

## **Section 13 – Roadway Design**

### **Administrative Requirements**

The horizontal and vertical alignment may be adjusted to provide a more economical design that meets project constraints identified within this document.

The horizontal and vertical alignment shall tie into existing US 6 at the same approximate limits as shown in the Reference Documents.

### **US 6**

The primary requirements for the design and construction of highways shall include, but are not limited to, the following documents (latest versions at project advertisement):

- CDOT, CDOT Design Guide, 2005.
- AASHTO, A Policy on Geometric Design of Highways and Streets, 2011 (PGDHS).
- AASHTO, Roadside Design Guide, Third Edition, 2006.
- CDOT, Standard Plans, M & S Standards, July 2012.
- CDOT, Standard Specifications for Road and Bridge Construction, 2011.
- United States Access Board, ADA Accessibility Guidelines for Buildings and Facilities.
- State of Colorado, State Highway Access Code

### **Local Roadways**

The requirements for the design and construction of local roadways shall include, but are not limited to, the following documents:

- Local Agency Design Standards.
- AASHTO, A Policy on Geometric Design of Highways and Streets, 2011 (PGDHS).
- AASHTO, Roadside Design Guide, Third Edition, 2006.
- State of Colorado, State Highway Access Code.
- Local Agency Standard Drawings.
- United States Access Board, ADA Accessibility Guidelines for Buildings and Facilities.

Other requirements provided on the plans shall govern the design and construction as applicable.

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### **Design Requirements**

Design of the Project shall be in accordance with the Technical Requirements Section 1 - General.

### **Design and Plan Submittals**

In addition to the submittal requirements specified in this Section, the Contractor shall submit all design and plan documents to the CDOT Project Engineer for Acceptance as required in Section 3 – Quality Management.

### **Traffic Lighting Analysis**

The contractor may use passenger comfort criteria to determine the length of sag vertical curves in place of the headlight stopping sight distance requirements in the design criteria, provided the final lighting within the project limits meets current design standards. The contractor shall perform and submit a lighting assessment of the existing lighting for acceptance. If additional lighting is required the contractor shall coordinate with CDOT and local agencies to provide a lighting design that meets current design standards.

### **Roadway Requirements**

#### **General**

The Contractor shall provide a design alignment, to the CDOT Project Engineer during the design review, which demonstrates the ability to meet all design criteria and requirements.

The design speed for US 6 shall be 70 mph.

#### **Typical Section**

The US 6 typical section shall consist of three 12-foot lanes with 4-foot inside and 12-foot outside shoulders in each direction as shown in the Reference Documents. The Structure typical section shall include bridge rail and chain link fence. The Garrison typical section shall consist of four 11-foot lanes with bike path and sidewalks. See Reference Documents for roadway typical sections.

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### **Cross Slope and Superelevation**

#### **Normal Cross Slope**

All new and reconstructed pavement sections shall have a normal cross slope of 2 percent.

For pavement widening sections, the widened section shall have a normal cross slope of 2 percent.

#### **Superelevation Rates**

The maximum superelevation rate shall be 6%.

#### **Stopping Sight Distance**

For US 6, the stopping sight distances and decision sight distances shall meet or exceed the requirements of CDOT Roadway Design Guide Table, Exhibit 3-1. Stopping sight distances shall be determined in accordance with the PGDHS.

#### **Fill and Cut Slopes and Clear Zones**

The Contractor shall design cut and fill slopes to obtain clear zones and shall exhaust all design efforts to eliminate the use of guardrail. Where clear zones cannot be obtained within CDOT right-of-way, the use of guardrail shall be allowed as an option, subject to CDOT's evaluation and acceptance.

Clear zones shall be designed in accordance with the recommendations of AASHTO, Roadside Design Guide.

#### **Roadside Slopes Adjacent to Pavement**

*(Note: All slopes stated herein are in terms of horizontal: vertical)*

The Point of Slope Selection (POSS) is defined as the location at which the roadside slope adjacent to the pavement ends and the cut or fill slope begins. Width and slope of the area between the edge of pavement (or sidewalk) and the POSS shall be as follows:

1. Mainline US 6: 12 feet minimum at a 6:1 slope
2. Ramps: 12 feet at a 6:1 slope
3. Curb and sidewalk areas: 2 feet at a 50:1 slope

Typical sections shall include a hinge point and maintain 2% positive drainage in the base course material as described in the CDOT Roadway Design Guide, Section 4.4 Typical Sections.

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### **Fill Slopes**

Fill slopes beyond the POSS shall be designed and constructed in accordance with the following priority.

1. Use 6:1 slopes where fill heights are less than 4 feet, and matches with existing conditions that can be obtained within the Project limits.
2. Use 4:1 slopes where fill heights are greater than 4 feet but less than 10 feet, and matches with existing conditions that can be obtained within the Project limits.
3. Use 3:1 slopes where fill heights are less than 10 feet and slopes steeper than 4:1 are required to match existing conditions within the Project limits.
4. Use 3:1 slopes where fill heights exceed 10 feet, and matches with existing conditions can be obtained within the Project limits and clear zone can be obtained within the Project limits.
5. Where the above conditions cannot be obtained, the Contractor may use any of the following design approaches:
  - a. Use 3:1 to 2.5:1 slopes with guardrail protection. Slopes 3:1 or steeper shall incorporate the use of soil retention blankets in compliance with the requirements of Section 17, Landscaping.
  - b. Use retaining walls as necessary, with guardrail protection. Where retaining walls are used, provide a traversable surface with a maximum 6:1 cross slope and minimum 10 feet width between face of wall and ROW or permanent easement line, fence line, or other obstruction.

Fill slope areas shall be designed to prevent Roadway and slope drainage from flowing onto adjacent properties.

All breakpoints shall be rounded to provide for a pleasing appearance.

### **Cut Slopes**

Cut slopes beyond the POSS shall be designed and constructed in accordance with the following priorities:

1. Cut slopes must be transitioned at the match with the 6:1 slopes adjacent to Roadway pavement in such a manner to comply with the recommendations of the AASHTO Roadside Design Guide.
2. Use 4:1 or flatter slopes for cut slopes where matches with existing conditions can be obtained within the Project limits.

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3. Use 3:1 slopes for cut slopes where such slopes steeper than 4:1 are necessary to obtain matches with existing conditions within the Project limits.
4. Where the above conditions cannot be obtained, the Contractor may use any of the following design approaches:
  - a. Use 3:1 to 2.5:1 slopes with guardrail protection. Slopes 3:1 or steeper shall incorporate the use of soil retention blankets in compliance with the requirements of Section 17, Landscaping.
  - b. Use retaining walls as necessary, with guardrail protection. Where retaining walls are used, provide a traversable surface with a maximum 6:1 cross slope and minimum 10 feet width between face of wall and ROW or permanent easement line, fence line, or other obstruction.

Cut slope areas shall be designed to prevent Roadway and slope drainage from flowing onto adjacent properties.

All breakpoints shall be rounded to provide for a pleasing appearance. Cut slopes shall include a brow ditch at the top to control offsite storm water from eroding cut slope.

### **Guardrail**

Guardrail along outside shoulders shall only be allowed, with CDOT's evaluation and acceptance, wherever clear zone requirements cannot be achieved with cut/fill slope configuration within the ROW.

The Contractor shall design the guardrail needed for the structure approaches and other areas that do not meet clear zone requirements. All outside shoulder guardrail type 3 shall be galvanized steel. All Posts shall be galvanized steel with composite blocks. All work shall be as specified in CDOT Standard M-606-1. The Contractor shall pave asphalt a minimum of 1-foot behind all Type 3 guardrail installed as part of the Work.

Median barrier is required along the entire length of US 6. Median barrier shall be concrete barrier in accordance with CDOT Standard M-606-13. All concrete barriers shall be cast-in-place. Precast barrier is not allowed for permanent installations.

### **Approach Roads**

Roadway approaches shall be designed to have sufficient sight distance as per reference Standards.

### **Sidewalks**

The contractor shall provide curb ramps at all four quadrants on Garrison Street that are ADA compliant. The contractor shall verify ADA compliance of existing curb ramps to remain.

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### **Design Exception Process**

Design Exceptions in addition to those identified herein shall be subject to the Approval of CDOT. If determined to be necessary by CDOT, Design Exceptions may be subject to the Approval of FHWA.

The Contractor shall comply with the following requirements when requesting a Design Exception to the requirements herein:

1. The Contractor shall submit Design Exception requests in the form of a letter addressed to the CDOT Project Director for Approval prior to issuance of applicable Released for Construction Documents.
2. The Design Exception request shall consist of the following items:
  - A. A letter identifying the exception(s) by number, Project number, location, and status (new submittal, resubmittal, etc.)
  - B. A completed CDOT Form 464a
  - C. Supporting documentation indicating the justification for the Design Exception. Justification shall address the following items:
    - (1) Site conditions of the exception.
    - (2) Compelling reason for the exception, including which standard is not being met. If the exception affects any other standards, state what will be done to mitigate the effects of the exception.
    - (3) Effects of the exception on safety and operation of the facility.
    - (4) Previous crash history near the location of the exception.
    - (5) Calculations estimating the cost of attaining the design standard and costs of exception as proposed.
    - (6) Effect on scenic, historical, or other environmental features.
    - (7) Plan and profile drawings depicting the exception.

### **Construction Requirements**

#### **Removals**

The Contractor shall be responsible for the removal of all items on the project designated for removal or found to conflict with project design elements. Removal items shall become the property of the Contractor unless designated to remain property of CDOT. Removal items shall include, but not be limited to: structures/portions of structures and obstructions, signs designated for removal, asphalt mat, culverts, and fencing. All removals shall be performed in accordance with Standard Specification 202.

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### **Fencing/Gates**

#### **Temporary Fencing**

Installation of temporary fencing will be required to protect adjacent private property. In remaining areas, temporary fencing should be considered to control construction operations and avoid impacts beyond ROW limits. Temporary fence shall be placed as may be required in any other section of the Contract.

#### **Permanent Fencing**

Fencing shall be provided to delineate ROW along the US 6 Corridor. The fence shall be 72” chain link. The fence shall be protected with a 2 foot wide asphalt weed barrier, with the posts placed at the centerline of the barrier.

#### **Gates**

Provide gates in fences at locations, width, and type as specified by requirements of the Contract or other maintaining entities for maintenance access, including CDOT. Field locations of gates shall be approved by CDOT.

#### **Deliverables**

The Contractor shall submit the following to the CDOT Project Engineer.

<b>Deliverable</b>	<b>Acceptance or Approval</b>	<b>Schedule</b>
Design Exceptions	Approval	30 days Prior to issuance of applicable Released for Construction Documents
Lighting Assessment	Acceptance	Prior to issuance of applicable Released for Construction Documents

All Deliverables shall also conform to the requirements of Section 3 Quality Management.

#### **Exhibits**

Exhibits are as follows:

- A. Roadway Design Criteria
- B. CDOT Design Exception Variance Request Form 454A

## Section 13 – Roadway Design

### Exhibit A: Roadway Design Criteria

Design Element	Ramp			US 6	Garrison	Remarks
	Garrison Terminal	Ramp Proper	US 6 Terminal			
<b>HIGHWAY FUNCTIONS</b>						
Functional Classification	N/A	N/A	N/A	Urban Principal Arterial	Urban Collector	
Access Control Classification	N/A	N/A	N/A	Expressway, Major Bypass	N/A	
<b>TRAFFIC DATA AND CONTROLS</b>						
Design Speed, mph	25	45	60	70	35	
Terrain	Rolling	Rolling	Rolling	Rolling	Rolling	
<b>HORIZONTAL GEOMETRY</b>						
Use of Spirals	N/A	N/A	N/A	Permitted	N/A	Use spirals where identified as desirable in PGDH
Minimum Radius	154	643	1330	2040	333	
Normal Cross-slope, %	2%			2%	2%	
Maximum Superelevation, $e_{max}$	4%	6%	6%	6%	Normal Crown	
Axis of Rotation, Location of Pivot Point	HCL	HCL	HCL	HCL	HCL	
Redirect Taper	N/A	45:1 Min.	N/A	65:1 Min.	15:1 Min.	
<b>VERTICAL GEOMETRY</b>						
Maximum Grade	5%			4%	5%	
Minimum Grade	0.30%			0.50%	0.30%	
Minimum K Value, Crest	12	61	151	247	29	
Minimum K Value, Sag	26	79	136	181	49	
<b>SIGHT DISTANCE</b>						
Level Stopping Sight Distance, feet	155	360	570	730	250	Grades $\geq$ 3% shall conform to Table 3-2 of the PGDHS
Decision Sight Distance, feet	520	930	1280	1445	720	
<b>VERTICAL CLEARANCE</b>						
Underpass, feet	N/A			14.5	N/A	
Overhead Sign Structures, feet	17.5			17.5	N/A	

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Design Element	Ramp			US 6	Garrison	Remarks
	Garrison Terminal	Ramp Proper	US 6 Terminal			
<b>CROSS SECTION</b>						
Lane Width, feet	12			12	11	
Inside Shoulder/Median, feet	4			4	N/A	
Outside Shoulder, feet	8			12	4	
Z-Slope, feet	12			12	N/A	
Normal Cross-slope	2%			2%	2%	
Maximum Algebraic Difference at Crossover Line	4 to 5%			4 to 5%	4 to 5%	
Design Vehicle	WB-67			WB-67	WB-50	
Sidewalk Width, feet	N/A			N/A	8	
<b>RAMP TERMINALS</b>						
Deceleration Length	Per CDOT Design Guide Table 10-3			N/A	N/A	
Acceleration Length	Per CDOT Design Guide Table 10-4			N/A	N/A	
Entrance Ramp Type	Parallel			N/A	N/A	
Exit Ramp Type	Parallel			N/A	N/A	
Gore Nose Width, feet	*21 Min.			N/A	N/A	*In accordance with Figure 10-15 of CDOT Design Guide

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### Exhibit B: CDOT Design Exception Variance Request Form 454A

COLORADO DEPARTMENT OF TRANSPORTATION <b>DESIGN EXCEPTION VARIANCE REQUEST</b>		FHWA Oversight <input type="checkbox"/> Yes <input type="checkbox"/> No	Project Code _____
Project name _____		Date _____	Project Number _____
Type (check all that are applicable) <input type="checkbox"/> New construction <input type="checkbox"/> Restoration <input type="checkbox"/> Resurfacing <input type="checkbox"/> Rehabilitation <input type="checkbox"/> _____ <input type="checkbox"/> Reconstruction <input type="checkbox"/> Safety <input type="checkbox"/> Enhancement <input type="checkbox"/> _____ <input type="checkbox"/> _____		Revised _____	Region _____
<b>Part 1 – Complete A through H for all projects.</b>			
A. Short project description ( <input type="checkbox"/> see CDOT Form 463 for more detailed description) _____		<input type="checkbox"/> AASHTO standards apply <input type="checkbox"/> 3R standards apply <input type="checkbox"/> Other: _____	
B. Description of standard(s) reduced _____			
C. Rational need for exception(s) _____			
D. Mitigation measures proposed (include safety discussion) _____			
E. Description of adjoining sections: ( <input type="checkbox"/> see CDOT Form 463) Other: _____		<input type="checkbox"/> same as existing project <input type="checkbox"/> same as proposed project	
F. Accident data   Source: _____ Most recent statewide accident rate (calendar year) for this functional class / facility: (per million vehicle-miles of travel) a) _____    b) _____ Latest accident rate for this highway (usually 3 years): _____ a) _____    b) _____		G. Cost Estimated item cost if built to full standard            \$ _____ Estimated item cost with exception                            \$ _____ ± difference in cost:    \$ _____	
H. Other (as needed) _____			
<b>Part 2 – Appropriate signatures required.</b>			
A. Submitted by (Project Manager)		Date _____	Program Engineer Approval
Resident Engineer Approval		Date _____	
Required for Federal-oversight projects only			
Approved by (FHWA Division Administrator)			Date _____
B. <input type="checkbox"/> Not approved <input type="checkbox"/> Approved with conditions		Conditions/comments _____	

Previous editions are obsolete and may not be used.

Distribution: Project Manager  
 Program Engineer  
 Resident Engineer  
 HQ Records Center  
 FHWA, if applicable

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