

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

Version 2.0

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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 *2010 Standard Specifications*. This Guideline is broken down into the following categories:

- Summary of Standard Special Provisions (SSPs) for traffic striping/pavement marking work.
- Contract cost data for traffic striping bid items.
- Flowcharts for selecting suitable traffic striping materials and SSPs.
- 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.

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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 2 percent of the construction cost on a typical California Department of Transportation (Caltrans) roadway contract.^{i, ii} 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 *MUTCD 2003 (Part 3)* and the *MUTCD 2003 California Supplement (Part 3)*, along with Caltrans *Standard Plans*,² contain all the approved traffic striping/marketing patterns. Web links to the *MUTCD 2003* and *MUTCD 2003 California Supplement* can be found at the Division of Traffic Operations Web site.

<http://www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/index.htm>

Caltrans *Standard Specifications*, Section 84, "Traffic Stripes and Pavement Markings," spells out the requirements for applying traffic stripes and pavement markings, and Section 85, "Pavement Markers," spells out the requirements for furnishing and placing pavement markers. Supplemental instructions are found in the SSPs and guides summarized below. These SSPs can be downloaded from the following Web site for the Caltrans Division of Engineering Services, Office Engineer:

<http://www.dot.ca.gov/hq/esc/oe/>

2.0 SUMMARY OF SSPS AND GUIDES FOR PERMANENT PAVEMENT DELINEATION

The SSPs used for specifying traffic striping/pavement marking work are summarized below. They typically contain instructions for material specification and application, as well as stripe measurement and payment clauses. Note that these SSPs may contain hidden instruction text that can only be viewed by opening the document in Microsoft® Word with the "Show/Hide" (¶) feature set to "Show."

- **SSP 84-2.03B**

Use this SSP for extrude thermoplastic when a more durable traffic striping is needed or when placed on open graded HMA pavement.

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 84-4, Two-Component Paint Traffic Stripe and Pavement Marking**

Two-component traffic paint (i.e., epoxy and polyurea) is recommended for striping snowplowed roads due to its excellent abrasion resistance and bond strength to PCC pavement. METS maintains an authorized materials list 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.

- **SSP 84-5, Recessed Thermoplastic Traffic Stripes**

Recessed thermoplastic is placed into slots (~ 0.04 inches in depth) that are milled into the pavement. This is the most durable type of traffic striping for snowplowed areas.

- **SSP 84-6, Enhanced Wet Night Visibility**

SSP 84-6 includes specifications for applying thermoplastic traffic stripes and pavement markings with enhanced wet night visibility with the use of 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. The high-performance glass beads are available in separate white and yellow colors for use with the corresponding thermoplastic stripe colors.

Suggested uses for these beads include; increasing the nighttime visibility of thermoplastic traffic stripes in general, increasing the wet-night visibility of thermoplastic traffic stripes, and for enhancing the visibility of traffic striping in areas where reflective pavement markers cannot be used. 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 39-1.16, Rumble Strips**

Shallow depressions (0.40 to 0.60 inches deep) are ground into the centerline of two-lane roads to provide a tactile warning to drivers crossing the centerline. This “centerline rumble strip” is then striped over with a double yellow traffic stripe (preferably using two-component traffic paint). Thus, the rumble strip becomes a part of the centerline delineation. Centerline rumble strip- type traffic striping is durable enough for use in snowplowed areas.

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

This is an authorized materials list of pavement delineation products and signing materials. The list contains approved reflective and non-reflective pavement markers (both temporary and permanent types), traffic tapes (both temporary and permanent types), reflective sign sheeting, and other approved traffic safety products. It is located on the METS website,

http://www.dot.ca.gov/hq/esc/approved_products_list/

2.1 SUMMARY OF SSPS FOR TEMPORARY PAVEMENT DELINEATION (FOR USE DURING CONSTRUCTION)

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

These SSPs include clauses for furnishing, placing, maintaining, and removing (if necessary) temporary delineation and associated signage. Measurement and payment clauses describe how each delineation item (paint stripe, temporary striping tape, temporary pavement markers, channelizers, etc.) is paid for.

- **SSP 12-8_X1, Temporary Pavement Delineation**

This SSP is recommended when temporary pavement delineation will be needed for 14 days or less. It utilizes temporary reflective markers, temporary striping tape, traffic paint, cones, etc., for short-term delineation.

- **SSP 12-8_X2, Temporary Pavement Delineation**

This SSP is recommended for temporary pavement delineation on bituminous seal coat projects. Temporary flexible tab-type reflective markers (with disposable protective covers) are specified. These reflective markers are applied before binder/aggregate application, after which the protective covers are removed to reveal the reflective tabs.

- **SSP 12-8_X3, Temporary Pavement Delineation**

This SSP is recommended when temporary pavement delineation will be in place for longer than 14 days but less than 6 months. It utilizes temporary reflective markers, temporary striping tape, traffic paint, cones, etc., as needed for interim delineation.

2.2 SUMMARY OF SSP FOR REMOVAL OF EXISTING TRAFFIC STRIPES AND PAVEMENT MARKINGS

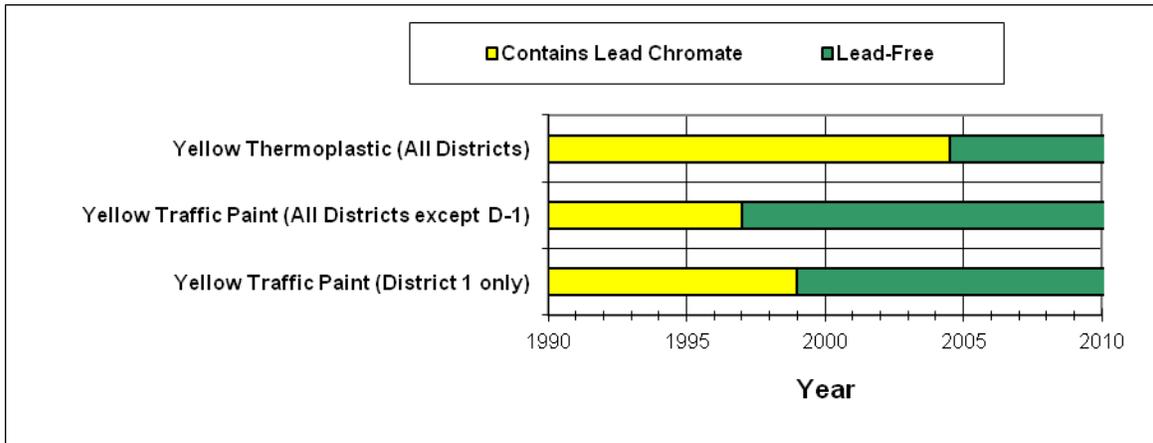
SSP 15-1.03B, Residue Containing High Lead Concentration Paints

Existing striping is often removed prior to repaving as it can interfere with interlayer adhesion of old and new HMA layers. Striping is also removed when traffic lanes must be shifted during construction. This SSP addresses the removal of traffic striping and the hazardous waste issues created when removing and disposing of lead and chromium-containing yellow traffic striping (see section 2.2.1). Existing traffic striping may be left in place and paved-over under certain conditions. The Division of Engineering Services, Materials Engineering and Testing Services, the Office of Roadway Materials and Testing has produced two guidelines that suggest if, and when, existing traffic striping and pavement markers must be removed prior to bituminous seal coating or repaving operations. These guidelines have been included as Figures 2 and 3 in this document.

2.2.1 HAZARDOUS WASTE ISSUES INVOLVING THE REMOVAL OF LEAD AND CHROMIUM-CONTAINING YELLOW TRAFFIC STRIPE

Lead chromate is the yellow pigment that was used in “safety yellow” colored traffic striping for many years. Only recently was this hazardous pigment replaced with lead-free and chromium-free yellow substitute pigments (see Figure 1). Lead chromate containing yellow striping materials may contain ~ 20,000 ppm of lead and ~ 5000 ppm of hexavalent chromium. The debris produced when this older yellow striping is ground from the pavement will likely meet the definition of hazardous waste, unless it is substantially diluted with the underlying paving material—as in the case where extensive pavement milling is being done.

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



SSP 15-1.03B includes instructions for removal and disposal of lead chromate containing 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 lead chromate containing 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. 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 15-2.02C

http://dot.ca.gov/hq/esc/oe/specifications/std_specs/2010_StdSpecs/

Caltrans Construction Manual, see Section 7-106B (2)

<http://www.dot.ca.gov/hq/construc/manual2001/>

For stripe look for Thermoplastics and Road Striping Waste,

http://env.dot.ca.gov/haz_waste/haz_guidance/hw_guidance.shtml

There is also specific guidance from the Division of Environmental Analysis for preparing the 2006 version of the SSP (14-001) posted on their specifications web page:

http://env.dot.ca.gov/haz_waste/haz_sp_provisions/hw_sp.shtml

The direct link to this guidance is:

http://env.dot.ca.gov/haz_waste/haz_sp_provisions/docs/GUIDANCE%20FOR%2014-001.doc

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. Use the link below to find the contact information for the senior in each district.

http://env.dot.ca.gov/haz_waste/haz_waste_index.shtml

3.0 STANDARDS PLANS FOR PAVEMENT DELINEATION

Detail drawings for standard traffic striping/markings schemes are found on pages 9 through 17 of the 2010 Caltrans *Standard Plans*, located at:

http://dot.ca.gov/hq/esc/oe/project_plans/HTM/10_plans_disclaim_US.htm

4.0 CONTRACT COST DATA FOR PAVEMENT DELINEATION ITEMS

Table 1 contains average bid prices for pavement delineation items (installed cost) from 2010 contract cost data. See the Office Engineer Web site for the most up-to-date cost data:

<http://www.dot.ca.gov/hq/esc/oe/awards/>

TABLE 1
2010 Contract Cost Data for
Traffic Striping/Pavement Marking Bid Items

Bid Item Code	Pavement Delineation Material Description	SSP or Standard Specification number	Average Bid Price
840656	Paint Traffic Stripe (2-coat)	84-3	\$0.13/LF (4 inch wide solid line)
840560	Thermoplastic Traffic Stripe (Sprayable)	84-2.03C	\$0.21/LF (4 inch wide solid line)
840561	4 inch Thermoplastic Traffic Stripe	84-2	\$0.82/M (4 inch wide solid line)
840573	Recessed Thermoplastic Traffic Stripe	84-5	\$20.27/M (4 inch wide skip line) 2008 data
840575	Two-Component Paint Traffic Stripe (epoxy)	84-4	\$7.00/M (4 inch wide solid line) 2009 data
394054	Ground-in Rumble Strip (Centerline) w/double yellow thermoplastic stripe	39-1.16 (modified) & 84-2	\$14.8/LF (est.)
120300	Temporary Pavement Marker	12—8_X2	\$2.80/ea.
850101	Pavement Marker (Non-Reflective)	85-1.02B	\$1.01/ea.
850111	Pavement Marker (Retroreflective)	85-1.02C	\$2.83/ea.
150704	Remove Yellow Thermoplastic Traffic Stripe	15-1.03B	\$0.35/LF
150714	Remove Thermoplastic Traffic Stripe	15-1.03B	\$0.31/LF

Bid Item Code	Pavement Delineation Material Description	SSP or Standard Specification number	Average Bid Price
850122	Pavement Marker (Retroreflective-Recessed)	85-1.02C	\$8.21/ea.
840666	Paint Pavement Markings, 2-coat	84-3	\$1.95/ SQFT
840661	Two-Component Paint Pavement Marking	84-4	\$4.94/ SQFT
840515	Thermoplastic Pavement Marking	84-2	\$3.3/ SQFT

5.0 PAVEMENT DELINEATION SSP SELECTION GUIDE

The attached “New Pavement Delineation SSP 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 obliterated on lanes open to public traffic. Select from the three above-mentioned SSPs (see section 2.1) for 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 Pre-Qualified Products Lists (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 thermoplastic and/or two-component traffic paint can provide durable traffic stripes/markings in snow areas. Two-component traffic paint striping applied to ground-in centerline rumble strips is also effective in providing snowplow-resistant pavement delineation. A separate flowchart titled “Two-Component Paint Traffic Stripes and Pavement Markings—Material Selection Guide” (Figure 5) lists additional information about the four categories of two-component traffic paints.

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. SSP 84-6, Enhanced Wet Night Visibility allows the use of larger, composite glass beads embedded in the thermoplastic. This improves nighttime and wet night visibility, but not as much as reflective pavement markers. Lanelines and centerlines consisting of both traffic striping and non-reflective pavement markers (i.e., combining *Standard Plans* details #12 and #13) 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 (i.e., 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

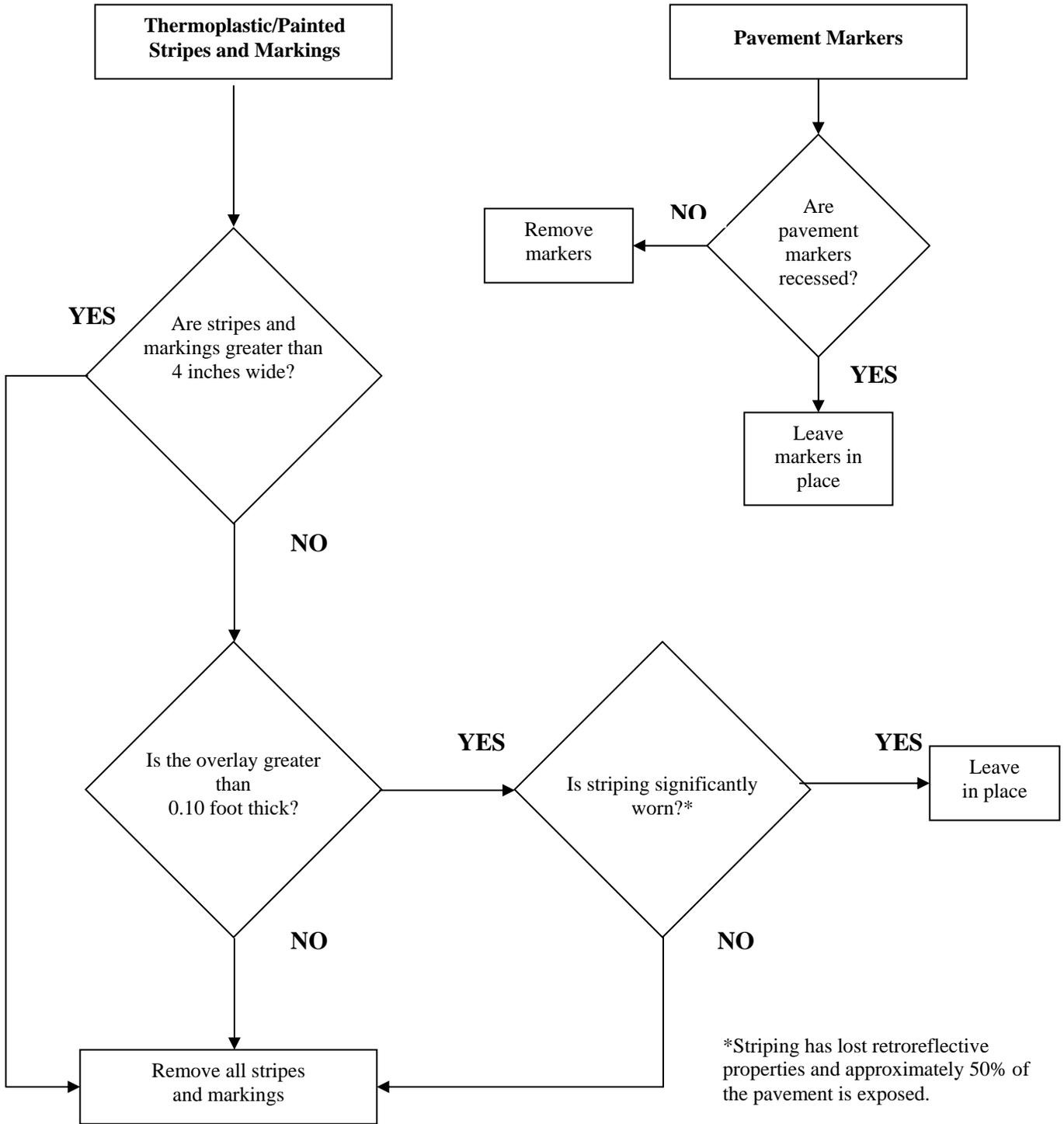


FIGURE 3
Guideline for Removing/Not Removing Existing Striping, Markings, and Pavement Markers Prior to Sealing

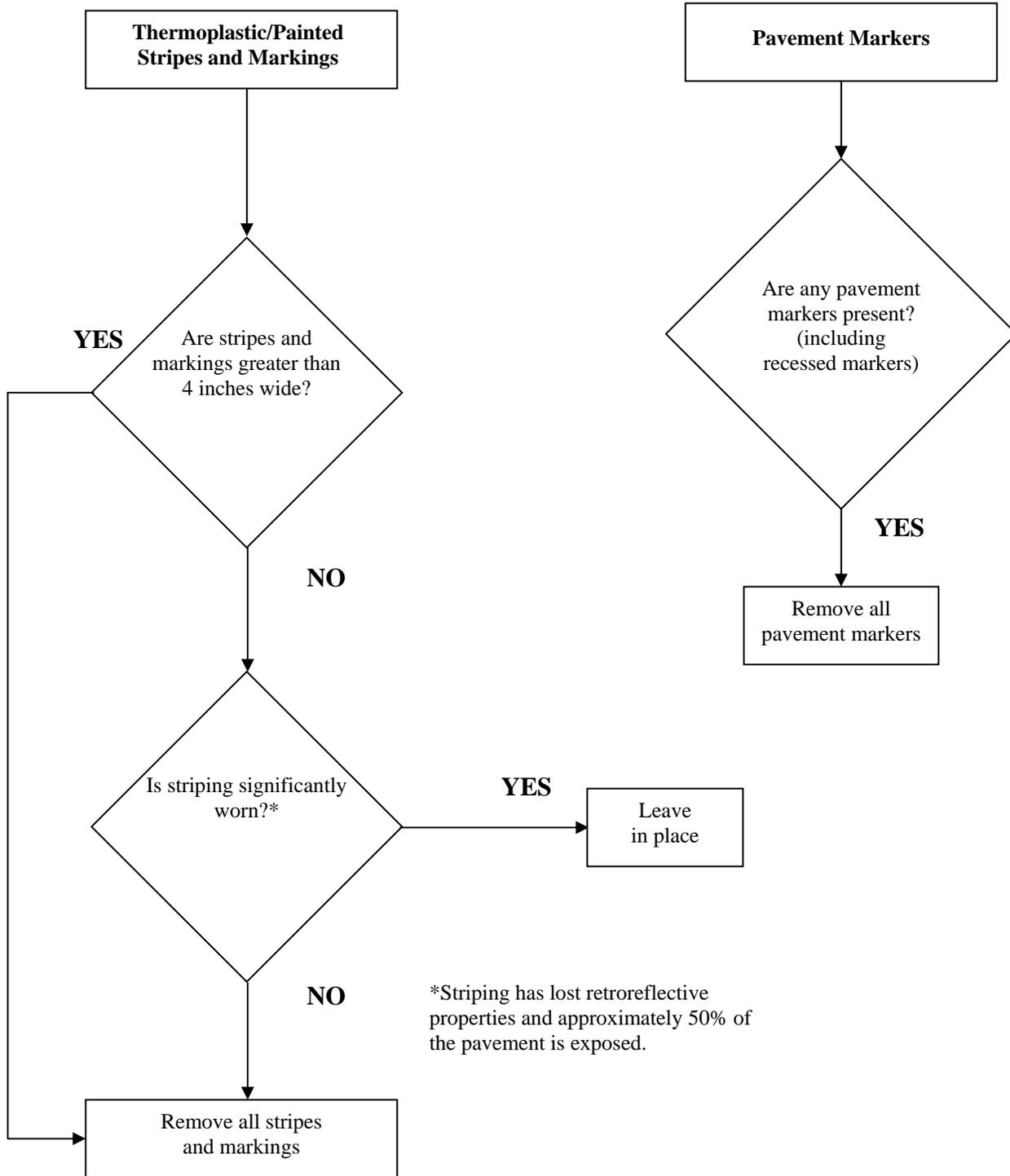


FIGURE 4: New Pavement Delineation SSP Selection Guide

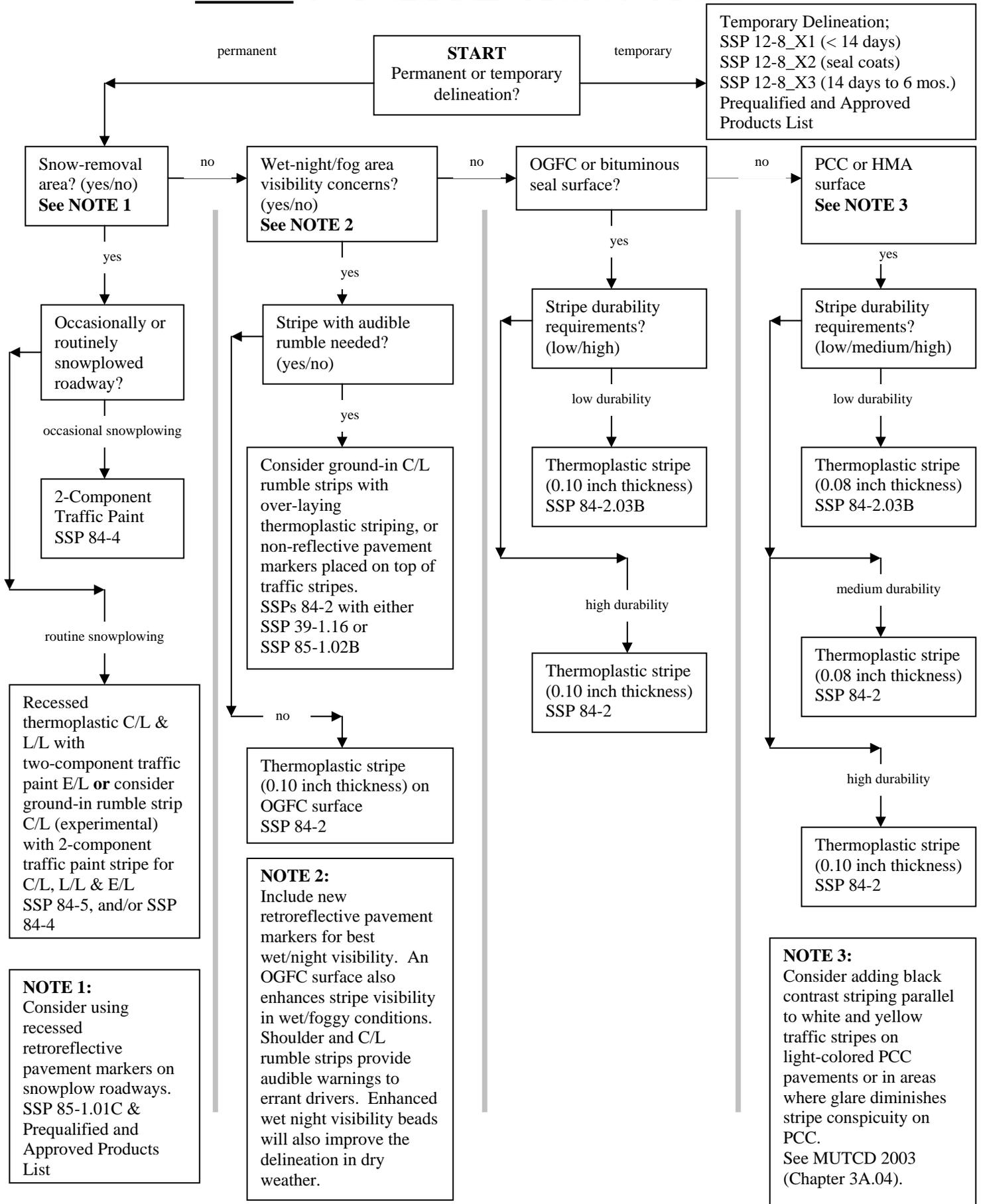
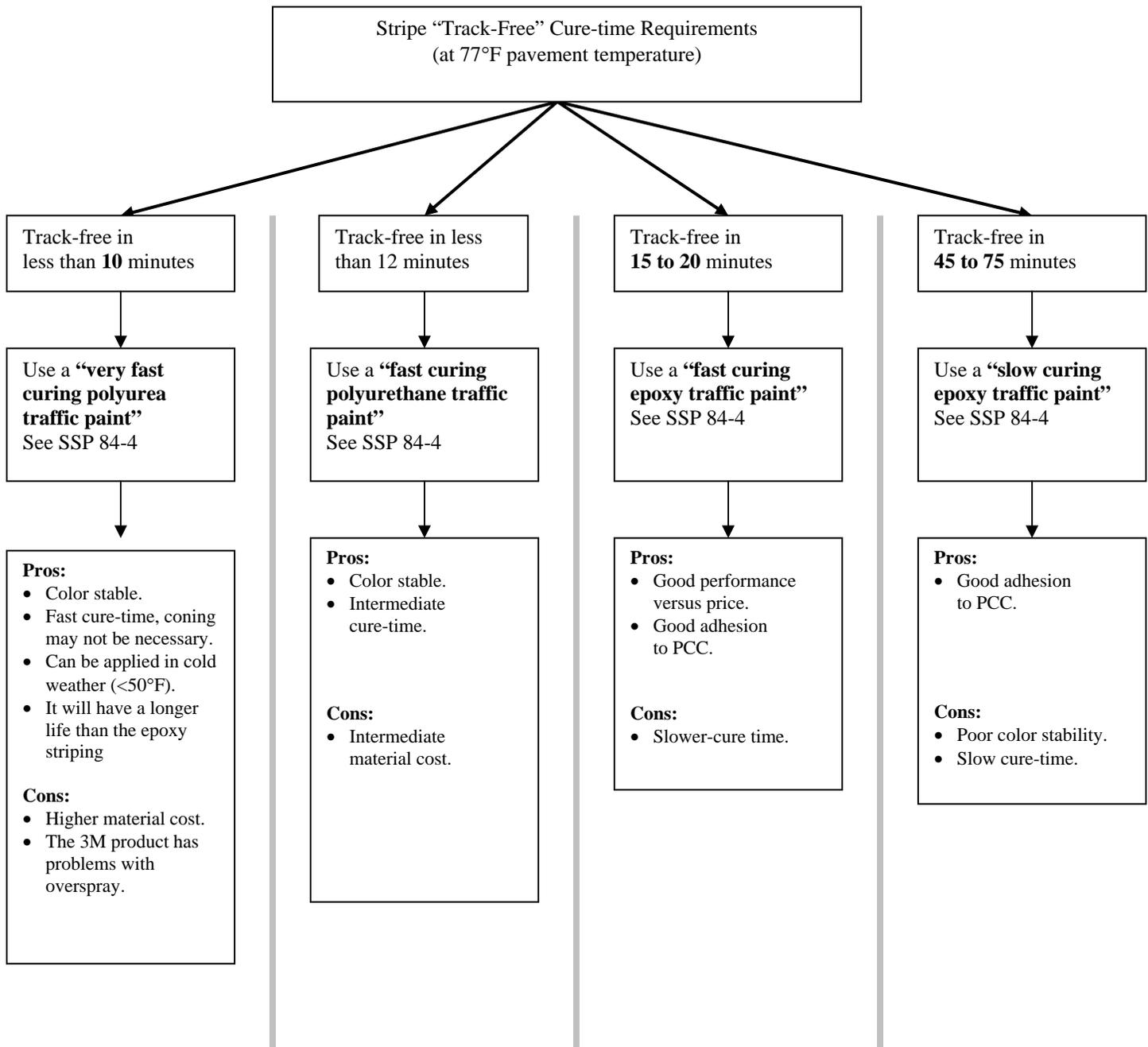


FIGURE 5: Two-Component Paint Traffic Stripes and Pavement Markings
—Material Selection Guide—
 (Use in conjunction with SSP 84-4)



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 road, two-lane winding roads, HOV lane buffer striping, areas where reflective pavement markers are not used.

6.0 EXAMPLES OF IMPROVED TRAFFIC STRIPING TREATMENTS

PHOTO 1: Ground-in centerline rumble strips provide snowplow-resistant striping in addition to an



audible warning to errant drivers (03-ED-50-PM~65, contract #03-1M8804).

PHOTO 2: Recessed thermoplastic striping provides long-term delineation on routinely snow-plowed routes. Recessed retroreflective pavement markers are snowplowable and provide a longer preview



distance (at night) than traffic striping alone (06-FRE-168-PM~34, contract #06-385304).

PHOTO 3: Epoplex LS-90 (two-component polyurea paint) was used to apply test-sections of white and yellow edgelines (non-recessed) on W/B I-80 near the Truckee CHP Weigh Station (elev. ~ 6000'). After one winter season in this routinely snowplowed area, this type of striping was still in satisfactory condition.



PHOTO 4: Black contrast stripes can increase the conspicuity of traffic striping on light-colored PCC pavements, especially in areas with PCC shoulders (03-PLA-80-E/B near Kingvale, striped by District 3 Maintenance).



PHOTO 5: Traffic striping SSPs now require minimum levels of stripe retroreflectivity (nighttime visibility) for new striping. The Chemical Testing Branch can measure the retroreflectivity of questionable new striping.



7.0 OTHER RESOURCES

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

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

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

- Traffic volumes
- MUTCD California Supplement (Signs & Pavement Marking standards)
- Highway Safety Improvement Program Guidelines
- Special Reports/studies about alternative pavement delineation treatments

Division of Traffic Operations (external)

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

Division of Traffic Operations (intranet)

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

- **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.
- Preliminary testing of yellow traffic striping material for lead and chromium.

The Chemical Testing Branch maintains a Web site with lab contact information and downloadable specifications for thermoplastic, traffic paint, and glass beads:

<http://dot.ca.gov/hq/esc/ttsb/chemical/index.html>

- **Traffic Striping Information from Industry**

American Traffic Safety Services Association (ATSSA) Web site

<www.atssa.com>

8.0 REFERENCES

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

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