

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.

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 in Table 14.1-1 as appropriate for the jurisdictional ownership, oversight and approval of the Work.

REQUEST FOR PROPOSAL – US6 BRIDGES DESIGN BUILD PROJECT
BR 0061-083, SUB ACCOUNT 18838 (CN)
BOOK 2 – TECHNICAL REQUIREMENTS
SECTION 14 – SIGNING, PAVEMENT MARKING, SIGNALIZATION, AND LIGHTING

Table 14.1-1 LIGHTING STANDARDS		
	Author	Title
1	CDOT	Special Provisions included in Section 14
2	CDOT	<i>Standard Specifications for Road and Bridge Construction Section 613</i>
3	Excel	<i>Excel Outdoor Lighting Standards</i>
4	CDOT	<i>Sign Design Manual – May 21, 2010</i>
5	FHWA	<i>Manual on Uniform Traffic Control Devices (Current Edition)</i>
6	AASHTO	<i>A Policy on Geometric Design of Highways and Streets</i>
7	AASHTO	<i>Roadside Design Guide</i>
8	AASHTO	<i>Standard Specifications for Highway Bridges, 16th Edition</i>
9	Local Jurisdiction	<i>Design Standards, Details, and Specifications</i>

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)*. 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.

Signing design for the intersections, local streets and Federal Boulevard shall comply with the City and County of Denver Traffic Engineering Standards of Signs and Markings. City and County of Denver Traffic Engineering Standards of Signs and Markings require submittal of sign post and foundation details, and sign sheeting and material details for review and approval.

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.

REQUEST FOR PROPOSAL – US6 BRIDGES DESIGN BUILD PROJECT
BR 0061-083, SUB ACCOUNT 18838 (CN)
BOOK 2 – TECHNICAL REQUIREMENTS
SECTION 14 – SIGNING, PAVEMENT MARKING, SIGNALIZATION, AND LIGHTING

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 and the CDOT Sign Design Manual. 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. All existing overhead sign structures shall be replaced with new structures.

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 consistent with current CDOT Standard S-614-50 measured from the high point on the roadway surface under the sign panels to the bottom of the VMS, VTMS, or guide sign (whichever 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 in accordance with CDOT Standard S-614-50, to accommodate 80 mph wind speed.

All ground mounted signage, delineators, etc., shall be installed within a full depth PVC sleeve at locations where the device is installed within concrete sidewalk, median cover material, concrete pavement, slope paving, etc.

14.1.1.2 Materials

The Contractor shall use schedule 80 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.

City and County of Denver Traffic Engineering Standards of Signs and Markings shall be utilized for all City and County of Denver signs. Brake away bases shall not be utilized for City and County of Denver signs.

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 CDOT facilities 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. The requirements of the MUTCD shall include both the standard requirements and the guidance recommendations of the manual.

Striping design for the local streets, intersections and Federal Boulevard shall comply with City and County of Denver Traffic Engineering Standards of Signs and Markings.

The conceptual mainline and other roadway striping as shown in the Reference Documents is for information and reference only.

14.1.2.2 Materials

The Contractor shall use the pavement-marking materials on US 6 and I25 for the locations specified in Table 14.1-2.

Table 14.1-2 PAVEMENT MARKING MATERIALS	
Location	Pavement Marking Type
Edge lines	Epoxy Pavement Marking
Skip lines, challelizing lines, and lane drop lines on Portland concrete cement pavement (PCCP)	Preformed Plastic Pavement Marking Type II (contrast)(Inlaid)
Skip lines, channelizing lines, and lane drop lines on Hot Mix Asphalt (HMA)	Preformed Plastic Pavement Marking Type I
Words/symbols/cross walks/stop lines	Preformed Plastic Pavement Marking Type I

The City and County of Denver requires the use of Preformed Thermoplastic for all Xwalks, stop bars, and symbols.

The Contractor shall refer to CDOT’s Material Striping Chart as shown below for pavement marking materials for US6 and I-25.

REQUEST FOR PROPOSAL – US6 BRIDGES DESIGN BUILD PROJECT

BR 0061-083, SUB ACCOUNT 18838 (CN)

BOOK 2 – TECHNICAL REQUIREMENTS

SECTION 14 – SIGNING, PAVEMENT MARKING, SIGNALIZATION, AND LIGHTING

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

Removal of the existing traffic signal is required at:

1. Westbound off-ramp at US 6 and Bryant

New traffic signals and improvements are required at:

1. US 6 and Federal Boulevard ramp terminals (north intersection and south intersection)
2. Eastbound off-ramp US 6 and Bryant
3. 5th Avenue and Federal Boulevard

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.

Refer to Book 2, Section 19 – ITS for fiber optics along and within Federal Boulevard.

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.

REQUEST FOR PROPOSAL – US6 BRIDGES DESIGN BUILD PROJECT
BR 0061-083, SUB ACCOUNT 18838 (CN)
BOOK 2 – TECHNICAL REQUIREMENTS
SECTION 14 – SIGNING, PAVEMENT MARKING, SIGNALIZATION, AND LIGHTING

14.1.4 Lighting

14.1.4.1 Permanent 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. All permanent lighting within the Project shall be designed and constructed to be consistent with current CCD Guidelines, including Guidelines for required lighting values, and Excel Standards.

Lighting plans shall address both temporary and permanent Work and shall include existing topography, right of way, 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.

Roadway lighting for US 6 & I-25 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 & I-25 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 I-25 & US 6 CD roads and exit ramps at Federal Blvd. and Bryant Street.

The Contractor shall submit to CCD for Acceptance lighting calculations, including voltage-drop calculations for each circuit, showing that 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.

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 Permanent Lighting 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. Lighting Plans for which the lighting is

REQUEST FOR PROPOSAL – US6 BRIDGES DESIGN BUILD PROJECT
BR 0061-083, SUB ACCOUNT 18838 (CN)
BOOK 2 – TECHNICAL REQUIREMENTS
SECTION 14 – SIGNING, PAVEMENT MARKING, SIGNALIZATION, AND LIGHTING

the responsibility of the City and County of Denver shall be provided to CCD for review and approval before any materials are ordered

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.

14.1.4.3 Temporary Lighting

The Contractor shall provide installation, maintenance, and removal of all temporary lighting devices. The Contractor shall maintain temporary lighting at a level equivalent to existing lighting provided within the Project limits.

14.2 Construction Requirements

14.2.1 Permanent Signing

The Contractor shall remove and dispose of all existing sign structures, ground-mounted signs, and delineators within the Project area, and 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 cabinets, controllers, CCTV's and associated traffic signal equipment, and shall deliver the equipment to the City and County of Denver, Traffic Engineering Services Department a minimum of 6 weeks prior to the scheduled installation date. The Contractor shall transport the devices to the project site for the Contractor's installation after the City and County of Denver staff have completed City performed tasks as identified below.

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 City and County of Denver shall provide the Contractor 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 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 provide timing plans for the permanent traffic signals for the Contractor to initiate and install with the initial startup.

REQUEST FOR PROPOSAL – US6 BRIDGES DESIGN BUILD PROJECT

BR 0061-083, SUB ACCOUNT 18838 (CN)

BOOK 2 – TECHNICAL REQUIREMENTS

SECTION 14 – SIGNING, PAVEMENT MARKING, SIGNALIZATION, AND LIGHTING

The Contractor shall coordinate with the City and County of Denver to ensure timing plans function properly, and to ensure they minimize intersection approach delays and accommodate pedestrians.

All signal timing plan modification requests shall be approved and completed by the City and County of Denver. The Contractor shall allow 28 Days prior to implementation of any signal timing plan modification for review and approval by the City and County of Denver.

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 and or CCD for review, Approval, and/or Acceptance:

Deliverable	Review, Acceptance, or Approval	Schedule
Pavement Marking Plans	Approval	60 Days prior to issuance of Released for Construction Documents
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 CCD ROW	Review	90 Days prior to issuance of Released for Construction Documents
All permanent lighting plans at intersections and local streets owned and maintained by CCD	Review	60 Days prior to issuance of Released for Construction Documents
Traffic Signal Timing Plans and associated electronic timing plan software files (by CCD)	Approval	28 Days prior to implementation

REQUEST FOR PROPOSAL – US6 BRIDGES DESIGN BUILD PROJECT

BR 0061-083, SUB ACCOUNT 18838 (CN)

BOOK 2 – TECHNICAL REQUIREMENTS

SECTION 14 – SIGNING, PAVEMENT MARKING, SIGNALIZATION, AND LIGHTING

Lighting and electrical design calculations (by CCD)	Acceptance	90 Days prior to issuance of the Released for Construction Documents
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