14.0 SIGNING, PAVEMENT MARKING, SIGNALIZATION, AND LIGHTING INFRASTRUCTURE

The Contractor shall provide permanent signing, pavement marking, traffic signalization, and lighting for the Project.

The Contractor shall be responsible for the design and installation of the Project permanent signing, pavement marking, traffic signalization, and lighting elements within the limits of the Project and comply with the requirements of this Section 14.

The signing, pavement marking, traffic signalization, and lighting elements shall have the flexibility to accommodate Project changes that produce benefits or savings to CDOT or the Contractor without impairing the essential functions and characteristics of the Project such as safety, operations, durability, maintainability, and visibility.

14.1 Design Requirements

The Contractor shall prepare signing, pavement marking, and traffic signal designs and plans for all areas on the Project in accordance with the requirements of the following sections. These plans shall be a component of all Released for Construction Documents where any signing, pavement marking, traffic signal, or lighting element is required for the Work. No material, part, or attachment of any equipment shall be substituted or applied contrary to the manufacturer's recommendations and standard practices.

The Contractor shall provide permanent signing, pavement marking, delineation, and other traffic control devices that facilitate safe flow of traffic through the completed Project elements and that accommodates future phases of the Project (subsequent phases and any Additional Requested Elements [ARE] not included in the Basic Configuration).

The Contractor shall prepare lighting, electrical designs, and plans for all areas on the Project. The electrical designs shall include the electrical and power requirements for the Intelligent Transportation Systems (ITS) as described in Book 2, Section 19, ITS. The Contractor shall coordinate with the electrical utility company to determine electric power requirements for the Project and to develop the Project lighting design and construction requirements.

The Contractor shall obtain approval of the power service design from the power service provider and coordinate and meet all requirements as specified by the power service provider for the complete and operational power service to all required locations. All power connections to devices shall include a quick-disconnect.

The Contractor shall be responsible for the coordination of power source work to be performed by Xcel Energy. The Contractor shall contact the Xcel Energy Builder's Call Line at 1-800-628-2121 to request, and process to completion, the required coordination to establish the power sources for traffic signals, traffic signal pole mounted lighting and all roadway and street lighting. The Contractor shall perform all work necessary to maintain existing or establish new power sources for traffic signals and lighting. All cost charges from the power service provider, and all

necessary materials, including meter (if required), labor, and coordination required to maintain existing or establish new power sources shall be included in the Work.

The Contractor shall design and construct signing, pavement marking, traffic signal, and lighting elements in accordance with the requirements of the standards listed by priority in Table 14.1-1.

Table 14.1-1
LIGHTING STANDARDS

Priority	Author	Title
1	CDOT	Special Provisions included in Section 14
2	CDOT	*Standard Specifications for Road and Bridge Construction Section 613*
3	Excel	*Excel Outdoor Lighting Standards*
4	CDOT	*Sign Design Manual* – May 21, 2010
5	FHWA	*Manual on Uniform Traffic Control Devices* (Current Edition)
6	AASHTO	*A Policy on Geometric Design of Highways and Streets*
7	AASHTO	*Roadside Design Guide*
8	AASHTO	*Standard Specifications for Highway Bridges*, 16th Edition
9	Local Jurisdiction	*Design Standards, Details, and Specifications*

14.1.1 Permanent Signing

14.1.1.1 Signing Design

The Contractor shall prepare signing designs and plans for the Project area. These plans shall include all necessary guide, warning, supplemental, and regulatory signs, and additions, removals, or modifications to existing signs and appurtenances. Plans shall also include a preliminary layout of signs, which will be required for future phases of the Project and that may affect placement and configuration of signs placed as a part of the Basic Configuration.

Signing design shall comply with the requirements of the most current publications of the CDOT *Standard Specifications for Road and Bridge Construction*, *M & S Standard Plans*, and *Sign Design Manual*; and the FHWA *Manual for Uniform Traffic Control Devices* (MUTCD). Signing design for the intersections affected by US 6 improvements shall also comply with the City and County of Denver *Standard Specifications*. The requirements of the MUTCD shall include both the standard requirements and the guidance recommendations of the manual. The design and plans shall address modifications to permanent signing inside and outside the Project that is rendered inaccurate, ineffective, confusing or unnecessary by the Project. Signing plans shall provide layouts showing the locations of ground-mounted and overhead signs, special sign details, and structural and foundation requirements.

The Contractor shall submit plans for all Class III, major overhead signs, and regulatory and guide signs to CDOT for Approval. These plans shall identify the location and legend for each sign. Sign legends shall be consistent with the Project Signing Concept Plan in the Reference Documents. Sign locations in the Signing Concept Plan are for reference only. The Contractor shall submit sign layouts for all special signs of any size to CDOT for Approval. Existing major

overhead sign structures shall be relocated as necessary to comply with the geometric requirements of the Basic Configuration.

Where CDOT sign structure standards cannot be met, provide custom-designed monotube sign structures and foundations for approval from CDOT Staff Bridge. Permanent signage on bridges shall not be hung from or be attached to the face of bridge superstructures. Existing signs attached to bridge superstructures shall be removed and replaced with monotube sign bridges or cantilever structures if signs are to remain.

The Contractor shall mount all overhead signs with a vertical clearance of 20 feet measured from the high point on the roadway surface under the sign panels to the bottom of the VMS, VTMS, or guide sign (which ever is lowest) to allow for the future installation of lane control signals.

Sign lighting and walkways shall not be used on overhead guide signs.

Sign structures shall be designed to accommodate 100 mph wind speed.

Signs on US 6 identifying local streets within Project boundaries and the boundaries of the City and County of Denver are subject to review and approval by the City and County of Denver.

Signing shall be provided on all Bikeway elements or connections in accordance with MUTCD and the AASHTO *Guide for the Development of Bicycle Facilities, and shall be subject to review and approval of the City and County of Denver Parks*.

14.1.1.2 Materials

The Contractor shall use tubular steel posts per CDOT *S-Standard Plans* for all Class I and Class II ground signs. Wood posts for mounting ground signs shall not be used. All delineators shall have metal posts.

All ground signs shall include breakaway devices per CDOT *S-Standard Plans*.

Sign panel materials shall conform to CDOT *Standard Specifications* Section 713. Sheeting shall be Type IV and Type XI as defined in the CDOT Retroreflective Sheeting Materials Guide, and shall conform to Subsections 713.04 and 713.06 when applicable. For all permanent signs, the legend, borders, and background shall be Type XI.

The Contractor shall be allowed to reuse any of the sign structures, ground signs, and their components that comply with the requirements of this Section 14.

14.1.2 Permanent Pavement Marking

14.1.2.1 Pavement Marking Design

The Contractor shall prepare pavement marking designs and plans for roads affected by the construction of the Project. These plans shall include, all striping required for center lines, edge lines, lane lines, gore areas, lane drops, merging lanes, transition lanes, bike lanes, arrows, legends, symbols, object markings, delineation, and other striping, as well as any modifications required for transitions to existing pavement markings.

Pavement marking design shall comply with the requirements of the most current publications of the CDOT *Standard Specifications for Road and Bridge Construction* and *M & S Standard Plans*; and the FHWA MUTCD. Striping design for the intersections owned by the City and

County of Denver shall also comply with the City and County of Denver *Standard Specifications*. The requirements of the MUTCD shall include both the standard requirements and the guidance recommendations of the manual.

Conceptual mainline and other roadway striping is shown in the Preliminary Plans in the Reference Documents and are for reference only.

14.1.2.2 Materials

The Contractor shall use the pavement-marking Materials at the locations specified in Table 14.1-2.

Table 14.1-2
PAVEMENT MARKING MATERIALS

Location	Pavement Marking Type
Edge lines and channelization lines	Epoxy Pavement Marking
Skip lines on Portland concrete cement pavement (PCCP)	Thermoplastic Pavement Marking Type II (contrast)
Skip lines on Hot Mix Asphalt (HMA)	Thermoplastic Pavement Marking Type I
Words/symbols/cross walks/stop lines	Thermoplastic Pavement Marking Type III

The contractor shall refer to CDOT's striping material chart (attached below) for the pavement marking materials for US 6, I-25 and City and County of Denver facilities

Collector / Arterial Striping Materials

Surface	Line	Material
New Asphalt*	4" White Edge Line	Epoxy
	4" Yellow Edge Line	Epoxy
	4" Double-Yellow Centerline	Epoxy
	4" White Lane Line	Preformed Plastic Type I (Surface Applied)
	4" White Extension Line	Preformed Plastic Type I (Surface Applied)
	8" White Channelizer	Epoxy or Preformed Plastic Type I
	8" White Lane Drop	Preformed Plastic Type I (Surface Applied)
	8" White Double-Left Guide	Preformed Plastic Type I (Surface Applied)
	Stop Bar / Crosswalk	Preformed Plastic Type I (Surface Applied)
	Word Message	Preformed Plastic Type I (Surface Applied)
Old Asphalt	4" White Edge Line	Epoxy
	4" Yellow Edge Line	Epoxy
	4" Double-Yellow Centerline	Epoxy
	4" White Lane Line	Preformed Plastic Type II (Inlaid)
	4" White Extension Line	Preformed Plastic Type II (Inlaid)
	8" White Channelizer	Epoxy or Preformed Plastic Type II
	8" White Lane Drop	Preformed Plastic Type II (Inlaid)
	8" White Double-Left Guide	Preformed Plastic Type II (Inlaid)
	Stop Bar / Crosswalk	Preformed Thermoplastic**
	Word Message	Preformed Thermoplastic**
New Concrete*	4" White Edge Line	Epoxy
	4" Yellow Edge Line	Epoxy
	4" Double-Yellow Centerline	Epoxy
	4" White Lane Line	Preformed Plastic Type II (Inlaid)
	4" White Extension Line	Preformed Plastic Type II (Inlaid)
	8" White Channelizer	Epoxy or Preformed Plastic Type II (S-App)
	8" White Lane Drop	Preformed Plastic Type II (Inlaid)
	8" White Double-Left Guide	Preformed Plastic Type II (Inlaid)
	Stop Bar / Crosswalk	Preformed Plastic Type I (Surface Applied)
	Word Message	Preformed Plastic Type I (Surface Applied)
Old Concrete	4" White Edge Line	Epoxy
	4" Yellow Edge Line	Epoxy
	4" Double-Yellow Centerline	Epoxy
	4" White Lane Line	Preformed Plastic Type II (Inlaid)
	4" White Extension Line	Preformed Plastic Type II (Inlaid)
	8" White Channelizer	Epoxy or Preformed Plastic Type II
	8" White Lane Drop	Preformed Plastic Type II (Inlaid)
	8" White Double-Left Guide	Preformed Plastic Type II (Inlaid)
	Stop Bar / Crosswalk	Preformed Plastic Type I (Surface Applied)
	Word Message	Preformed Plastic Type I (Surface Applied)

* Inlaid markings are preferred on new construction but not required.
**Preformed Plastic Type I markings may be acceptable depending on pavement condition.
-Typical first application of Preformed Plastic markings is surface-applied; consecutive applications are inlaid.

Freeway / Expressway Striping Materials

Surface	Line	Material
New Asphalt*	4" White Edge Line	Epoxy
	4" Yellow Edge Line	Epoxy
	4" Double-Yellow Centerline	Epoxy
	4" White Lane Line	Preformed Plastic Type I (Inlaid)
	4" White Extension Line	Preformed Plastic Type I (Surface Applied)
	8" White Gore Area	Preformed Plastic Type I (Surface Applied)
	8" White Channelizer	Preformed Plastic Type I (Surface Applied)
	8" White Lane Drop	Preformed Plastic Type I (Inlaid)
	8" White Double-Left Guide	Preformed Plastic Type I (Surface Applied)
	Stop Bar / Crosswalk	Preformed Plastic Type I (Surface Applied)
	Word Message	Preformed Plastic Type I (Surface Applied)
Old Asphalt	4" White Edge Line	Epoxy
	4" Yellow Edge Line	Epoxy
	4" Double-Yellow Centerline	Epoxy
	4" White Lane Line	Preformed Plastic Type II (Inlaid)
	4" White Extension Line	Preformed Plastic Type II (Inlaid)
	8" White Gore Area	Preformed Plastic Type II (Surface Applied)
	8" White Channelizer	Preformed Plastic Type II (Surface Applied)
	8" White Lane Drop	Preformed Plastic Type II (Inlaid)
	8" White Double-Left Guide	Preformed Plastic Type II (Inlaid)
	Stop Bar / Crosswalk	Preformed Thermoplastic**
	Word Message	Preformed Thermoplastic**
New Concrete*	4" White Edge Line	Epoxy
	4" Yellow Edge Line	Epoxy
	4" Double-Yellow Centerline	Epoxy
	4" White Lane Line	Preformed Plastic Type II (Inlaid)
	4" White Extension Line	Preformed Plastic Type II (Inlaid)
	8" White Gore Area	Preformed Plastic Type II (Surface Applied)
	8" White Channelizer	Preformed Plastic Type II (Surface Applied)
	8" White Lane Drop	Preformed Plastic Type II (Inlaid)
	8" White Double-Left Guide	Preformed Plastic Type II (Inlaid)
	Stop Bar / Crosswalk	Preformed Plastic Type I (Surface Applied)
	Word Message	Preformed Plastic Type I (Surface Applied)
Old Concrete	4" White Edge Line	Epoxy
	4" Yellow Edge Line	Epoxy
	4" Double-Yellow Centerline	Epoxy
	4" White Lane Line	Preformed Plastic Type II (Inlaid)
	4" White Extension Line	Preformed Plastic Type II (Inlaid)
	8" White Gore Area	Preformed Plastic Type II (Inlaid)
	8" White Channelizer	Preformed Plastic Type II (Inlaid)
	8" White Lane Drop	Preformed Plastic Type II (Inlaid)
	8" White Double-Left Guide	Preformed Plastic Type II (Inlaid)
	Stop Bar / Crosswalk	Preformed Plastic Type I (Surface Applied)
	Word Message	Preformed Plastic Type I (Surface Applied)

* Inlaid markings are preferred on new construction but not required.
**Preformed Plastic Type I markings may be acceptable depending on pavement condition.
-Typical first application of Preformed Plastic markings is surface-applied; consecutive applications are inlaid.

14.1.3 Temporary and Permanent Traffic Signalization

14.1.3.1 Traffic Signal Design

Traffic signal removal is required at:

1. Westbound off-ramp at US 6 and Bryant

Traffic signal improvements are required at:

1. US 6 and Federal Blvd. ramp terminals
2. Eastbound off-ramp US 6 and Bryant

Existing traffic signals at these locations are currently own and maintained by the City and County of Denver. The Contractor shall prepare traffic signal plans that include, existing and proposed intersection plan details, traffic signal pole locations, mast arm and signal head locations, signal pole mounted overhead lighting (luminaires), pedestrian button and signal locations, approach striping and marking locations and types, cabinet and power source locations, conduit and pull boxes, detection systems and locations, and all other plan and component details for complete traffic signal installation in accordance with City and County of Denver Traffic Signal Standards, and shall include Xcel Standards for all traffic signal poles and all non-signal lighting placed on the poles.

{Insert information regarding fiber optic along Federal}

All temporary and permanent traffic signals shall be designed and constructed in conformance with City and County of Denver *Standard Signal Specifications and Standard Drawings* and shall be subject to Approval of the City and County of Denver (CCD) . The Contractor shall coordinate all traffic signal design and installations with the CCD Public Works Department. Permanent traffic signal equipment shall match existing equipment in appearance.

Permanent traffic signalization appurtenances shall not be allowed to hang from, or be attached to the face of bridge superstructures.

14.1.3.3 Materials

The Contractor shall use traffic signal equipment, including traffic signal poles, for all temporary and permanent installations as specified in the CCD *Standard Specifications*

The Contractor shall use traffic signal equipment for the intersections owned by the City and County of Denver as specified in the City and County of Denver Standard Specifications and Xcel Standards.

14.1.4 Permanent Lighting

14.1.4.1 Lighting Design

The Contractor shall prepare lighting designs and plans for US 6 and all existing permanent lighting conditions on roadways impacted by the Project. The plans shall address both temporary and permanent Work and shall include existing topography, ROW, Utilities and

drainage facilities, structures, and all other existing and proposed facilities. The plans shall include location and orientation of standards and fixtures, wiring, conduits, pedestals, power sources, and all other lighting components required to construct the lighting on the Project.

All permanent lighting within the Project shall be designed and constructed to be consistent with current CCD and Excel Standards.

Roadway lighting for US 6 shall be provided from the outside edges of the roadways, unless otherwise approved by CDOT. High-mast lighting will not be allowed.

Roadway lighting shall be provided on US 6 for the entire length of highway being constructed by the Project.

Full interchange lighting shall be provided for at the Federal Interchange.

Lighting for ramps shall replace any lighting impacted by the Project, and at a minimum provide partial interchange lighting for all ramp entrances and exits.

Lighting shall be provided along the CD roads and exit ramps at Federal Blvd. and Bryant Street.

The Contractor shall submit to CCD for Acceptance lighting calculations showing the design meets the performance criteria for roadway design to include average, maximum, minimum foot-candles; and average to minimum, and maximum to minimum luminance on the horizontal roadway plane. In addition, the Contractor shall submit voltage-drop calculations for each circuit.

Lighting on and underneath all bridge structures and within structures for public use facilities, such as sidewalks, bikeways, and trails, within the Project boundaries shall comply with the design criteria for average and minimum luminance for the roadway or pedestrian/bicycle facility. Roadway and pedestrian lighting on bridge structures shall comply with the requirements of the Aesthetic Treatment Concepts in the Reference Documents.

Lighting design and construction shall also include additional conduit and pull boxes within the new bridge structures for future use to provide illumination of US 6, ramps and beneath the bridges.

Lighting designs and plans for the Project shall be subject to CCD and Excel review and Approval.

14.1.4.2 Materials

The Contractor shall use lighting equipment for all permanent installations as specified in the CCD and Excel *Standards Specifications.*

The Contractor shall obtain approval of the lighting equipment from the agency responsible for maintenance. CCD is responsible for street lighting, and Xcel Energy owns & maintains the street lighting in accordance with their franchise agreement.

Xcel Energy is responsible for lighting maintenance for the entire project. The Contractor shall submit the materials lists for the proposed lighting, including under deck lighting for review and approval by Xcel Energy prior to ordering material. The Contractor shall contact the Xcel Energy Builder's Call Line at 1-800-628-2121 to request, and process to completion, the required coordination to review and approve the lighting equipment. All cost charges from Xcel Energy for review and approval shall be included in the Work.

14.2 Construction Requirements

14.2.1 Permanent Signing

The Contractor shall remove and dispose of the existing sign structures, ground-mounted signs, and delineators within the Project area that do not meet the requirements of this Section 14. They shall become the property of the Contractor.

14.2.2 Permanent Pavement Marking

New PCCP shall be sandblasted prior to placement of any primer or pavement-marking material.

14.2.3 Permanent Traffic Signalization

14.2.3.1 Contractor Requirements

The Contractor shall purchase and deliver controller cabinets to the City and County of Denver Public Works for traffic signals.

All existing signalization equipment removed by the Contractor is the property of the City and County of Denver. The Contractor shall deliver in good condition all equipment removed to the City and County of Denver Public Works.

14.2.3.2 Operational

The Contractor shall provide traffic signal timing plans for each traffic signal installation to include these six timing plans: AM, PM, and Off-peak for both weekday and weekend periods. Timing plans shall be prepared using Synchro 7 and include signal coordination with adjacent signals, cycle length, splits, optimal phasing, and sequence. The Contractor shall design timing plans to minimize intersection approach delay and accommodate pedestrians.

Signal timing plans shall be coordinated and approved by the City and County of Denver. Signal timing plans for review and approval shall be submitted a minimum of 28 Days prior to implementation.

The City and County of Denver will equip the controller cabinets with all the necessary software to operate the permanent traffic signals. The City and County of Denver will implement the timing plans for the permanent traffic signals during the initial startup.

14.2.4 Permanent Lighting

Xcel Energy will remove the existing lighting as required within the Project area only for lighting that is owned by Xcel Energy. The Contractor shall be responsible for the coordination of lighting removal and lighting relocation work to be performed by Xcel Energy. The Contractor shall contact the Xcel Energy Builder's Call Line at 1-800-628-2121 to request, and process to completion, the required coordination for Xcel Energy lighting removal or lighting relocation Work. The Contractor shall remove the existing lighting as required within the Project area that is not owned by Xcel Energy, and shall become the property of the Contractor.

14.3 Deliverables

At a minimum, the Contractor shall submit the following to CDOT for review, Approval, and/or Acceptance:

Deliverable	Review, Acceptance, or Approval	Schedule
Class III, major overhead signs, and regulatory and guide signs plan	Approval	90 Days prior to issuance of Released for Construction Documents
Sign layouts for all special signs of any size	Approval	90 Days prior to issuance of Released for Construction Documents
Custom-designed monotube sign structure and foundation plans	Approval	90 Days prior to issuance of Released for Construction Documents
Median butterfly sign structure and foundation plans	Approval	90 Days prior to issuance of Released for Construction Documents
All temporary and permanent traffic signal plans within CDOT ROW	Approval	90 Days prior to issuance of Released for Construction Documents
All temporary and permanent traffic signal plans within local entities	Review	60 Days prior to issuance of Released for Construction Documents
All permanent lighting plans at intersections and local streets owned and maintained by local entities	Review	60 Days prior to issuance of Released for Construction Documents
Traffic Signal Timing Plans and associated electronic timing plan software files	Approval	28 Days prior to implementation
Lighting and electrical design calculations	Acceptance	90 Days prior to issuance of the Released for Construction Documents