



**Pedestrian and Bicycle
Information Center**

Preview of the FHWA Crosswalk Marking Selection Guide

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Crosswalk Marking Webinar Series

Two sessions on crosswalk marking guidance:

Part 1 – Tuesday, February 15

Preview of the FHWA Crosswalk Marking Selection Guide

Part 2 – Thursday, February 17

Detailed Field Research Findings from the FHWA Crosswalk Marking Selection Guide

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Today's Panel



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Webinar Part 1

Crosswalk Marking Guide: Preview of the Guide

Tuesday, February 15, 2022

1:00 PM EST



FHWA

- Darren Buck
 - Pedestrian & Bicycle Program Coordinator-
FHWA Office of Human Environment,
Livability Team

Research Team

- Pierce Schwalb
 - Project Coordinator
- Sarah Worth O'Brien
 - Co-Principal Investigator
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 - Principal Investigator
- Mike Alston, RSP
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- Taha Saleem, PhD
- Sarah Brown



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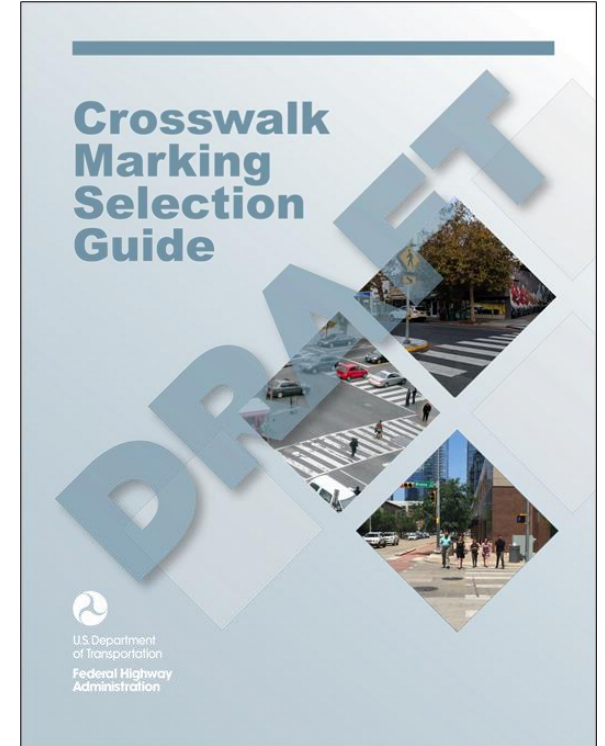
Outline

- Guide Purpose and Organization
- State of Practice
- Original Research
- Guide Recommendations

Guide Purpose and Organization

Guide Purpose

- Purpose of crosswalks and their documented benefits
- Factors to consider when selecting marking designs
- Question of whether to mark a crosswalk is **not** the intent of the guide



Guide Purpose



Provides support for agencies selecting crosswalk marking designs



Considers various aspects including Safety, Visibility, Effectiveness, Materials, Maintenance, and Cost



Builds on existing research and guidance on these factors, highlights gaps in knowledge, and documents original research conducted

State of Practice

Why Do We Have Crosswalks?

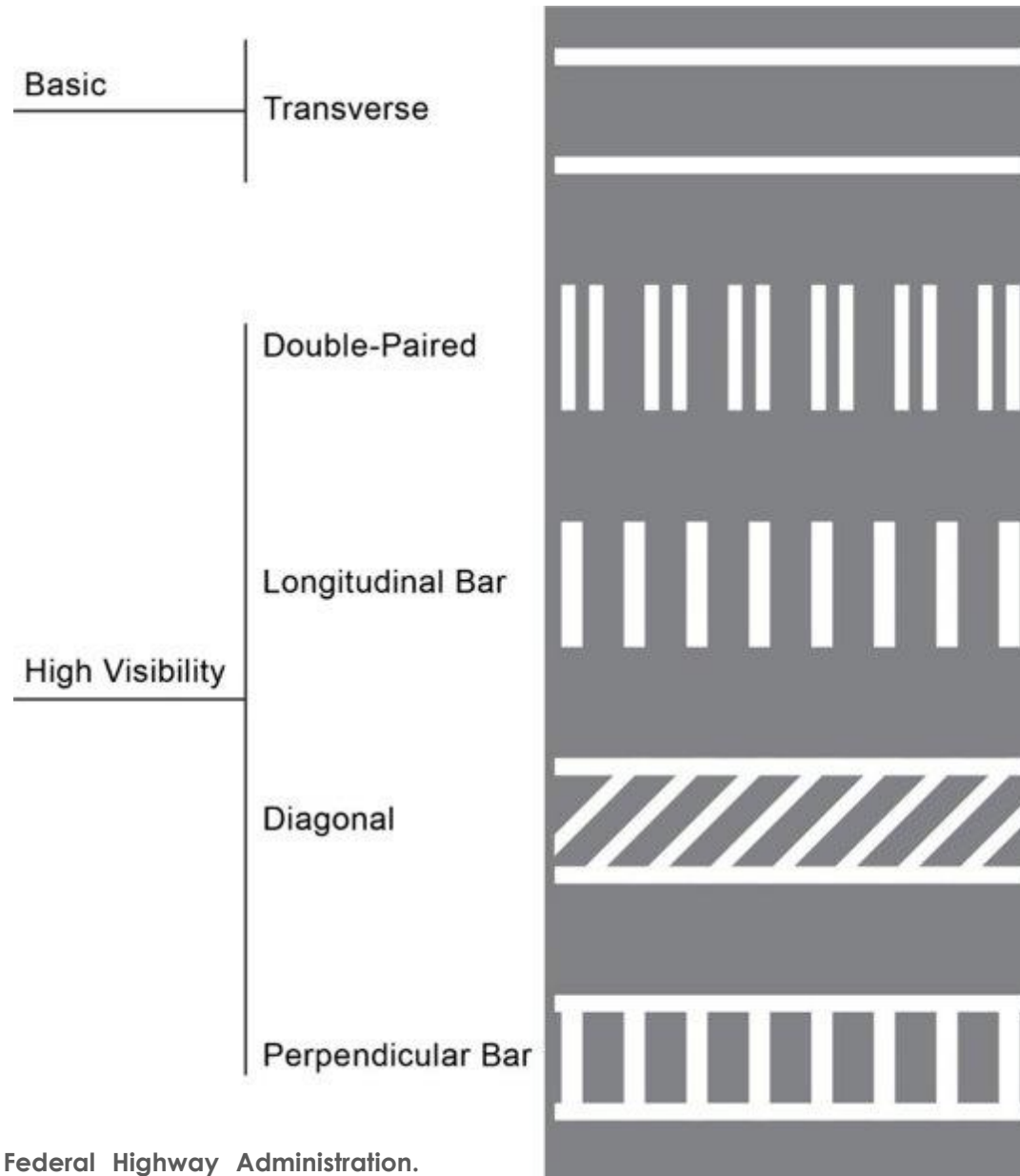
- **What are crosswalks?**
 - Areas where pedestrians are granted the right of way when crossing a roadway
 - May be marked or unmarked
- **Why do we mark them?**
 - Alert drivers to pedestrians' potential presence and right of way
 - Establish pedestrian right of way at midblock locations
 - Establish pedestrian right of way at crossings lacking sidewalk connections on both sides (in some states)
 - Provide wayfinding cues to pedestrians with low vision

Crosswalk Markings and Pedestrians With Low Vision

- Markings contrast with pavement can assist pedestrians with low vision
- Markings NOT detectable for blind pedestrians



What are the Types of Crosswalk Markings?



Source: Adapted from Federal Highway Administration. Manual on Uniform Traffic Control Devices for Streets and Highways. Section 3B.18(04). Washington, D.C., 2009

Crosswalk Marking Design Locations



Intersection



Midblock

What are the Safety Effects of Crosswalk Markings?

No conclusive findings on crash risk

- **Context matters!**
 - Marked crosswalks alone on multilane, higher-volume, and/or higher-speed facilities not known to reduce crash risk
 - Marked crosswalks are associated with increased driver yielding compared to unmarked crosswalks
 - Yielding rates inversely correlated with speed and are influenced by several factors
 - Roadway characteristics
 - Roadway and site context
 - Sociodemographic characteristics of the driver and pedestrian

Yielding rate is **negligible** at sites with high speeds over 30-35 mph

Safety Effects-- Crosswalk Marking Visibility

HVCs shown to be
more visible from
twice the distance of
basic



**Basic Crosswalk Marking
on Driver Approach
(approximately 150 feet
upstream)**



**HVC Marking on Driver
Approach (approximately
150 feet upstream).**

Original Research

Key Research Questions

1. Does the increased visibility of HVCs lead to increased **effectiveness**?
 - If so, where are they recommended? (i.e., why not use them for all marked crosswalks?)
2. What are agency criteria for selecting marking types, and which criteria should be included in federal guidance?

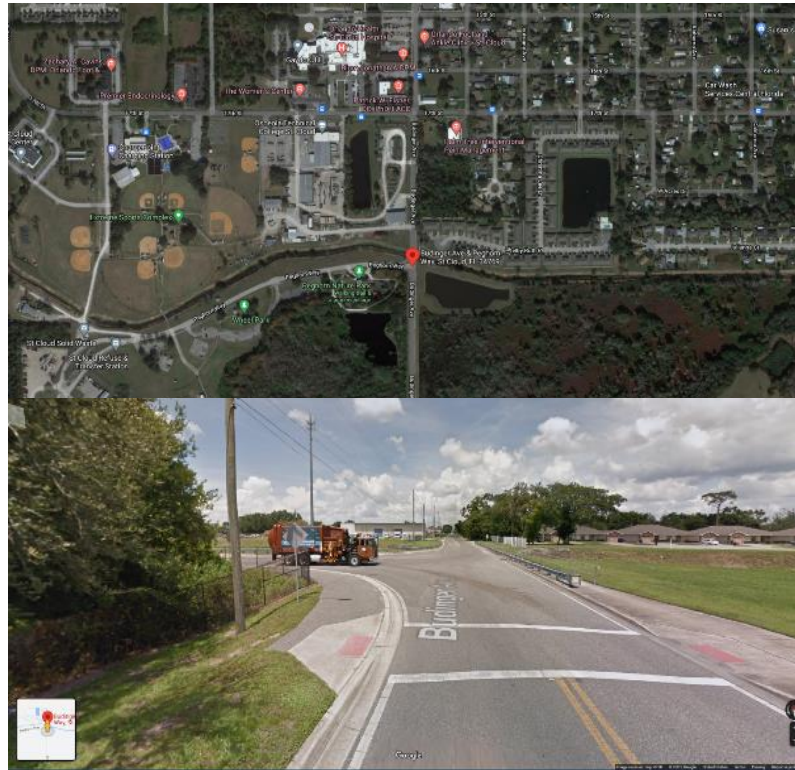
Field Study Approach

- **Compare yielding behavior**
- **Approach:**
 - Conducted staged pedestrian crossings at HVC and basic sites
 - Established internal protocol for crossing consistency (pedestrian, body language, influence area, etc.)
 - Collected volumes and speeds for all vehicles while in field for post-hoc evaluation

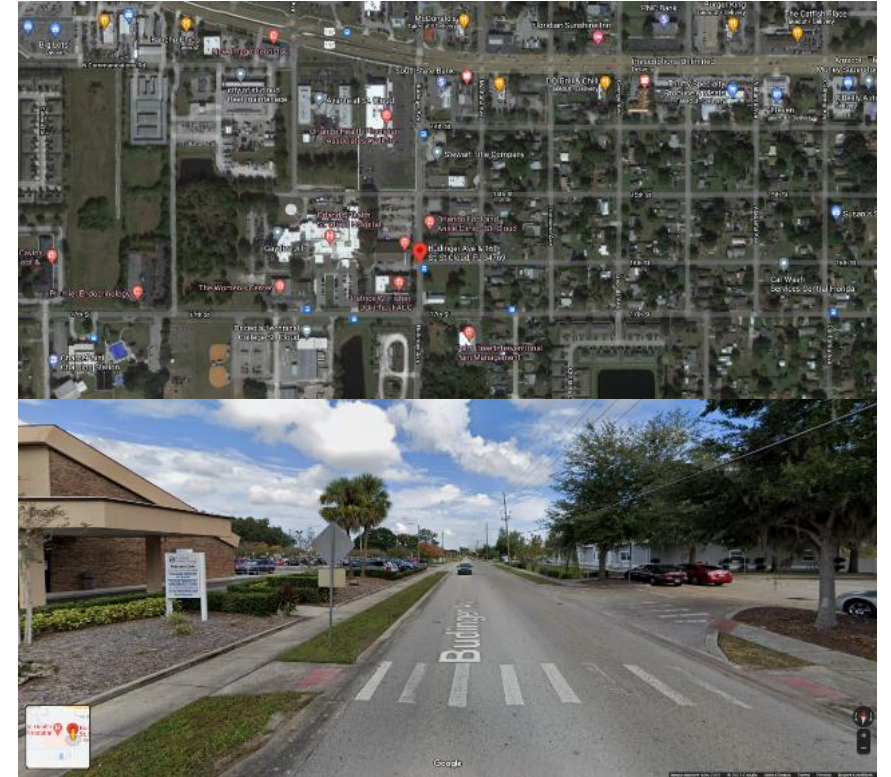


Example Site Pair

Basic crosswalk



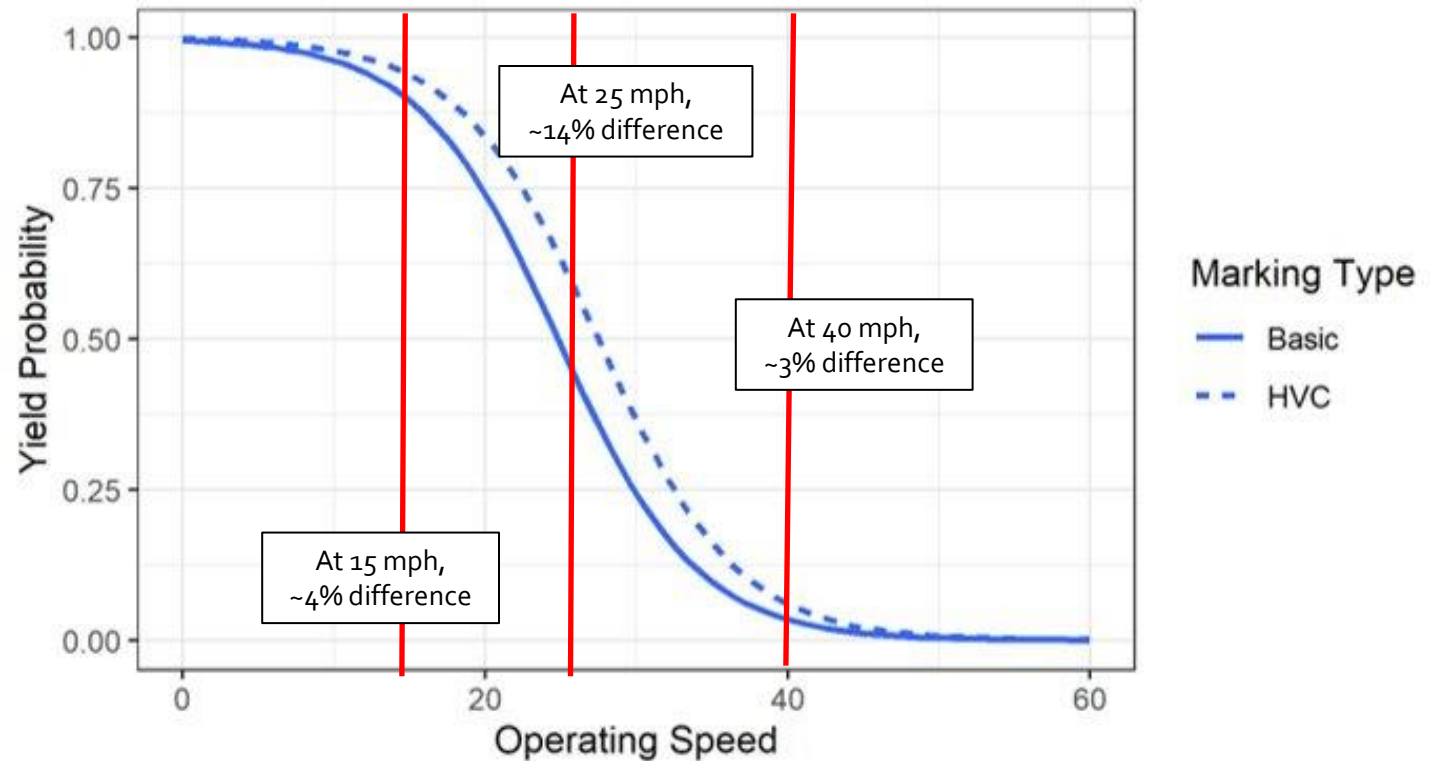
HVC crosswalk



Results

Join us Thursday (2/17) for **Part 2** of our webinar series and detailed results!

Modeled yielding behavior as a result of speed and crosswalk markings



Original Research Results

85th percentile speed

HVCs have strong positive effect on driver yielding **with 85th percentile speed ≤ 30 mph**; above that, HVCs alone no more impactful on driver yielding than basic markings

Presence of warning signs (MUTCD W11-1 and S1-1)

HVCs have strong positive effect on driver yielding **with or without warning signage at the crossing**

Site Context

HVCs associated with increased driver yielding at sites **on roadways not located within a dense grid street network.**

Summary of Original Research

- HVCs are associated with **increased** driver yielding compared to basic
- Yielding rates showed **robust negative relationship** with driver speeds
 - HVC effectiveness strongest with **lower driver speeds** (sites with 85th percentile speeds ≤ 30 mph)
- HVCs show **positive yielding effect** with and without supplemental warning signs present (a stronger effect in the absence of warning signs).

Implications for Marking Decisions

- HVCs are associated with increased yielding
- Driver speed has stronger relationship with yielding
- Context still matters! Test sites are limited in scope (2-lane, low-volume roads)
- HVC markings are *not* a panacea!



Guide Recommendations

When Should HVCs be used?

- Existing and original research have indicated potential crash reduction and yielding benefits from HVC markings in certain contexts.
- **If a crosswalk is worth marking, it is worth marking as HVC for improved visibility.** HVCs are recommended over basic patterns for all marked crosswalks.

HVC Marking Recommendation

Double-Paired



Longitudinal Bar



Recommended HVC Marking Styles for All Crosswalks.

Source: Adapted from Federal Highway Administration. Manual on Uniform Traffic Control Devices for Streets and Highways. Section 3B.18(04). Washington, D.C., 2009.

When is Marking Alone Not Enough?

- Two sets of criteria that agencies may consider:
 1. Roadway configuration, speed, and volume
 2. Pedestrian demand and delay



Existing Guidance on HVC Use

Table 1. Application of pedestrian crash countermeasures by roadway feature.

Roadway Configuration	Posted Speed Limit and AADT								
	Vehicle AADT <9,000			Vehicle AADT 9,000–15,000			Vehicle AADT >15,000		
	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph
2 lanes (1 lane in each direction)	① 2	①	①	①	①	①	①	①	①
	4 5 6	5 6	5 6	4 5 6	5 6	5 6	4 5 6	5 6	5 6
3 lanes with raised median (1 lane in each direction)	① 2 3	① ③	① ③	① 3	① ③	① ③	① ③	① ③	① ③
	4 5	5	5	4 5	5	5	4 5	5	5
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	① 2 3	① ③	① ③	① 3	① ③	① ③	① ③	① ③	① ③
	4 5 6	5 6	5 6	4 5 6	5 6	5 6	4 5 6	5 6	5 6
4+ lanes with raised median (2 or more lanes in each direction)	① ③	① ③	① ③	① ③	① ③	① ③	① ③	① ③	① ③
	5	5	5	5	5	5	5	5	5
4+ lanes w/o raised median (2 or more lanes in each direction)	① ③	① ③	① ③	① ③	① ③	① ③	① ③	① ③	① ③
	5 6	5 6	5 6	5 6	5 6	5 6	5 6	5 6	5 6

Given the set of conditions in a cell,

- # Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.
- Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.
- Signifies that crosswalk visibility enhancements should always occur in conjunction with other identified countermeasures.*

The absence of a number signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.

- 1 High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning signs
- 2 Raised crosswalk
- 3 Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line
- 4 In-Street Pedestrian Crossing sign
- 5 Curb extension
- 6 Pedestrian refuge island
- 7 Rectangular Rapid-Flashing Beacon (RRFB)**
- 8 Road Diet
- 9 Pedestrian Hybrid Beacon (PHB)**

More Existing Guidance for HVC Use

- 2009 MUTCD
- National Committee of Uniform Traffic Control Devices (NCUTCD)
- FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations
- National Association of City Transportation Officials (NACTO)
 - Urban Street Design Guide

Social Equity Prioritization

- Agencies should consider social equity when prioritizing investment and selecting supplemental treatments:
 - Quality and presence of existing transportation infrastructure in Black, Indigenous, People of Color (BIPOC) and low-income communities
 - Disparate sociodemographic safety effects on yielding
 - Avoid only responding to public comment and request

Marking Maintenance

- Typical schedules for refreshing markings include:
 - Ad hoc as needs are identified
 - On same schedule as inspection program--but only if the crosswalk needs refreshing
 - On a fixed schedule
- Some agencies prefer to replace rather than refresh due to:
 - Unit costs often the same to refresh as to replace
 - Mobilization more efficient for larger projects
 - Traffic control needed regardless of refresh or replace

Materials and Materials

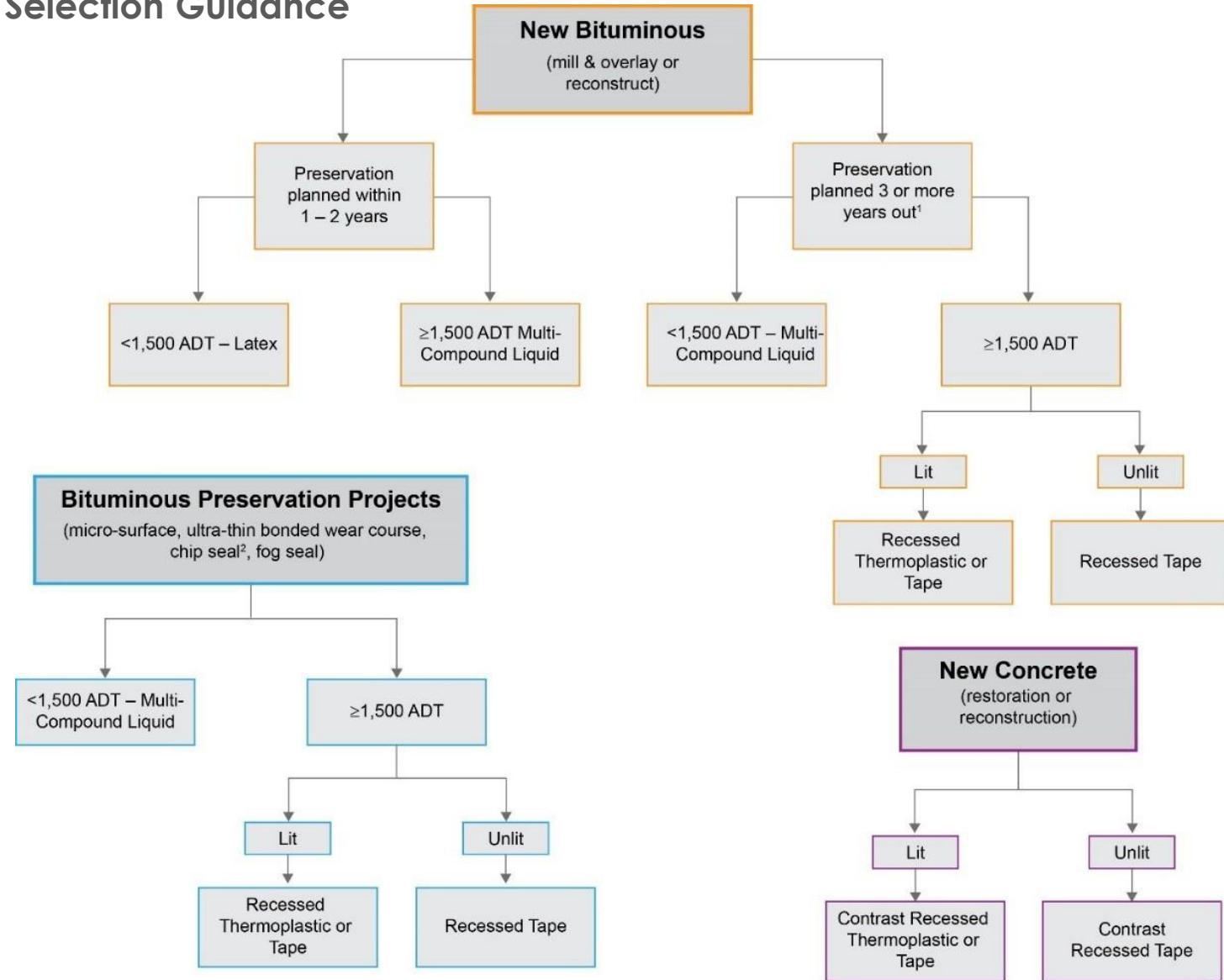
Material	Findings from State of Practice
Paint	Generally agreed paint lasts no longer than 1 year (or one winter season in cold-weather climates)
Thermoplastic	As low as 2–3 years in high-volume locations, but most agencies reported 5 or more years before needing refreshing. A few agencies reported 10–15 years
Methyl Methacrylate (MMA)	Generally lasted 3–5 years before needing refreshing
Epoxy	One agency reported durability for epoxy reported that it lasted 3–5 years before needing refreshing
Preformed polymer tape	Lasting more than 5 years before needing refreshing and more than 7 years when the markings are recessed

Factors Considered When Selecting Materials

- Equipment availability
- Desired material properties
- Material cost
- Job size
- Pavement type
- Lighting conditions
- Climate
- Traffic volume
- Time to the next planned pavement preservation project
- Environmental concerns
- Experience

Minnesota DOT Transverse Marking Selection Guidance

Example Selection: materials, not markings!



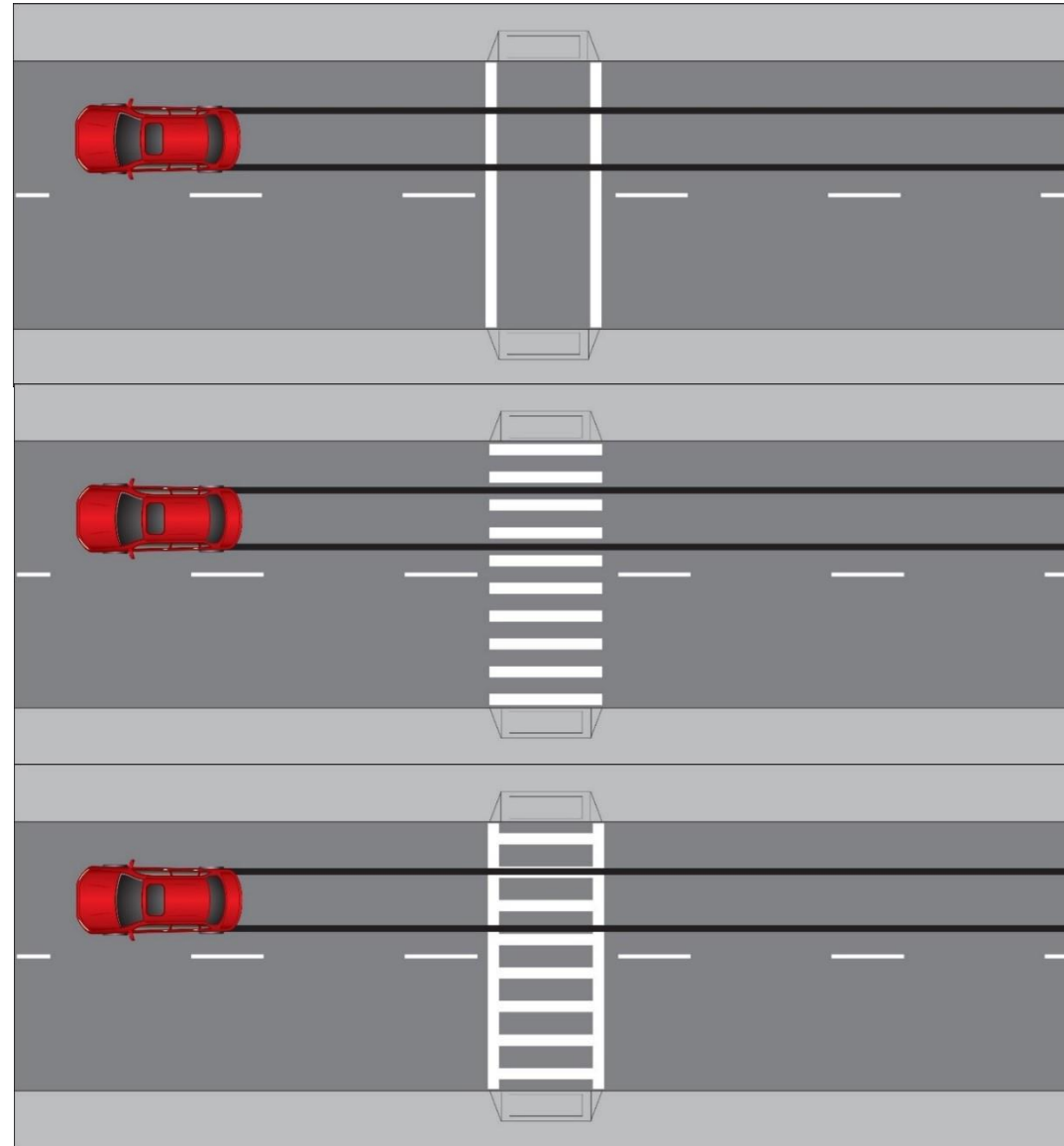
- 1 - Based on life of material and suggested optimum time to initial preservation project.
- 2 - Methods for recessing markings on chip seals are still being developed.
- 3 - Enhanced skid resistant materials are recommended for roundabouts and crosswalk blocks.

Source: Adapted from Minnesota DOT

Material Recommendations

Site Characteristic	Material or Application Recommendation
High-visibility crosswalk	Antiskid properties into marking material
Unlighted crossing	A material with high retroreflectivity (dry or wet retroreflectivity, depending on the climate)
Frequent winter snowplowing	Recessed markings more resistant to snowplow damage; alternatively, nondurable markings can be used and refreshed annually.
High-volume location	Use durable markings; consider recessed markings.
Low-volume location	Moderately durable markings
Roadway will be resurfaced within the next 1–2 years	Nondurable markings

Marking Design and Wear



Recommendations

- Designs incorporating longitudinal elements (e.g., longitudinal bar, double-paired) can place markings outside typical vehicle paths to improve longevity
- Regularly scheduling inspections or an asset management system are good options
- Staff observations and public input are supplemental means of identifying crosswalk markings
- Replacing markings can be as cost-effective as refreshing

Installation Costs

- The cost to install a crosswalk depends on several factors, including:
 - Traffic control
 - Removing old markings
 - Labor to install the new markings
 - Material used for marking
 - Crosswalk length and width
 - Marking pattern
 - Marking height

Comparative Crosswalk Installation Costs

- Difficult to provide exact cost estimates for installing crosswalk markings.
 - However, there are comparative installation costs of basic and HVC:

Comparative Crosswalk Installation Costs

Crosswalk Type	Median Cost	Average Cost	Minimum Cost	Maximum Cost	Cost Unit	Number of Sources
High Visibility	\$3,692	\$3,054	\$721	\$6,866	Each	4
Basic	\$409	\$926	\$132	\$2,513	Each	8

Source: UNC Highway Safety Research Center. Costs have been adjusted to 2020 U.S. dollars using the National Highway Construction Cost Index.

Maintenance Costs and Life-Cycle Costs

- Agencies generally agreed it cost as much to refresh as it costs to replace or install due to
 - Mobilization
 - Traffic control
 - Other labor costs
- No research available to quantify the effect of longitudinal markings on reducing need for maintenance
- Life-cycle costs
 - Mainly driven by the cost to install initially and refreshing before replacement
 - Other costs to potentially consider include:
 - Initial equipment costs
 - Traffic delay

Thank you!

Questions?

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Sarah Brown, sbrown@kittelsohn.com

Discussion

⇒ **Send us your questions**

⇒ **Follow up with us:**

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⇒ **Sarah Brown sbrown@kittelson.com**

⇒ **Bastian Schroeder bschroeder@kittelson.com**

⇒ **General Inquiries pbic@pedbikeinfo.org**

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