview indicating areas where tape distress has been documented to date. Locations are strictly for reference. This map is not to scale.



Disclaimer

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