

# GUIDELINE FOR SELECTING MATERIALS AND STANDARD SPECIAL PROVISIONS FOR TRAFFIC STRIPING AND PAVEMENT MARKING

Version 3.0



State of California Department of Transportation  
Division of Engineering Services  
Materials Engineering and Testing Services  
Office of Roadway Materials Testing  
5900 Folsom Boulevard  
Sacramento, CA 95819

## **ABSTRACT**

This Guideline provides information on the selection of traffic striping and pavement marking materials for use in highway construction contracts. It is intended to aid the project designer in selecting proper contract language and materials for traffic striping/marketing work. Abbreviations are defined in Section 1 of the *Standard Specifications*. This Guideline is broken down into the following categories:

- Summary of specifications for traffic striping/pavement marking work.
- Contract cost data for traffic striping bid items.
- Flowcharts for selecting suitable traffic striping materials.
- Links to additional resources/information about traffic striping (material specifications, inspection guides, troubleshooting, etc.).
- Photographic examples of optional traffic striping treatments.

## **DISCLAIMER**

This Guideline was prepared by the California Department of Transportation, Division of Engineering Services, Materials Engineering and Testing Services, Office of Roadway Materials and Testing. The contents of this Guideline reflect the view and experience of the author, who is responsible for the facts and accuracy of the information presented herein. Note that the contents do not necessarily reflect the official views or policies of the State of California or the Federal Highway Administration. This Guideline does not constitute a standard, specification, or regulation.

Comments on this Guideline should be directed to:

Lisa Dobeck, Senior Chemical Testing Engineer Chemical Testing Branch

### **Via e-mail**

<lisa.dobeck@dot.ca.gov>

### **Via US mail**

California Department of Transportation  
Materials Engineering and Testing Services  
Office of Roadway Materials Testing  
Chemical Testing Branch  
5900 Folsom Blvd., Sacramento, CA 95819

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## 1.0 INTRODUCTION

Traffic stripes and pavement markings have been identified as one of the most cost-effective means of improving highway safety, yet account for only about two percent of the construction cost on a typical California Department of Transportation (Caltrans) roadway contract.<sup>i, ii</sup> It is important to give traffic striping/marketing material selection its due attention in the design phase of a project to ensure that durable striping materials are utilized. This Guideline was created to aid project designers in the selection of suitable traffic striping materials and specifications in the form of SSPs for use in traffic striping/pavement marking work. It also provides links to additional resources on topics related to pavement delineation. These are suggested guidelines only. The district traffic engineer should be consulted whenever there are questions regarding traffic striping and pavement marking issues. Nonstandard or experimental pavement delineation treatments need the approval of the district traffic engineer.

In May 20, 2004, Caltrans adopted the Federal Highway Administration's (FHWA's) *Manual on Uniform Traffic Control Devices (MUTCD) 2003*, as amended by the *MUTCD 2003 California Supplement*, to prescribe uniform standards and specifications for all official traffic control devices and pavement delineation schemes on State highways.

The current revision of the CA *MUTCD* along with Caltrans *Standard Plans*, contain all the approved traffic striping/marketing patterns. A link to the CA *MUTCD* can be found at the Division of Traffic Operations website.

Caltrans *Standard Specifications*, Section 84, Markings, gives direction for applying traffic stripes and pavement markings, and Section 81, Miscellaneous Traffic control Devices, contains requirements for furnishing and placing pavement markers.

## 2.0 SUMMARY OF MATERIALS FOR PERMANENT PAVEMENT DELINEATION

The materials specifying traffic striping/pavement marking work are summarized below.

- **Thermoplastic stripe for open graded friction course (OGFC)**

The durability of thermoplastic traffic stripe is proportional to the application thickness of the material. Rough-textured pavements, such as OGFC and bituminous sealed surfaces, need the heavier 0.08 inches to 0.10 inches application thickness.

- **SSP 84-2, Two-Component Paint Traffic Stripe and Pavement Marking**

Two-component traffic paint (i.e., epoxy and polyurea) is recommended for striping lightly snowplowed roads due to its excellent abrasion resistance and bond strength to PCC pavement. METS maintains an Authorized Materials List, AML, of approved two-component traffic striping paints to use with this SSP. This list of products is divided into four categories based on the “no-track” or “cure time” of the different two-component traffic paints. Traffic control and/or coning of “wet paint” stripes may be necessary to avoid tracking of paint during the curing period.

- **Recessed Methyl Methacrylate (MMA) Traffic Stripes**

Recessed MMA is placed into slots that are milled into the pavement. This is the most durable type of traffic striping for snowplowed areas.

- **Thermoplastic with Enhanced Wet Night Visibility**

Thermoplastic traffic stripes and pavement markings with enhanced wet night visibility use specialized glass beads. These high-performance glass beads are typically applied in conjunction with a second ‘drop’ of smaller gradation glass beads (e.g.: AASHTO Designation M247, Type 2 beads) when applying thermoplastic traffic stripes and pavement markings. Certain high-performance glass beads are available in separate white and yellow colors for use with the corresponding thermoplastic stripe colors.

The wet-night traffic stripe visibility advantage provided by high-performance glass beads is affected by the pavement's texture and drainage efficiency. Best wet-night visibility is afforded when used on well-drained, open-graded friction course. Please note that reflective pavement markers provide much better wet-night visibility than traffic stripes utilizing high-performance glass beads. Therefore, the use of high-performance glass beads in traffic stripes does not replace the use of pavement markers but can augment roadway delineation by providing brighter traffic stripes.

- **SSP 84-4 Audible Traffic Stripes System**

Use Audible traffic stripe system to provide enhanced visibility and to provide audible or vibratory indication to the driver when the vehicle passes over the striping. The Authorized Material List for these systems is located on the METS website. Do not use in areas that are routinely snow plowed.

- **SSP 84-5 Warranty for Traffic Stripes and Pavement Markings**

This SSP is for a 5-year warranty for traffic stripes and a 2-year warranty on pavement markings. It should only be used for roadways not scheduled for repaving during the warranty period. The Division of Maintenance monitors the traffic stripes and markings for compliance during the warranty period and coordinates any repair or replacement as needed.

Do not use in mountainous areas above 3,000 ft or areas where routine snow plowing will be performed.

- **Prequalified and Tested Signing and Delineation Materials**

This is an Authorized Materials list for pavement delineation products and signing materials. The list contains approved reflective pavement markers (both temporary and permanent types), traffic tape (both temporary and permanent types), retroreflective sign sheeting, and other approved traffic safety products. It is located on the Engineering Services, Authorized Materials Lists webpage.

## **2.1. SUMMARY OF TEMPORARY PAVEMENT DELINEATION (FOR USE DURING CONSTRUCTION)**

Temporary pavement delineation is typically specified based on the length of time that temporary traffic striping is needed prior to application of the permanent striping.

- **Temporary Pavement Delineation, 14 days or less**

When temporary pavement delineation will be needed for 14 days or less use temporary reflective markers, temporary striping tape, traffic paint, cones, etc., for short-term delineation.

- **Temporary Markers for Short Term Day/Night Use (14 days or less)**

For temporary pavement delineation on bituminous seal coat projects use flexible tab-type reflective markers with disposable protective covers. These reflective markers are applied before binder/aggregate application, after which the protective covers are removed to reveal the reflective tabs.

- **Temporary Pavement Delineation, 180 days or less**

When temporary pavement delineation will be in place for longer than 14 days but less than six months, use temporary reflective markers, temporary striping tape, traffic paint, cones, etc., as needed for interim delineation.

## **2.2. SUMMARY OF REMOVAL OF EXISTING YELLOW TRAFFIC STRIPES AND PAVEMENT MARKINGS**

Yellow thermoplastic prior to 2005 contained lead chromate pigment, most of this striping probably has been removed or worn off the highway. There is no assurance that it is completely gone so there are two SSPs that include instructions for removal and disposal of yellow striping. The handling and disposal requirements differ depending on the level of lead and chromium in the collected waste. Removal of white striping alone does not create hazardous waste and should be measured and paid for as a separate item when both white and yellow striping are being removed. Lead safety training for the contractors' crews and a written compliance plan are necessary when the striping debris to be collected contains hazardous levels of lead or chromium. The Caltrans *Construction Manual* spells out the requirements.

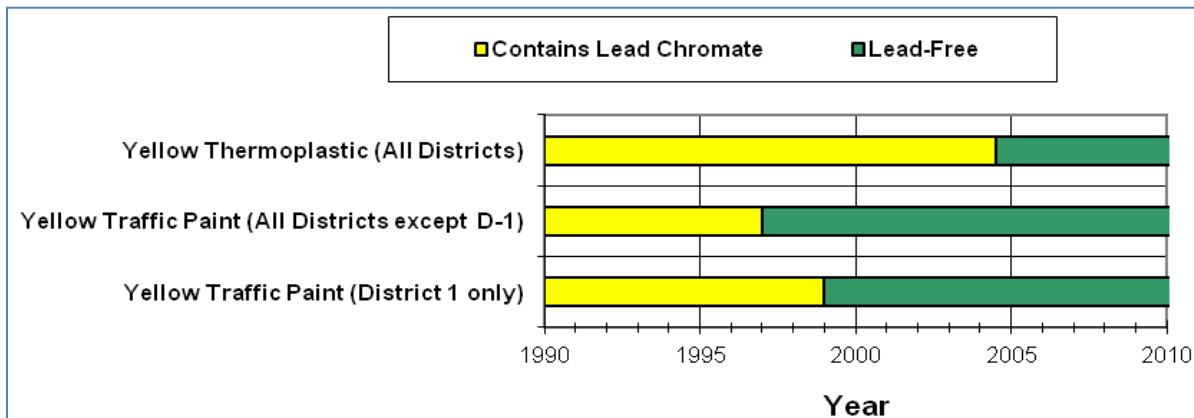
- **SSP 14-11.12**

Use if yellow residue, expected to be a hazardous waste (lead concentration equal to or greater than 1,000 mg/kg total lead or 5 mg/l soluble lead), will be produced.

- **SSP 84-9.03B**

Use if residue from removing yellow painted or yellow thermoplastic traffic stripes and pavement markings contains lead from the paint or thermoplastic and the average lead concentrations are less than 1,000 mg/kg total lead and 5 mg/L soluble lead. Use if removing other colors of paint (white, blue, black, etc.).

**Figure 1: Timeline Showing the Phase-Out of the Use of Lead Chromate Pigments in Yellow Traffic Striping/Marking Materials on California State Highways**



The district's hazardous waste coordinator should be consulted whenever there are questions about disposal issues. Guidance on the removal and disposal of yellow traffic stripe containing lead and chromium can be found at the following Caltrans Web sites.

*Caltrans Standard Specifications*, see Section 14-11.12  
 <<https://dot.ca.gov/programs/design/ccs-standard-plans-and-standard-specifications>>

*Caltrans Construction Manual*, see Section 7-107E  
 <<https://dot.ca.gov/programs/construction/construction-manual>>

There is also guidance from the Division of Environmental Analysis, Hazardous Waste webpage.

Each district has a Senior in the hazardous waste technical group that may know of existing contracts for environmental services (for stripe sampling and testing) that can be utilized for testing yellow striping.

### **3.0 STANDARDS PLANS FOR PAVEMENT DELINEATION**

Detail drawings for standard traffic striping/markings schemes are found under Pavement Markers, Traffic Lines and Pavement Markings of the 2018 Caltrans Standard Plans, located at the Engineering Services webpage.



## 4.0 CONTRACT COST DATA FOR PAVEMENT DELINEATION ITEMS

Table 1 contains average bid prices for pavement delineation items (installed cost) from 2018 contract cost data. See the Office Engineer website for the most up-to-date cost data.

**Table 1: 2018/2019 Contract Cost Data for Traffic Striping/Pavement Marking Bid Items**

<b>Bid Item Code</b>	<b>Pavement Delineation Material Description</b>	<b>SSP or Standard Specification Number</b>	<b>Average Bid Price</b>
840656	Paint Traffic Stripe (2-coat)	84-2	\$1.57/LF (6 in, solid line)
840560	Thermoplastic Traffic Stripe (Sprayable)	84-2	\$1.96/LF (6 in, solid line)
840505	Thermoplastic Traffic Stripe	84-2	\$3.05/LF (6 in, solid line)
846007	Thermoplastic Traffic Stripe (Enhanced Wet Night Visibility)	84-2	\$2.04/LF (6 in, solid line)
840626	Two-Component Paint Traffic Stripe	84-2	\$2.84/LF (6 in, solid line)
846014	Audible Traffic Stripe Systems	84-4	\$2.59/LF (6 in, solid line)
847128	Methyl Methacrylate Paint Traffic Stripe	84	\$1.66/LF (6 in, solid line)
847082	Traffic Stripe Tape with Contrast	84	\$8.72/LF (6 in, solid line)
847000	Traffic Stripe (Warranty)	84-5	\$3.12/LF (6 in, solid line)
120300	Temporary Pavement Marker	12	\$8.36/ea.
810230	Pavement Marker (Retroreflective)	81	\$8.47/ea.
141103	Remove Yellow Thermoplastic Traffic Stripe	84-9.03B	\$4.50/LF
846030	Remove Thermoplastic Traffic Stripe	84	\$1.66/LF
810250	Pavement Marker (Retroreflective-Recessed)	81-3	\$31.00/ea.
847150	Methyl Methacrylate Paint, Traffic Stripe, Recessed		\$8.43/LF (6 in, solid line)

## 5.0 PAVEMENT DELINEATION SELECTION GUIDE

The attached “New Pavement Delineation Selection Guide” (Figure 4) divides traffic striping requirements into five categories based on pavement surface and environmental conditions. This guide recommends striping materials for new pavement with at least 2 years (or more) of expected service life. The rationale for using different types of striping materials in these five categories is explained below.

### 1. Temporary Pavement Delineation:

Temporary pavement delineation is used during construction when existing pavement delineation will be removed on lanes open to public traffic. Select temporary pavement delineation based on the length of time the temporary delineation will be needed prior to application of the permanent striping/markings treatment. Temporary pavement delineation utilizes traffic paint and approved materials found on the list of “Prequalified and Tested Signing and Delineation Materials” found on the METS Authorized Materials List website.

### 2. Snow Removal Area Roadways:

Snow area roadways require very durable pavement delineation to withstand abrasion by snow removal equipment and tire chains. Recessed Methyl Methacrylate traffic paint can provide durable traffic stripes/markings in snow areas.

### 3. Roadways with Wet-Night or Fog Area Visibility Concerns:

A thick application (0.100 inches) of thermoplastic striping on OGFC in conjunction with reflective pavement markers, increases the visibility of pavement delineation during wet-night driving conditions. An OGFC surface enhances wet-night visibility of traffic stripes by reducing water ponding and wheel spray, and by providing a matte black pavement color that enhances traffic striping contrast. Thermoplastic Enhanced Wet Night Visibility allows the use of larger and composite glass beads embedded in the thermoplastic. This improves nighttime and wet night visibility, but not as much as reflective pavement markers.

Lane lines and centerlines consisting of audible traffic striping provide an audible rumble when driven over and may be useful on fog area roadways. Shoulder and/or centerline rumble strips also provide a tactile warning to errant drivers.

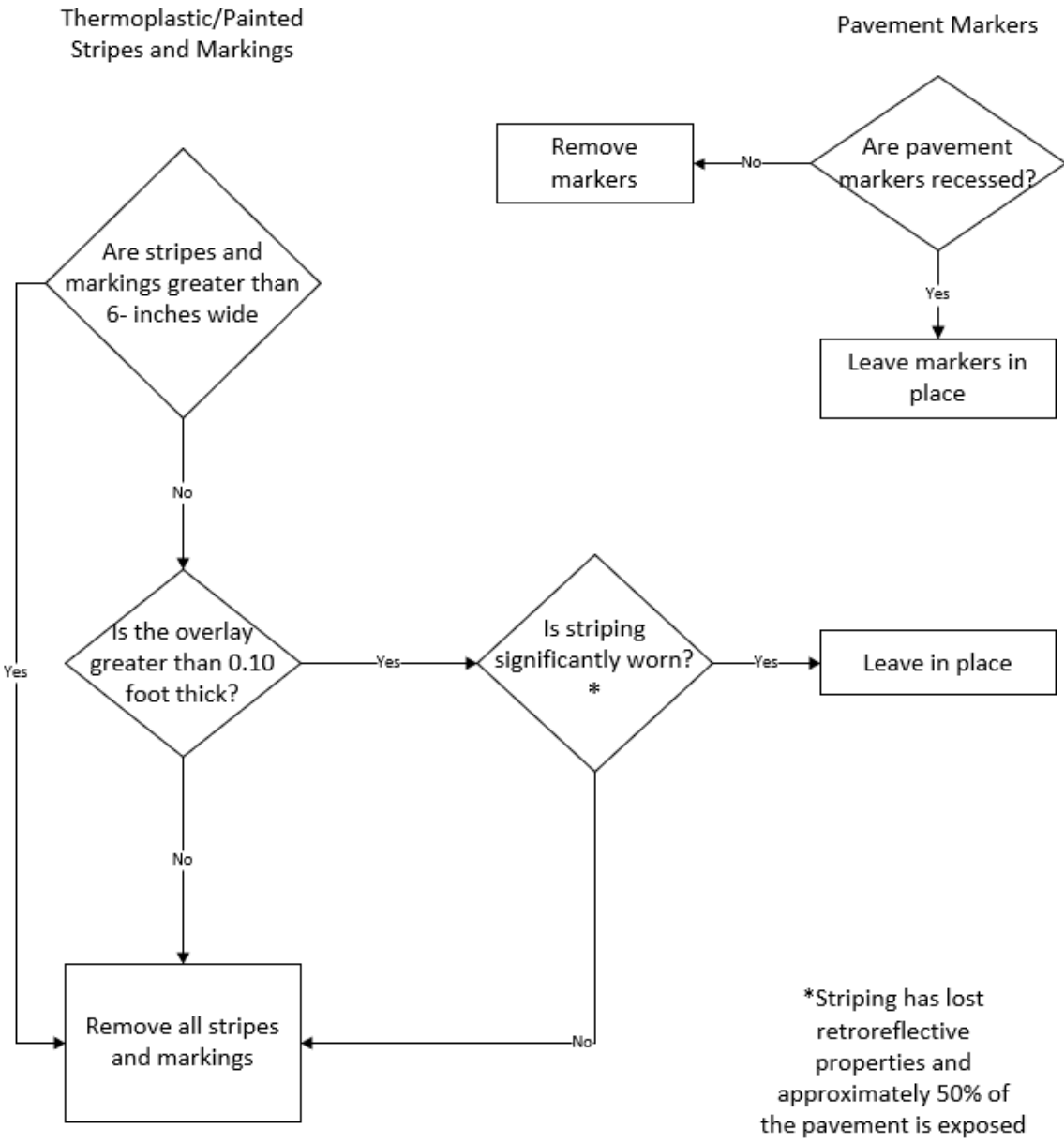
#### **4. OGFC and Bituminous Seals:**

Thermoplastic traffic striping is recommended for these pavement surfaces. Traffic striping durability is reduced on porous or rough textured pavements. Increasing the application thickness of thermoplastic striping (to 0.08 or 0.10 inches) helps to counter this reduced durability. Using enhanced wet night visibility glass beads would also increase the wet and dry nighttime visibility.

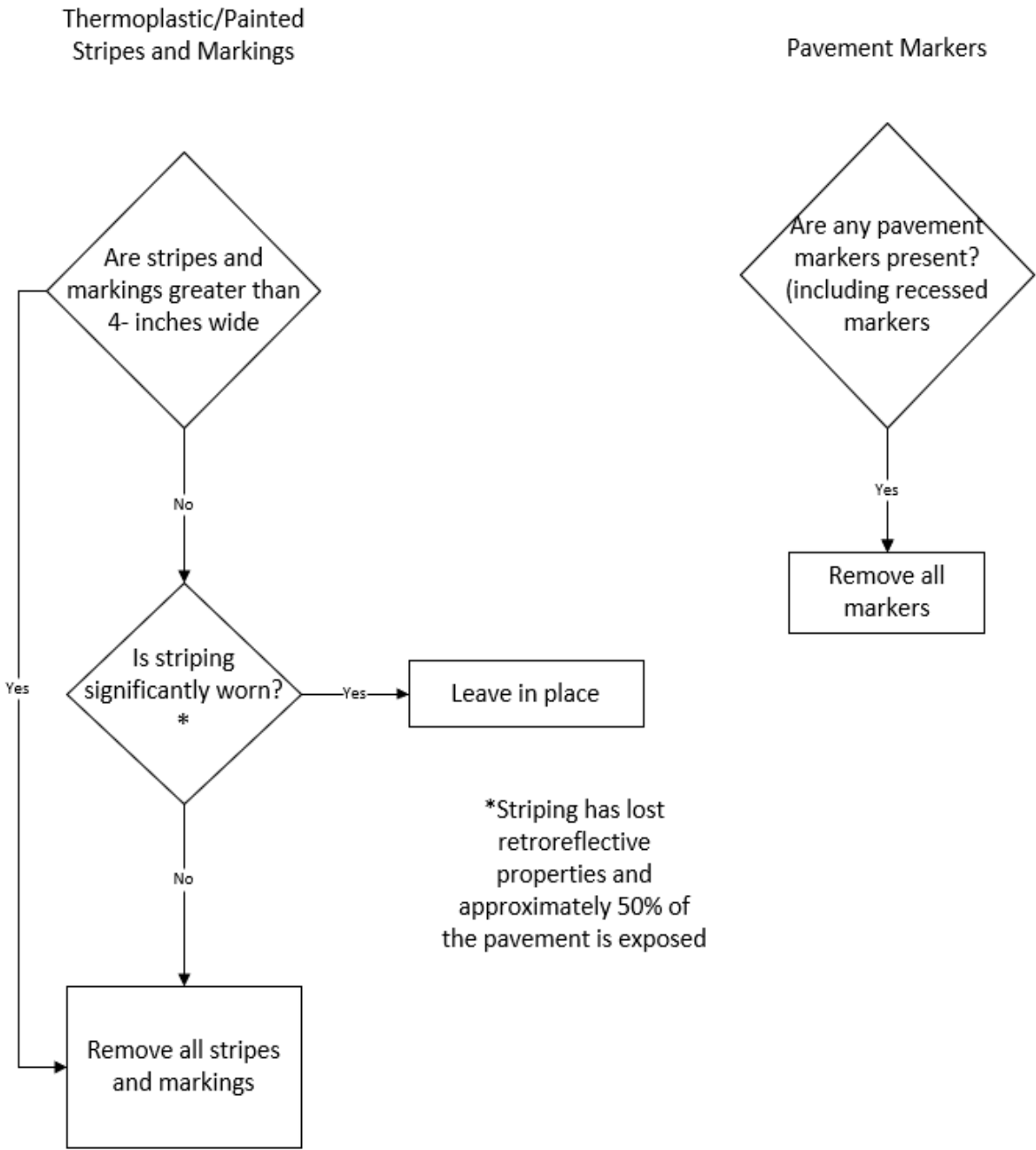
#### **5. Portland Cement Concrete (PCC) and HMA:**

Thermoplastic traffic striping is recommended for these pavement surfaces. The application thickness (0.06, 0.08, or 0.10 inches) can be adjusted to match the durability requirements for the striping. Surface preparation and primer application is critical to a successful thermoplastic application on PCC pavement.

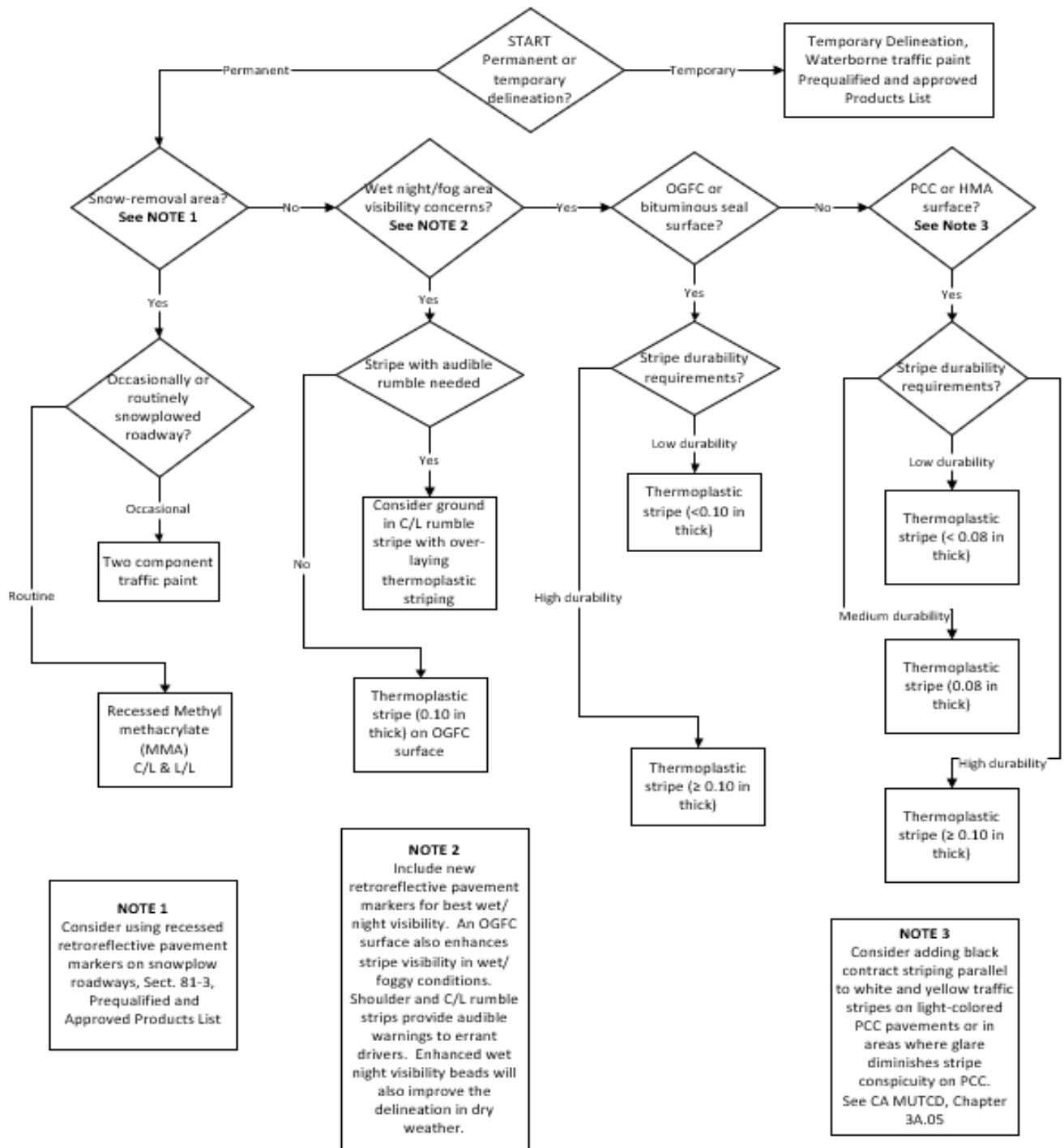
**Figure 2: Guideline for Removing/Not Removing Existing Striping, Markings, and Pavement Markers Prior to Repaving**



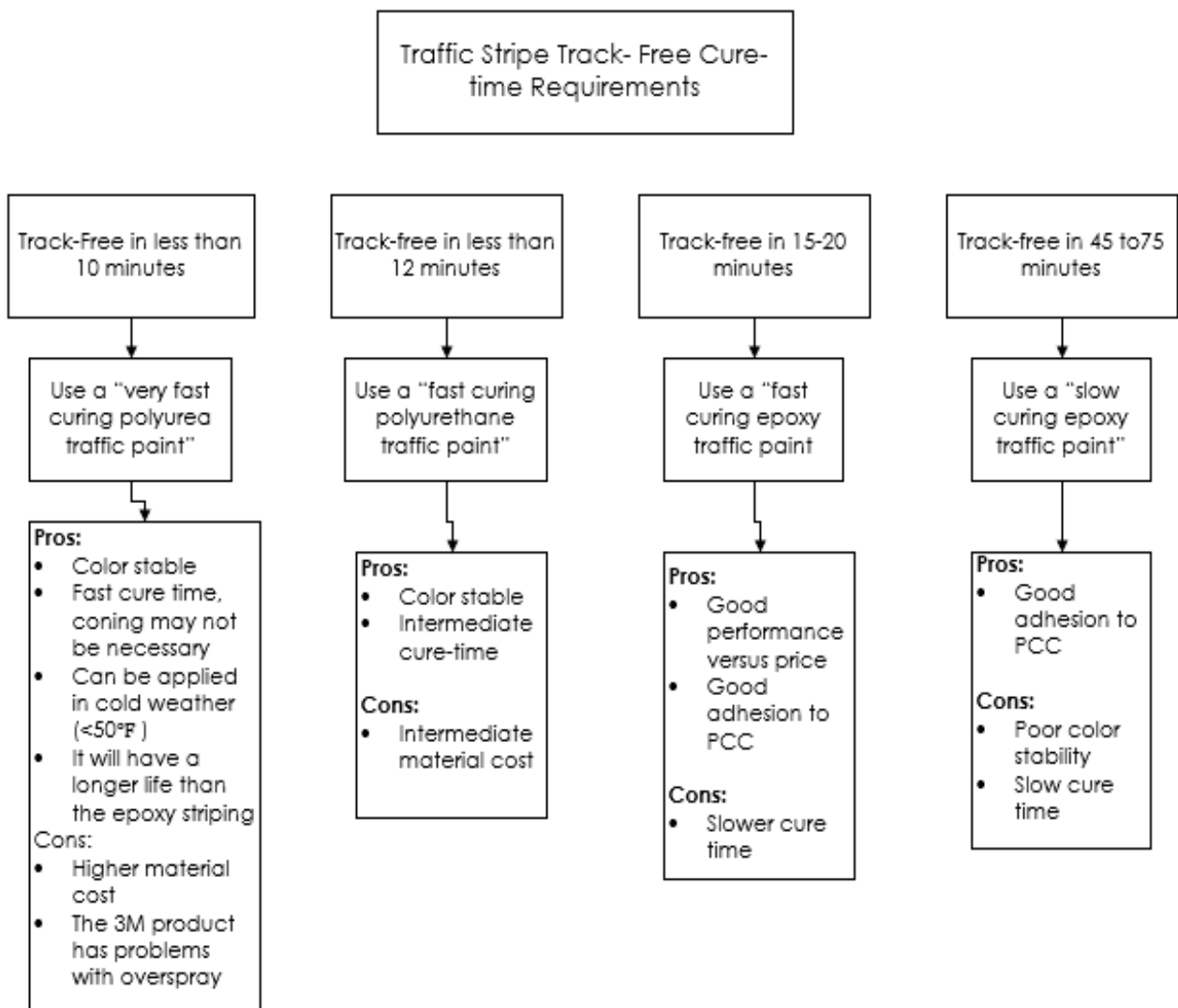
**Figure 3: Guideline for Removing/Not Removing Existing Striping, Markings, and Pavement Markers Prior to Sealing**



**Figure 4: New Pavement Delineation Selection Guide**



**Figure 5: Two-Component Paint Traffic Stripes and Pavement Markings Material Selection Guide**



**GENERAL ADVANTAGES:**  
 Two-component traffic paints (i.e. epoxy, polyurethane, polyurea) are more abrasion resistant than waterborne traffic paint or surface-applied thermoplastic striping when used on snowplowed roadways. Two-component traffic paint striping is generally brighter at night (higher retroreflectivity) than waterborne traffic paint or thermoplastic striping. Yellow Two-component traffic paints typically have a more vivid yellow color at night than yellow waterborne traffic paint or thermoplastic.

**SUGGESTED APPLICATION AREAS:** Snowplowed roadways, areas where sand/abrasives are found on the road, two-lane winding roads, HOV lane buffer striping, areas where reflective pavement markers are not used.

**Photo 1: Ground-in centerline rumble strips provide snowplow-resistant striping in addition to an audible warning to errant drivers.**



**Photo 2: Black contrast stripes can increase the conspicuity of traffic striping on light-colored PCC pavements, especially in areas with PCC shoulders.**





**Photo 3: Traffic striping SSPs now require minimum levels of stripe retro reflectivity (nighttime visibility) for new striping. The Chemical Testing Branch measuring the retro reflectivity of questionable new striping.**



## **6.0 OTHER RESOURCES**

The websites listed below provide information related to pavement delineation, traffic striping materials, stripe application, stripe inspection, troubleshooting, etc.

- **Caltrans Division of Traffic Operations (Headquarters)**

External: <<http://www.dot.ca.gov/hq/traffops/>>

Internal: <<http://www.onramp.dot.ca.gov/hq/traffops/>>

The Traffic Operations websites below provide the following information about traffic striping/markings issues:

- Traffic volumes
- CA MUTCD (Signs & Pavement Marking standards)
- Highway Safety Improvement Program Guidelines
- Special Reports/studies about alternative pavement delineation treatments Division of Traffic Operations (external)

- **Caltrans Transportation Laboratory Services**

The Chemical Testing Branch can provide the following lab services relating to traffic striping:

- Testing of materials for specification compliance (i.e., traffic paint, glass beads, thermoplastic, pavement markers, signs, etc.).
- Measuring the retroreflectivity and color of newly applied striping suspected of not meeting requirements.
- Striping material recommendations and troubleshooting.
- The Chemical Testing Branch maintains a website with lab contact information and downloadable specifications for thermoplastic, traffic paint, and glass beads. It is located at the Engineering Services website, Bridge Paint and Pavement Striping Paints.

- **Traffic Striping Information from Industry**

American Traffic Safety Services Association (ATSSA) website  
<[www.atssa.com](http://www.atssa.com)>

## 7.0 REFERENCES

<sup>i</sup> Miller, T.R., *Benefit/Cost Analysis of Lane Markings. Final Report*. American Glass Bead Manufacturers Association. The Urban Institute, Washington, D.C., 1991.

<sup>ii</sup> Lane, B., *Quantities & Costs for Lane Line Delineation Materials*, Internal Communication. California Department of Transportation, Division of Traffic Operations, Sacramento. May 16, 2001.