



**DEVELOPMENTAL SPECIFICATIONS  
FOR  
MULTI-COMPONENT LIQUID PAVEMENT MARKINGS**

**Effective Date  
February 15, 2022**

**THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE DEVELOPMENTAL SPECIFICATIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.**

**15089.01 DESCRIPTION.**

Provide reflectorized white and yellow multi-component, 100% solids multi-component liquid pavement markings that are free of toxic heavy metals for installation on asphalt and PCC pavement surfaces.

**15089.02 MATERIALS.**

**A. General.**

1. Apply multi-component liquid pavement markings in accordance with [Article 2527.01](#) of the Standard Specifications.
2. Use materials capable of producing pavement markings with a wet-film thickness (WFT) of at least 20 mils. Apply at a greater WFT as recommended by the material manufacturer based on pavement type, pavement composition, environmental conditions, placement within a rumble, and other relevant factors. The following is a list of approved products. The Contractor may use an approved equal product pursuant to meeting all other areas of this specification.
  - HPS-3/ HPS-4 manufactured by Ennis-Flint, Inc.
  - 3180 Series MFUA-10 manufactured by SWARCO
  - LS65qs manufactured by Epoplex
3. Provide materials in accordance with the retroreflectivity requirements below.

**Table 15089.02-1: Minimum Initial Retroreflectivity Requirements**

<b>Minimum Coefficient of Retroreflected Luminance</b>	
White lines, Symbols, and Legends	400 mcd/sq. m/lux
Yellow lines	250 mcd/sq. m/lux

4. Provide yellow markings distinguishable from white markings in the dark.
5. Mix individual components before use if stored for more than 12 months.

**B. Multi-Component Liquid Material.**

1. Provide multi-component liquid material meeting the following requirements and characteristics:
  - a. Composed only of multi-component liquids and pigments,
  - b. Does not emit or leach solvents into the environment upon application to a pavement surface,
  - c. The infrared spectrum for all components shall match the reference sample provided by the manufacturer for the product tested and approved by the Department,
  - d. Free of lead, cadmium, mercury, hexavalent chromium, and other toxic heavy metals as defined by the EPA,
  - e. White material no darker than or no yellower than 17778 of Federal Standard Number 595C Colors,
  - f. Daytime color of the yellow epoxy meeting the following CIE chromaticity limits using illuminant "D65/2":

**Table 15089.02-2: Daytime Chromaticity Coordinates**

<b>Daytime Chromaticity Coordinates (Corner Points) - Yellow</b>				
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
x	0.470	0.485	0.520	0.480
y	0.440	0.460	0.450	0.420

- g. White daylight directional reflectance (Y) of least 83%,
- h. Yellow daylight directional reflectance (Y) of at least 50%,
- i. Nighttime color of yellow meeting the following chromaticity limits in ASTM D 6628:

**Table 15089.02-3: Nighttime Chromaticity Coordinates**

<b>Nighttime Chromaticity Coordinates (Corner Points) - Yellow</b>				
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
x	0.575	0.508	0.473	0.510
y	0.425	0.415	0.453	0.490

- j. Contrast ratio of 0.98 or greater when measured on a black/white drawdown card at 15 mils WFT application rate.
2. Provide shadow lane line markings (legend BLB6 or BLC6) according to attached modified Standard Road Plans. Black epoxy should satisfy color chip 37038 of Federal Standard 595B and have similar quality as the white and yellow multi-component pavement markings. An anti-skid material shall be incorporated with the shadow line marking at a minimum rate of 15 pounds per gallon.
3. **Adhesion Capabilities.**  
Provide material meeting the adhesion requirements of the ACI Committee 403 when tested on PCC. Apply multi-component liquid pavement markings during the test to concrete pavements with a tensile strength of at least 300 psi and ensure the failure of the system occurs in the concrete during testing.
4. **Abrasion Resistance.**  
Provide material with an abrasion resistance wear index no greater than 82 when tested in accordance with ASTM C 501 with a CS 17 wheel under a load of 1000 g for 1000 cycles. The Department defines the wear index as the weight in milligrams of material abraded from the sample under the test conditions.

**5. Hardness.**

Provide material with a Type D durometer hardness from 75 to 90 when tested in accordance with ASTM D 2240 after curing for 72 hours at 73°F ±4°F.

**6. Tensile Strength.**

For epoxy-amine based multicomponent systems, including variations of this base chemistry, provide material with a tensile strength of at least 6000 psi when tested in accordance with ASTM D 638 after curing for 72 hours at 73°F ±4°F. For polyurea based multicomponent systems provide material with a tensile strength of at least 3000 psi when tested in accordance with ASTM D 638 after curing for 72 hours at 73°F ±4°F.

**7. Compressive Strength.**

For epoxy-amine based multicomponent systems, including variations of this base chemistry, provide material with a compressive strength of at least 12,000 psi when tested in accordance with ASTM D 695 after curing for 72 hours at 73°F ±4°F.

**C. Retroreflective Media.**

1. Provide first drop wet media per the minimum rate shown for each product below. Use one of the following products for all grooved: edge lines, white broken lines, ramp edge lines, and lane drop lines:
  - 3M Connected Roads All Weather Elements Series 70E or 50E: Minimum rate 5 pounds per gallon
  - Potters VisiUltra 455: Minimum rate 8 pounds per gallon
  - SWARCO DURALUX 334/ 334 Plus: Minimum rate 8 pounds per gallon
2. Provide second drop glass spheres with the following gradation on all lines except for black broken lane lines:

**Table 15089.02-4: Utah Blend Gradation**

Sieve Size	% Passing
No. 18	65-80
No. 30	30-50
No. 50	0-5

- a. Glass spheres shall be dual coated.
- b. Apply glass spheres at a minimum rate of 15 pounds per gallon. Application rate shall provide required minimum levels of retroreflectivity in accordance with Table 15089.02-1.
3. Provide beads packaged in moisture-proof, multi-wall shipping bags, and in containers marked with the following information:
  - a. Manufacturer name,
  - b. Manufacturer address,
  - c. Type of treatment,
  - d. Batch number, and
  - e. Date of manufacture.

**D. Sampling and Testing.**

1. Test daylight directional reflectance and color meeting the requirements of ASTM E 1349.
2. Provide 1 pint samples of each manufacturer's lot or batch of material when manufactured to an independent lab for this testing. NTPEP data may be substituted if the product has not changed from initial submittal to NTPEP for evaluation of these products.

3. Submit to the Engineer a manufacturer's Certificate of Compliance for all components of the multi-component liquid pavement marking system.
4. Mark containers with the following information:
  - a. Name of manufacturer,
  - b. Product identification number,
  - c. Lot or batch number,
  - d. Date of manufacture,
  - e. Color, and
  - f. Net weight of contents.

**15089.03 CONSTRUCTION.**

**A. General.**

1. The contract documents will specify quantity, locations, and type of pavement markings required.
2. Allowable painting dates will be from April 8th to October 22nd. Minimum pavement surface temperatures for application of pavement markings shall be 40°F and rising.
3. For all pavement markings, ensure pavement surface is dry and free from dirt, dust, oil, curing compound, and other contaminants which may interfere with markings properly bonding to the surface. Ensure the clean surface is at least 1 inch wider than anticipated marking. Shoot an air blast on the pavement surface immediately prior to placing new marking. Air blast is not intended to remove large amounts of dust, but only a very small amount of residue that might be left from removal and cleaning operation.
4. For pavement markings placed on a new asphalt surface, install any necessary temporary pavement markings, and wait a minimum of 2 weeks from the day the surface is completed before installing permanent markings.
5. Ensure the following for all painted pavement markings:
  - Uniform thickness
  - Uniform distribution of glass beads throughout the line width,
  - Line widths as specified, with a tolerance of  $\pm 1/2$  inch for all lines,
  - Markings have sharp edges and cutoffs at the ends.

**B. Grooving.**

1. Perform grooving after surface corrections for pavement smoothness, shouldering, and fog sealing have been completed.
2. Grooved in lines shall be 80 mils with a tolerance of  $\pm 10$  mils in depth and the width of the line plus 1 inch with a tolerance of  $\pm 1/8$  inch.
3. Equipment shall be capable of recessing the total width of the recess in one pass. Ensure the bottom of the groove has a fine corduroy-like texture. The maximum allowable rise between the high and low points across the width of the groove is 10 mils.
4. Do not place temporary pavement markings within grooves.

**C. Traffic Control.**

Apply the provisions of [Section 2528 of the Standard Specifications](#) to traffic control for removing

and placing painted and taped pavement markings, along with the following additional requirements:

1. Place traffic control devices on the roadway before removal operations have commenced. Leave traffic control devices in place through the completed curing time of the newly applied pavement markings.
2. Do not close any longer length of lane than can be adequately removed and replace in a single working day.
3. For painted pavement markings, do not remove traffic control devices until the newly applied pavement markings are tack free.

**D. Final Inspection**

Provide an acceptable, calibrated 30 meter geometry (100 feet), retroreflectometer to use on the project which will remain the property of the Contractor. In the presence of the Engineer, measure the retro-reflectivity of the pavement markings. Take a minimum of five randomly spaced readings per line type every 1 mile. The average minimum retro-reflectivity per mile shall be as per table 1 from Article 15089.02, A, 3.

**E. Defective Pavement Markings.**

1. Markings that are low on initial retroreflectivity up to 20% may, at the discretion of the Engineer, be accepted with a price adjustment.
2. Repair, at no additional cost to the Contracting Authority, all pavement markings which, after application and curing, the Engineer determines to be defective and not in conformance with these specifications. Remove the defective markings completely and clean to the underlying pavement surface according to the requirements of [Article 2527.03, C of the Standard Specifications](#). Remove the defective area plus all adjacent marking material extending 1 foot in any direction. After surface preparation work is complete, finish the repair by reapplying new marking material over the cleaned pavement surface according to the requirements of these specifications.

**15089.04 METHOD OF MEASUREMENT.**

- A.** Measurement for pavement markings and grooves cut, satisfactorily placed, or approved, will be as follows:

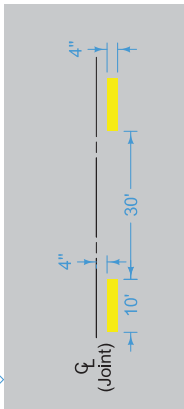
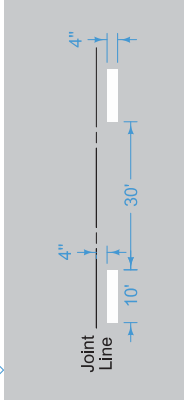
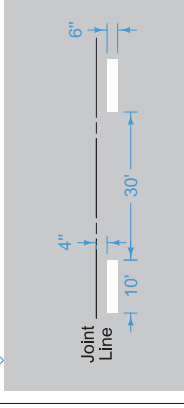
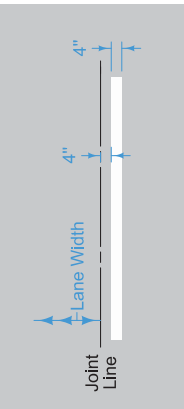
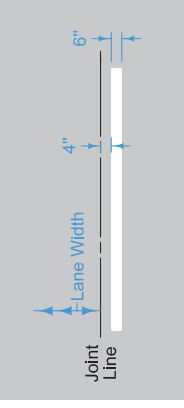
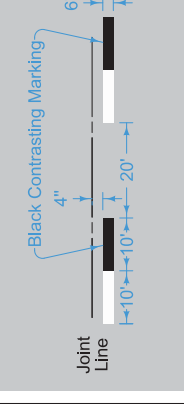
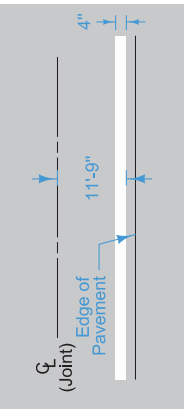
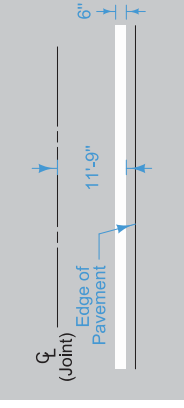
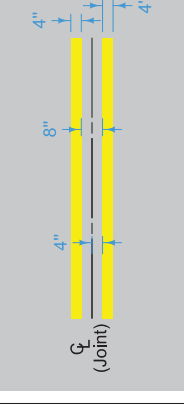
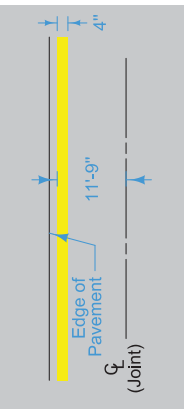
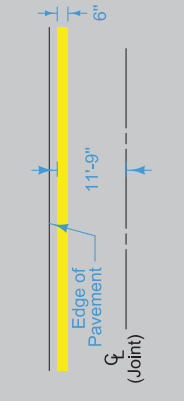
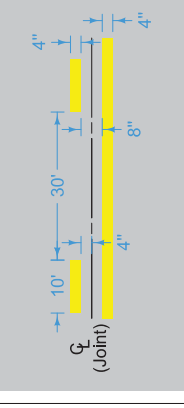
1. **Painted Pavement Markings, Multi-Component Liquid.**  
Stations placed.

2. **Grooves Cut for Pavement Markings.**  
Stations. This quantity will be equivalent to the number of stations measured for the pavement markings. Additional width and transition length will be incidental.

- B.** The Engineer will measure the number of stations, based on a single 6 inch width of line. The length of markings will be determined using beginning and ending points, and adjusting for breaks at ramps, station equations, or other locations shown in the contract documents. The measurement for dashed and dotted lines will be adjusted to exclude skips. Measurement of lines wider than 6 inches will be adjusted by the quantity factor to a 6 inch line.

**15089.05 BASIS OF PAYMENT.**

Painted Pavement Markings, Multi-Component Liquid and Grooves Cut for Pavement Markings will be paid for per [Article 2527.05](#) of the Standard Specifications.

<p>BCY4 &gt; BROKEN CENTERLINE (Yellow)</p> 	<p>BLW4 &gt; BROKEN LANE LINE (White)</p> 	<p>BLW6 &gt; BROKEN LANE LINE (White)</p> 
<p>SLW4 &gt; SOLID LANE LINE (White)</p> 	<p>SLW6 &gt; SOLID LANE LINE (White)</p> 	<p>BLC6 &gt; BROKEN LINE CONTRAST (White/Black)</p> 
<p>ELW4 &gt; EDGE LINE RIGHT (White)</p> 	<p>ELW6 &gt; EDGE LINE RIGHT (White)</p> 	<p>DCY4 &gt; DOUBLE CENTERLINE (Yellow)</p> 
<p>ELY4 &gt; EDGE LINE LEFT (Yellow)</p> 	<p>ELY6 &gt; EDGE LINE LEFT (Yellow)</p> 	<p>NPY4 &gt; NO PASSING ZONE LINE (Yellow)</p> 

Lane layouts shown are typical.  
Centerlines and lane lines may be painted either side of centerline.  
Drawings on sheets 1 to 3 are oriented to represent direction of traffic moving from left to right.

Possible Contract Items:  
Pavement Marking Line Items  
Painted Pavement Markings,  
Multi-Component Liquid  
Grooves Cut for Pavement Markings  
Possible Tabulations:  
108-22  
108-22M

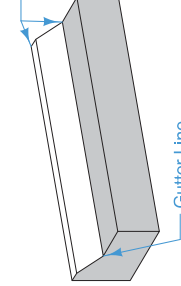
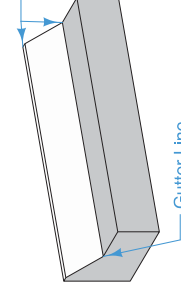
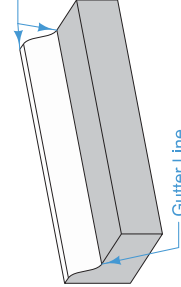
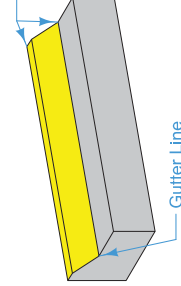
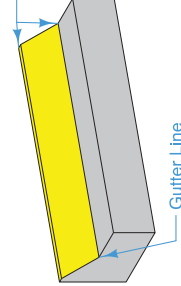
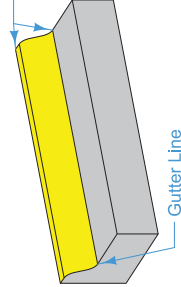
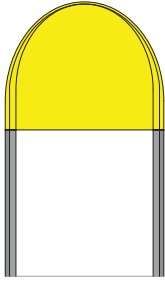
<p><b>MODIFIED</b></p>	<p>REVISION 3 04-27-20</p>
<p><b>STANDARD ROAD PLAN</b></p>	<p><b>PM-110</b></p>
<p>MODIFICATIONS: ADDED BLM6, BLC6, SLW6, ELY6, BLW6, DCY4, DLY4, CHW12, and LDM12; ADDED NEW POSSIBLE CONTRACT ITEMS AND TABULATIONS.</p>	<p>SHEET 1 of 4</p>
<p><b>LINE TYPES</b></p>	

<p>RLW4 &gt; RAMP EDGE LINE RIGHT (White)</p>	<p>RLW6 &gt; RAMP EDGE LINE RIGHT (White)</p>	<p>RLY4 &gt; RAMP EDGE LINE LEFT (Yellow)</p>
<p>RLY6 &gt; RAMP EDGE LINE LEFT (Yellow)</p>	<p>DLY4 &gt; DOTTED LINE (Yellow)</p>	<p>DDY4 &gt; DOUBLE DOTTED LINE (Yellow)</p>
<p>DLW4 &gt; DOTTED LINE (White)</p>	<p>DLW6 &gt; DOTTED LINE (White)</p>	<p>CHY8 &gt; CHANNELIZING LINE (Yellow)</p>
<p>CHW8 &gt; CHANNELIZING LINE (White)</p>	<p>CHW12 &gt; CHANNELIZING LINE (White)</p>	<p>LINE TYPES</p>

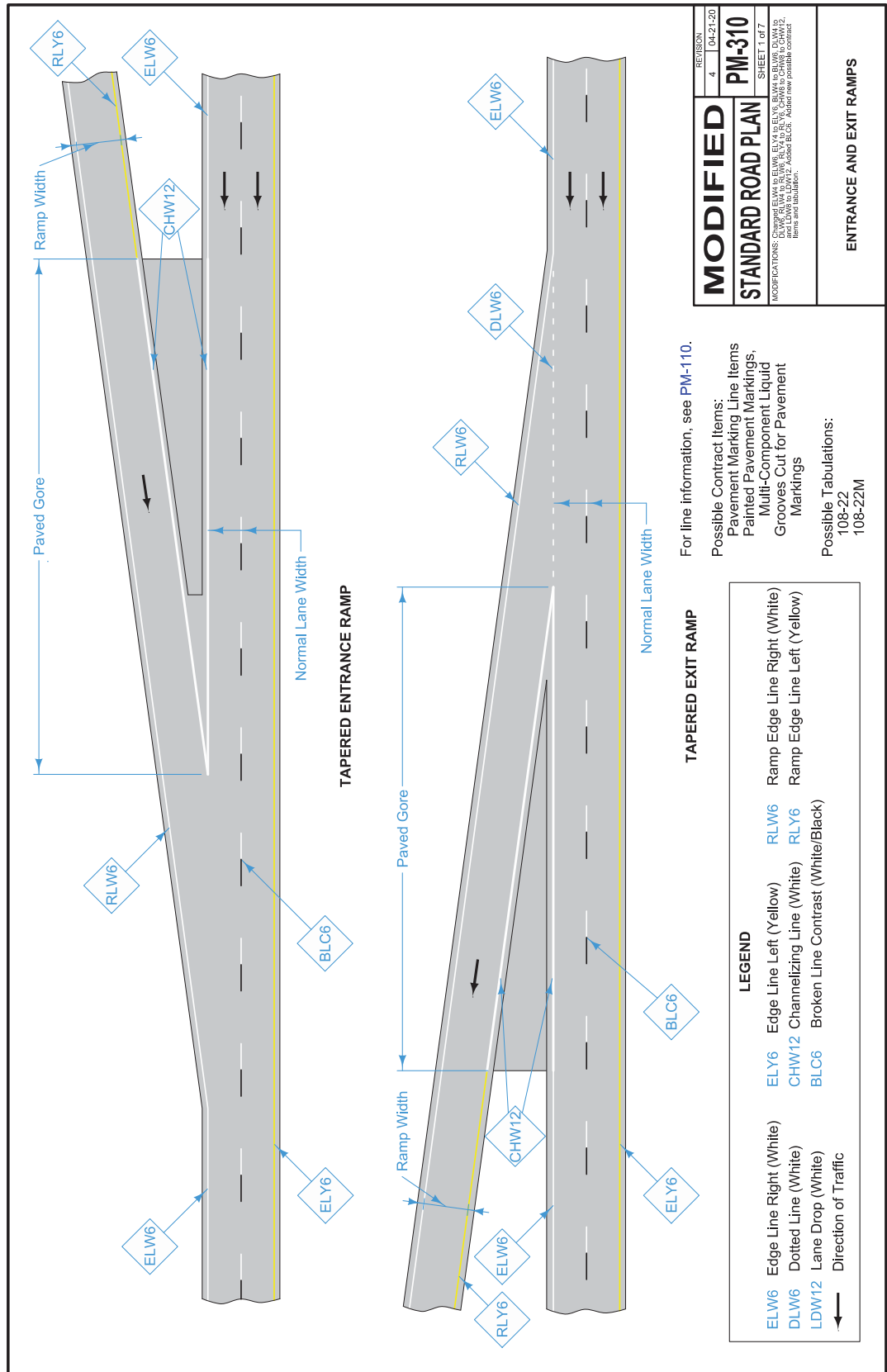
<b>MODIFIED</b>	REVISION 3   04-27-20
	<b>PM-110</b>
<b>STANDARD ROAD PLAN</b>	
SHEET 2 of 4	
<small>MODIFICATIONS: ADDED BLANK BLOCK, SLWS, ELY4, ELY6, ELY8, RLY4, RLY6, DLY4, DLY6, CHW8, CHW12, and DDW12. Added new possible contract items and tabulation.</small>	
LINE TYPES	

<p>LDW8 &gt; LANE DROP (White)</p>	<p>LDW12 &gt; LANE DROP (White)</p>	<p>SLW2 &gt; STOP LINE (White)</p>	<p>YLW2 &gt; YIELD LINE (White)</p>	<p>CBW6 &gt; CROSSWALK BAR (White)</p>	<p>CLW6 &gt; CROSSWALK LINE (White)</p>			<table border="1"> <tr> <td>REVISION</td> <td>3</td> <td>04-27-20</td> </tr> <tr> <td colspan="3"><b>MODIFIED</b></td> </tr> <tr> <td colspan="3"><b>STANDARD ROAD PLAN</b></td> </tr> <tr> <td colspan="3"><b>PM-110</b></td> </tr> <tr> <td colspan="3">SHEET 3 of 4</td> </tr> <tr> <td colspan="3">MODIFICATIONS: Added BLWS, BLOS, SLWS, ELVLS, BLVLS, DLWS, CLW12, and LDW12. Added new possible contract items and tabulation.</td> </tr> <tr> <td colspan="3" style="text-align: center;"><b>LINE TYPES</b></td> </tr> </table>	REVISION	3	04-27-20	<b>MODIFIED</b>			<b>STANDARD ROAD PLAN</b>			<b>PM-110</b>			SHEET 3 of 4			MODIFICATIONS: Added BLWS, BLOS, SLWS, ELVLS, BLVLS, DLWS, CLW12, and LDW12. Added new possible contract items and tabulation.			<b>LINE TYPES</b>		
REVISION	3	04-27-20																											
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<b>LINE TYPES</b>																													

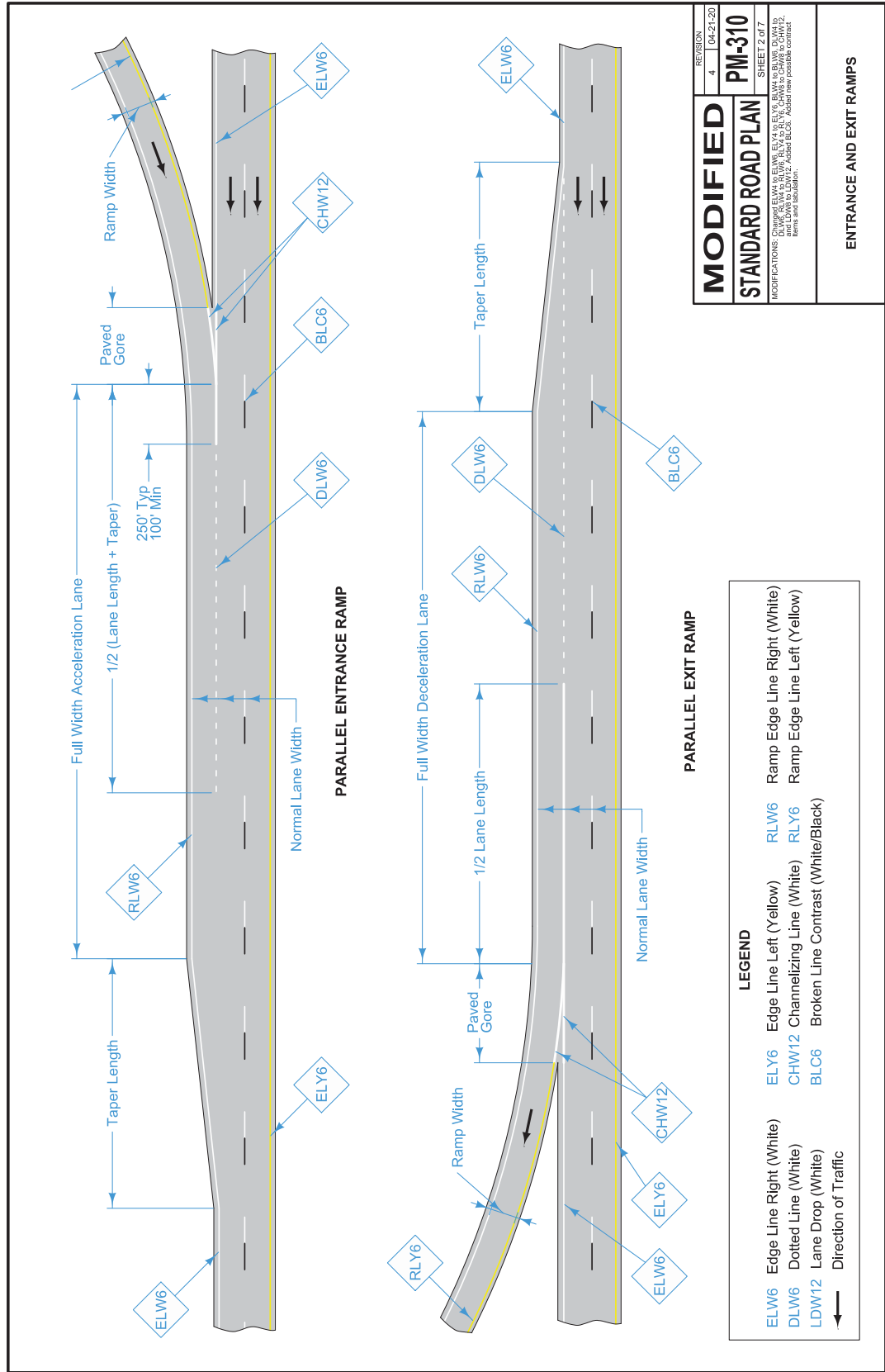


<p>&lt;SPW4&gt; SLOPED CURB 4" (White)</p>  <p>Gutter Line</p>	<p>&lt;SPW6&gt; SLOPED CURB 6" (White)</p>  <p>Gutter Line</p>	<p>&lt;STW6&gt; STANDARD CURB 6" (White)</p>  <p>Gutter Line</p>	<p>Apply paint from back of curb to gutter line.</p>
<p>&lt;SPY4&gt; SLOPED CURB 4" (Yellow)</p>  <p>Gutter Line</p>	<p>&lt;SPY6&gt; SLOPED CURB 6" (Yellow)</p>  <p>Gutter Line</p>	<p>&lt;STY6&gt; STANDARD CURB 6" (Yellow)</p>  <p>Gutter Line</p>	
<p>&lt;MNY4&gt; MEDIAN NOSE (Yellow)</p> 			

<p>REVISION</p> <p>3 04-27-20</p>	<p><b>MODIFIED</b></p>
<p>PM-110</p> <p>SHEET 4 of 4</p> <p>MODIFICATIONS: ADDED BLANK BLOCK, SLABS, ELYS, BLANK, BLANK, CURB, CHW12, and CHW12Z. Added new possible contract items and tabulation.</p>	<p><b>STANDARD ROAD PLAN</b></p>
<p>LINE TYPES</p>	

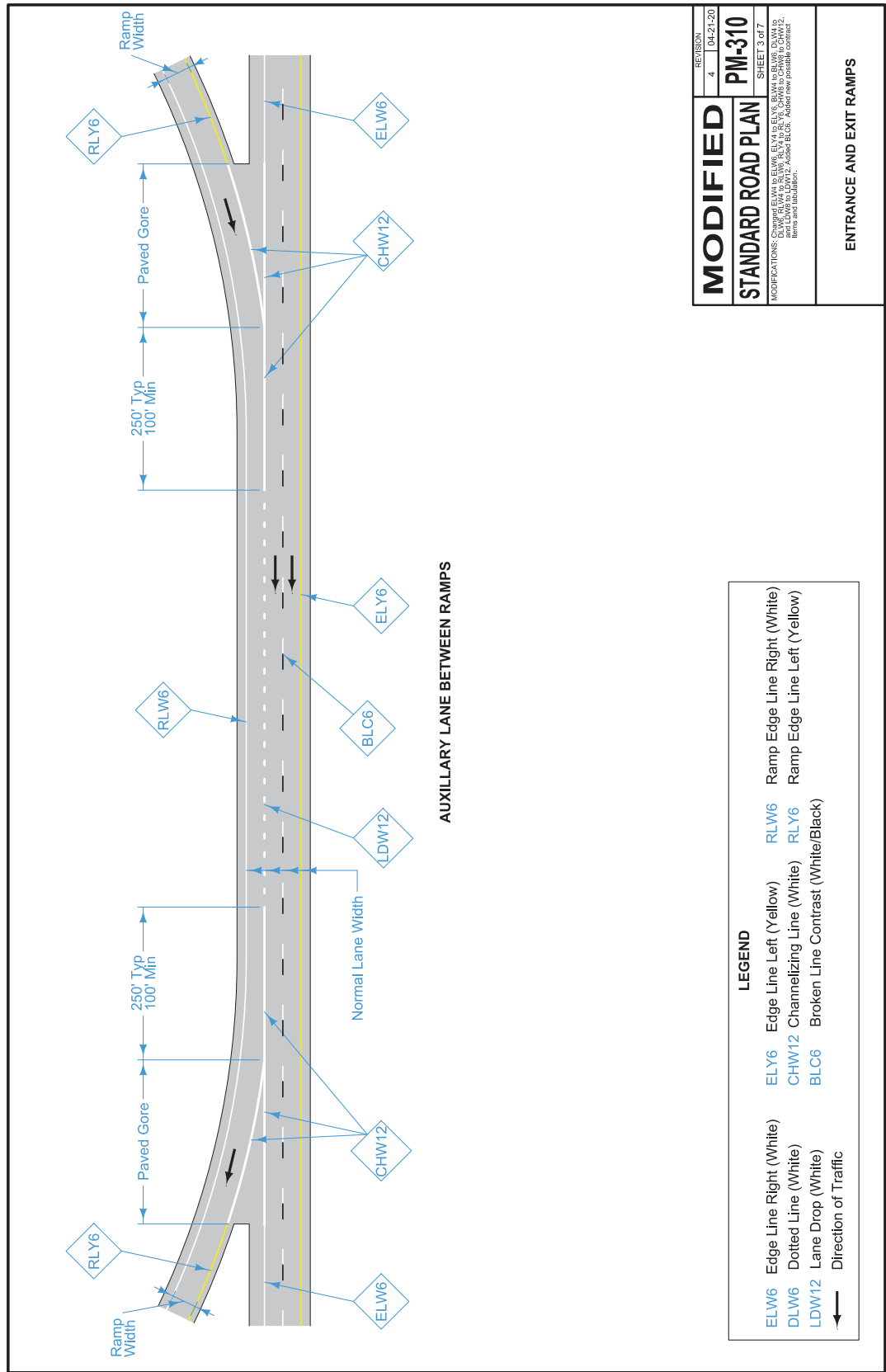


<b>MODIFIED</b>	REVISION	4	04-27-20
	<b>PM-310</b>		
<b>STANDARD ROAD PLAN</b>		SHEET 1 of 7	
<small>MODIFICATIONS: Changed ELW6 to ELY6, ELY6 to ELY6, BLY6 to ELW6, DLY6 to DLW6, RLY6 to RLY6, CHW12 to CHW12, BLC6 to BLC6, Added new possible contract items and tabulations.</small>			
<b>ENTRANCE AND EXIT RAMP</b>			



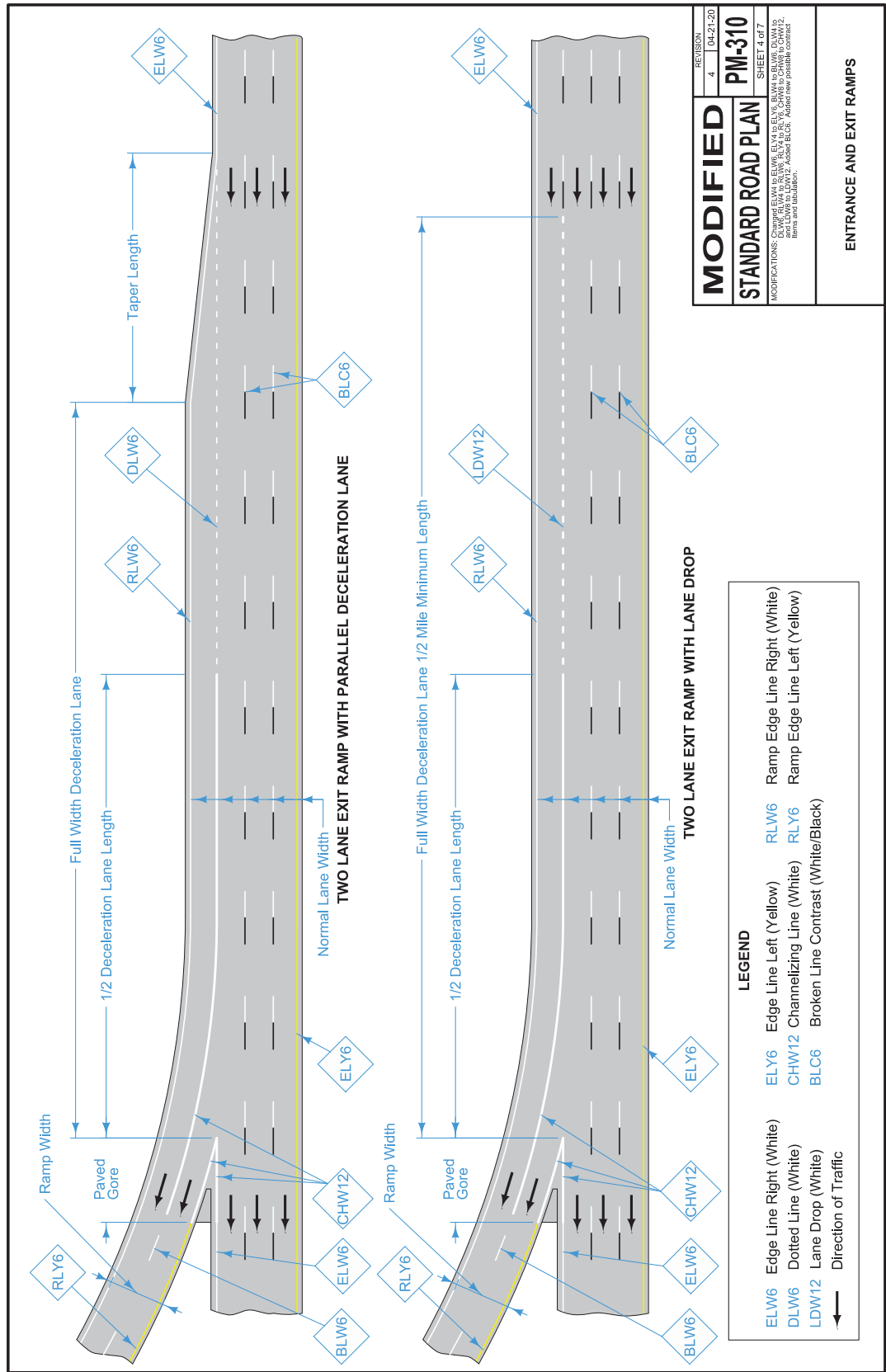
REVISION	4	04-27-20
<b>MODIFIED</b>	<b>PM-310</b>	
<b>STANDARD ROAD PLAN</b>	SHEET 2 of 7	
<small>MODIFICATIONS: Changed ELW6 to ELY6, ELW4 to ELY4, BLM6 to BLY6, DMM6 to DMY6, RLY6 to RLY6, CHW6 to CHW12, CHW12 to CHW12, BLC6 to BLC6, Added new private contract items and fabrication.</small>		
<b>ENTRANCE AND EXIT RAMP</b>		

LEGEND			
ELY6	Edge Line Right (White)	RLW6	Ramp Edge Line Right (White)
DLW6	Edge Line Left (Yellow)	RLY6	Ramp Edge Line Left (Yellow)
CHW12	Dotted Line (White)	BLC6	Broken Line Contrast (White/Black)
LDW12	Channelizing Line (White)		
	Lane Drop (White)		
	Direction of Traffic		

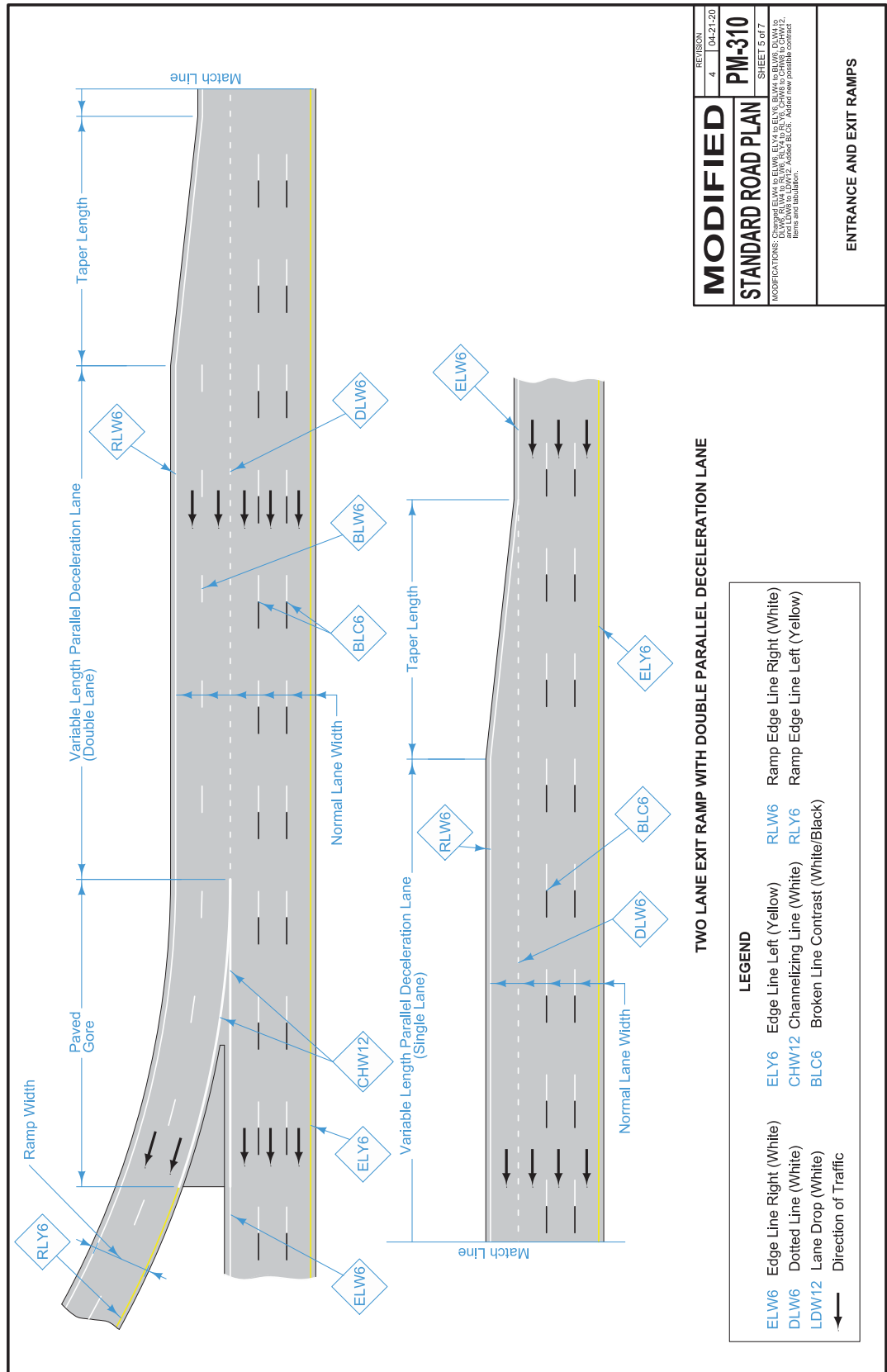


<b>MODIFIED</b>	REVISION 4	DATE 04-27-20
	<b>PM-310</b>	
<b>STANDARD ROAD PLAN</b>		
MODIFICATIONS: Changed ELW6 to ELW6, ELN4 to ELN4, BLM6 to BLM6, DMW6 to DMW6, RLY6 to RLY6, CHW12 to CHW12, BLC6 to BLC6, LDW12 to LDW12, and added RLY6, RLM6, ELY6, CHW12, BLC6, LDW12, and ELW6.		
<b>ENTRANCE AND EXIT RAMP</b>		

LEGEND			
ELW6	Edge Line Right (White)	RLW6	Ramp Edge Line Right (White)
ELY6	Edge Line Left (Yellow)	RLY6	Ramp Edge Line Left (Yellow)
DLW6	Dotted Line (White)	BLC6	Broken Line Contrast (White/Black)
LDW12	Lane Drop (White)	CHW12	Channelizing Line (White)
→	Direction of Traffic		



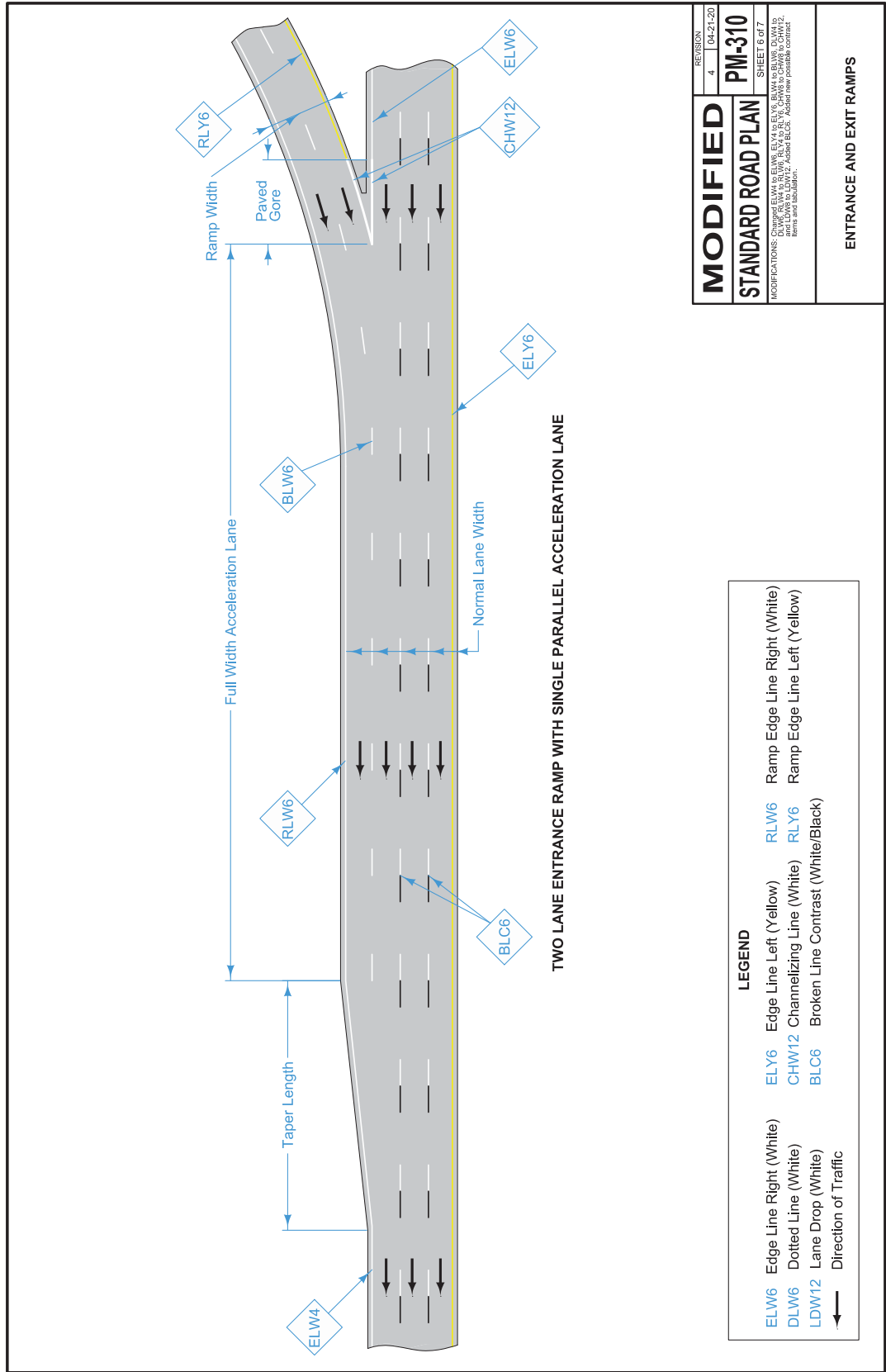
<b>MODIFIED</b>		REVISION 4	DATE 04-27-20
<b>STANDARD ROAD PLAN</b>			
PROJECT <b>PM-310</b>		SHEET 4 of 7	
<small>MODIFICATIONS: Changed ELW6 to ELW6, ELW6 to ELW6, BLW6 to BLW6, DLW6 to DLW6, RLY6 to RLY6, RLY6 to RLY6, CHW12 to CHW12, BLC6 to BLC6, ELY6 to ELY6, CHW12 to CHW12, ELY6 to ELY6. Added new private contract items and fabrication.</small>			
<b>ENTRANCE AND EXIT RAMP</b>			



TWO LANE EXIT RAMP WITH DOUBLE PARALLEL DECELERATION LANE

LEGEND			
ELW6	Edge Line Right (White)	ELY6	Edge Line Left (Yellow)
DLW6	Dotted Line (White)	CHW12	Channelizing Line (White)
LDW12	Lane Drop (White)	BLC6	Broken Line Contrast (White/Black)
→	Direction of Traffic	RLW6	Ramp Edge Line Right (White)
		RLY6	Ramp Edge Line Left (Yellow)

<b>MODIFIED</b>	REVISION 4   04-27-20
	<b>PM-310</b>
	SHEET 5 of 7
MODIFICATIONS: Changed ELW6 to ELY6, ELW6 to ELY6, BLW6 to BLW6, DLW6 to DLW6, RLY6 to RLY6, RLY6 to RLY6, CHW12 to CHW12, LDW12 to LDW12, BLC6 to BLC6, BLC6 to BLC6, Added new private contract items and fabrication.	
<b>STANDARD ROAD PLAN</b>	
<b>ENTRANCE AND EXIT RAMPS</b>	



<b>MODIFIED</b>	REVISION 4   04-27-20
<b>STANDARD ROAD PLAN</b>	<b>PM-310</b> SHEET 6 of 7
MODIFICATIONS: Changed ELW6 to ELW4 to ELY6, BLW6 to BLW4, DLW6 to DLW4, RLY6 to RLY4, CHW12 to CHW10, CHW6 to CHW4, CHW12 to CHW10, and tabulation.	
<b>ENTRANCE AND EXIT RAMP</b>	

LEGEND			
ELW6	Edge Line Right (White)	ELY6	Edge Line Left (Yellow)
DLW6	Dotted Line (White)	CHW12	Channelizing Line (White)
LDW12	Lane Drop (White)	BLC6	Broken Line Contrast (White/Black)
→	Direction of Traffic	RLY6	Ramp Edge Line Right (White)
		RLY4	Ramp Edge Line Left (Yellow)

