CONTRACT NO: 009947 FEDERAL AID NO:ARPA
CONTRACT TITLE: I-5 / TRIBUTARIES TO, FRIDAY, LAKE & CHU FISH PASS
CHANGE ORDER NO: 6 LAKE CREEK BARRIER CHANGES

PRIME CONTRACTOR: [redacted] KIEWIT INFRASTRUCTURE WEST CO.
33930 WEYERHAEUSER WAY S
SUITE 300
FEDERAL WAY WA 98001-

(X)Ordered by Engineer under the terms of Section 1-04.4 of the Standard Specifications

( )Change proposed by Contractor

ENDORSED BY: *Signature on file* Justin O'Brien (Jun 24, 2025 17:21 PDT)	SURETY CONSENT:
CONTRACTOR SIGNATURE 06/24/2025 DATE	ATTORNEY IN FACT DATE

ORIGINAL CONTRACT AMOUNT: 136,275,000.00
CURRENT CONTRACT AMOUNT: 134,914,730.00
ESTIMATED NET CHANGE THIS ORDER: 623,918.00
ESTIMATED CONTRACT TOTAL AFTER CHANGE: 135,538,648.00

Signature on file 06/25/2025 PROJECT ENGINEER SIGNATURE DATE	RECOMMEND EXECUTION (X) EXECUTED ( )
Signature on file 06/25/2025 REGIONAL ADMIN SIGNATURE DATE	RECOMMEND EXECUTION (X) EXECUTED ( )
Signature on file 06/25/2025 STATE CONSTRUCTION ENGINEER SIGNATURE DATE	EXECUTED (X)
SIGNATURE RESPRESENTING DATE	OTHER APPROVAL WHEN REQUIRED

CONTRACT NO:009947 CHANGE ORDER NO: 6

All work, materials, and measurements to be in accordance with the provisions of the Standard Specifications and Special Provisions for the type of construction involved.

This contract is revised as follows:

Description:
This Change Order addresses changes to the roadway barrier requirements for the Lake Creek (FR75) site only with the following modifications:

Appendix D01, WSDOT Bridge Design Manual (LRFD) dated June 2022, Section 10.3, shall be replaced with the updated Bridge Design Manual (LRFD) Section 10.3, dated July 2024, as shown on pages 4 through 10 of 20 of this Change Order.

Appendix D05, WSDOT Design Manual dated September 2022, Sections 1610.06 & 1610.07, shall be replaced with the updated Design Manual Section 1610.06 & 1610.07, dated September 2024, as shown on pages 11 through 19 of 20 of this Change Order.

This Change Order also clarifies the requirement to provide TL-4 barrier that meets the requirements of Bridge Traffic Barrier on top of Class 1 and Class 2 Buried Structures.

Change Order 001, Form W, Traffic Impact Days is deleted and replaced with revised Form W as shown on page 20 of 20 of this Change Order.

Material Requirements:
Material requirements remain unchanged.

Construction Requirements:
Construction requirements remain unchanged.

Measurement:
No specific unit of measurement shall apply to the new lump sum item added to the Contract.

Payment:
The new lump sum item "CO# 006, Lake Creek Barrier Change" in the amount of $623,918, shall be full payment for incurred costs including but not limited to permitting, engineering, labor, equipment and material for this Work.

Contract Time:
This Change Order does not impact Contract time.

CONTRACT NO:009947 CHANGE ORDER NO: 6

ITEM NO	GROUP NO	STD ITEM	UNIT OF MEASURE	UNIT PRICE	EST QTY CHANGE	EST AMT CHANGE
ITEM DESCRIPTION:			CO# 006, LAKE CREEK BARRIER CHANGE			
1002	05		L.S.	0.00	0.00	623,918.00

AMOUNT TOTAL

623,918.00
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CONTRACT 009947 DISTRICT 1

CHANGE ORDER NUMBER 006 TYPE OF CHANGE ORDER CONSTRUCTION **NEW BID ITEM**

DATED 06-30-2025 TIME 13:29:09

ITEM	GROUP	STD ITEM	UNIT OF MEAS	UNIT PRICE	QUANTITY CHANGE	AMOUNT CHANGE
018	05		L.S.	$623,918.0000	.00	$623,918.00

CCIS TEMP ITEM NUMBER: 1002

DESC..: CO# 006, LAKE CREEK BARRIER CHANGE

TOTAL NET CHANGE $623,918.00

REPORT STATUS: COMPLETE

10.3 At Grade Concrete Barriers

10.3.1 Differential Grade Concrete Barriers

The top of the differential grade concrete barrier shall have a minimum width of 6″. If a luminaire or sign is to be mounted on top of the differential grade concrete barrier, then the width shall be increased to accommodate the mounting plate and 6″ of clear distance on each side of the luminaire or sign pole. The transition flare rate shall follow the *Design Manual*.

Differential grade concrete barriers are walls and barriers. All applicable limit states, design considerations, detailing, and constraints associated with walls and barriers shall apply. This includes, but is not limited to, provisions in AASHTO LRFD-BDS, the WSDOT GDM, and the WSDOT Design Manual for both walls and barriers.

Differential grade concrete barriers placed adjacent to a slope require implications of the slope to be incorporated into the design. The bench requirements for walls from the WSDOT GDM are applicable.

See Section 10.2 for how elements are accepted for use within Washington State. Blunt edges, snags, and pinch points are not appropriate to expose to traffic.

10.3.1.A Differential Grade Concrete Barriers

Concrete barriers at grade are sometimes required in median areas with different roadway elevations on each side. The standard Single Slope barrier can be used for a grade difference up to 10″ for a 2′-10″ safety shape and up to 6″ for a 3′-6″ safety shape. See Standard Plans C-70.10 and C-80.10 for details.

If the difference in grade elevations is 4′-0″ or less, then the concrete barrier shall be designed as a rigid system in accordance with AASHTO LRFD with the following requirements:

1. All applicable loads shall be applied in accordance to AASHTO LRFD Section 3. The structural capacity of the differential grade concrete barrier and supporting elements shall be designed for the required Test Level (TL) vehicle impact design forces in accordance with AASHTO LRFD Sections 5 and 13. Any section along the differential grade barrier and supporting elements shall not fail in shear, bending, or torsion when the barrier is subjected to the TL impact forces.
2. For soil loads without vehicle impact loads, the concrete barrier shall be designed as a retaining wall (barrier weight resists overturning and sliding). Passive soil resistance may be considered with concurrence by the geotechnical engineer.
3. Vehicle impact loads shall be applied on the side of the concrete barrier retaining soil if there is traffic on both sides. The vehicle impact loads shall be applied at the height specified for intended Test Levels in accordance to the AASHTO LRFD Section 13, Table A13.2-1 "*Design Forces for Traffic Railing* (32-inch for TL-4, and 42-inch for TL-5)" as modified by Section 10.2.4.

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4. For soil loads with vehicle impact loads, the AASHTO LRFD-BDS Extreme Event loading for vehicular collision shall also be analyzed. Equivalent Static Load (ESL) per NCHRP Report 663 may be applied as the transverse vehicle impact load for evaluating sliding, bearing, and overturning only. For TL-3 barrier systems, the ESL shall be 10 kips, for TL-4 barrier systems, the ESL shall be 15 kips and for TL-5, the ESL shall be 23 kips. The point of rotation for overturning shall be taken at the toe of barrier. Sliding resistance factor shall be 0.8 and overturning resistance factor shall be 0.5 (supersedes AASHTO 10.5.5.3.3).
5. The effective length of the concrete barrier required for stability shall be no more than 10 times the overall height, but not to exceed the length between barrier expansion joints (or one precast section). The barrier shall act as a rigid body behavior and shall be continuous throughout this length of barrier. Any coupling between adjacent barrier sections or friction that may exist between free edges of barrier and the surrounding soil shall be neglected.
6. A special impact analysis shall be performed at the barrier ends if the barrier terminates without being connected to a rigid object or dowelled to another barrier. Differential barrier deflection from barrier impact may cause a vehicle to “snag” on the undeflected barrier. The barrier depth may need to be increased at the end to prevent this deflection.
7. The differential grade traffic barrier shall have dummy joints at 8 to 12 foot centers based on project requirements.
8. Full depth expansion joints with shear dowels at the top will be required at intervals based on analysis but not to exceed a 120′-0″ maximum spacing.
9. Barrier bottom shall be embedded a minimum 6″ below roadway. Roadway subgrade and ballast shall be extended below whole width of differential grade barrier. When a single slope barrier is used, or other configurations absent a footing, the depth of embedment shall be equal or greater than the grade separation.

Traffic barriers supporting a soil height greater than 4’-0” shall be designed as reinforced concrete retaining walls with a traffic barrier at the top and a barrier shape at the cut face. For external stability, the full loadings for the Extreme Event Limit State from AASHTO LRFD-BDS, Section 13 are applicable as modified by Section 10.2. When using these AASHTO loadings the associative phi factors from AASHTO are applicable. These provisions do not waive any requirements for walls or barriers from other codes, manuals, or sources.

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10.3.2 *Moment Slab Traffic Barrier*

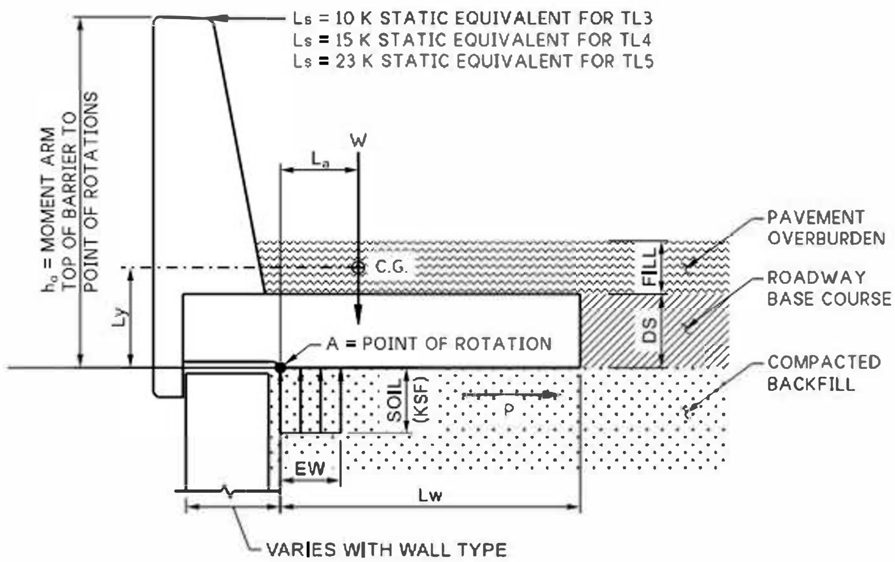
10.3.2.A General

The guidelines provided herein are based on NCHRP Report 663, FHWA/TX-12/9-1002-5, input from Texas Transportation Institute (TTI) on past WSDOT Standards, calculations, and engineering judgement. A resistance factor of 0.5 shall be used to determine rotational resistance. This guideline is applicable for TL-3, TL-4 and TL-5 barrier systems as defined in Section 13 of AASHTO LRFD-BDS. Moment Slab Traffic Barriers shall employ a current concrete traffic barrier from Section 10.2.3.

~~The options included in standard plan C81.15 are limited to cast in place slab applications.~~

Standard Plan C81.15 was developed for cast-in-place construction. Many of the details may also work for precast design. Other considerations such as weight revisions, shipping and picking considerations, super-elevation considerations, base friction variations, moment slab and/or barrier jointing details would need to be addressed by the Engineer of Record with stamped calculations and plans.

Figure 10.3.2-1 Global Stability of Barrier–Moment Slab System



10.3.2.B Guidelines for Moment Slab Design

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10.3.2.B.1 *Structural Capacity*

The structural capacity of the barrier and concrete moment slab shall be designed using impulse loads at appropriate Test Level applied to the top of the barrier, as shown in Figure 10.3.2-1 and in accordance with Sections 5 and 13 of AASHTO LRFD-BDS. For strength design the impact force, Ft, is applied at H_e. Any section along the moment slab shall not fail in shear, bending, or torsion when the barrier is subjected to the design impact loads. The torsion capacity of the moment slab must be equal to or greater than the traffic barrier moment generated by the specified TL static equivalent of the vehicle impulse load.

The moment slab shall be designed as a deck supporting barrier in accordance to AASHTO LRFD-BDS A13.4.2 as modified by Section 10.2.4.A. The moment slab reinforcement shall be designed to resist combined forces from the moment M_S (kip-ft/ft) and the tensile force T (kip/ft). M_S and T are determined from the lesser of the ultimate transverse resistance of barrier R_W (kip) and 120 percent of transverse vehicle impact force F_T (kip). M_S is not to be exceeded by the ultimate strength of barrier at its base M_C (kip-ft/ft).

10.3.2.B.2 *Global Stability*

Bearing stress, sliding, and overturning stability of the moment slab shall be based on an Equivalent Static Load (ESL) applied at the top of the barrier as shown in figure 10.3.2-1. For TL-3 barrier systems, the ESL shall be 10 kips. For TL-4 barrier systems, the ESL shall be 15 kips. For TL-5 barrier systems, the ESL shall be 23 kips.

The Equivalent Static Load (ESL) is assumed to distribute over the length of continuous moment slab through rigid body behavior. Barrier shall also be continuous or have shear connections between barrier sections if precast throughout this length of moment slab. Any coupling between adjacent moment slabs or friction that may exist between free edges of the moment slab and the surrounding soil shall be neglected.

10.3.2.B.3 *Minimum and Maximum Dimensions*

The minimum height of the traffic barrier portion of the moment slab shall be 42 inches above the finished roadway surface.

Moment slabs shall have a minimum width of 4.0 feet measured from the point of rotation to the heel of the slab and a minimum average depth of 0.83 feet. Moment slabs meeting these minimum requirements are assumed to provide rigid body behavior up to a length of 60 feet limited to the length between moment slab joints.

Rigid body behavior may be increased from 60 feet to a maximum of 120 feet if the torsional rigidity constant of the moment slab is proportionately increased and the reinforcing steel is designed to resist combined shear, moment, and torsion from TL static equivalent of the vehicle impulse loads.

For example: Rigid Body Length = (J'/J60)x(60 ft.) < 120 feet

The torsional rigidity constant for moment slabs shall be based on a solid rectangle using the following formula:

$$J = a \cdot b^3 \left[\frac{16}{3} - 3.36 \left(\frac{b}{a} \right) \left(1 - \frac{b^4}{12a^4} \right) \right]$$

Where:
- 2a = total width of moment slab
- 2b = average depth of moment slab

For example:
- Minimum Moment Slab Width = 48 inches: a = 24 inches
- Minimum Moment Slab Average Depth = 10 inches: b = 5 inches J = J60 = 13,900 in^4

10.3.2.B.4 *Sliding of the Barrier*

The factored static resistance to sliding (ϕP) of the barrier-moment slab system along its base shall satisfy the following condition:

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$$\phi P \geq \gamma Ls \quad (1)$$

Where:

Ls = Equivalent Static Load (10 kips for TL-3, 15 kips for TL-4, and 23 kips for TL-5)

ϕ = resistance factor (0.8) Supersedes AASHTO 10.5.5.3.3—Other Extreme Limit States

γ = load factor (1.0) for TL-3 and TL-4 [crash tested extreme event] load factor (1.2) for TL-5 [untested extreme event]

P = static resistance (kips)

P shall be calculated as: (2)

$$P = W \tan \phi_r$$

Where:

W = weight of the monolithic section of barrier and moment slab between joints or assumed length of rigid body behavior whichever is less, plus any material laying on top of the moment slab

ϕr = friction angle of the soil on the moment slab interface (°)

If the soil-moment slab interface is rough (e.g., cast in place), ϕ_r is equal to the friction angle of the soil ϕ_s. If the soil-moment slab interface is smooth (e.g., precast), tan ϕ_r shall be reduced accordingly (0.8 tan ϕ_s).

10.3.2.B.5 *Overturning of the Barrier*

The factored static moment resistance (ϕM) of the barrier-moment slab system to overturning shall satisfy the following condition:

$$\phi M \geq \gamma L_s h_a \quad (3)$$

Where:

A = point of rotation, where the toe of the moment slab makes contact with compacted backfill adjacent to the fascia wall, or end of slab neglecting barrier tail for on grade applications.

L_w = width of moment slab

L_s = Equivalent Static Load (10 kips for TL-3, 15 kips for TL-4, and 23 kips for TL-5)

φ = resistance factor (0.5) Supersedes AASHTO 10.5.5.3.3—Other Extreme Limit States and NCHRP Report 663

γ = load factor (1.0) for TL-3 and TL-4 [crash tested extreme event]
load factor (1.2) for TL-5 [untested extreme event]

h_a = moment arm taken as the vertical distance from the point of impact due to the dynamic force (top of the barrier) to the point of rotation A

M = static moment resistance (kips-ft)
M shall be calculated as:

$$M = W (L_a) \quad (4)$$

W = weight of the monolithic section of barrier and moment slab between joints or assumed length of rigid body behavior whichever is less, plus any material laying on top of the moment slab

L_a = horizontal distance from the center of gravity of the weight W to point of rotation A

The moment contribution due to any coupling between adjacent moment slabs, shear strength of the overburden soil, or friction which may exist between the backside of the moment slab and the surrounding soil shall be neglected.

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10.3.2.C Guidelines for the Soil Reinforcement

Design of the soil reinforcement shall be in accordance with the *Geotechnical Design Manual* Chapter 15.

10.3.2.D Design of the Wall Panel

The wall panels shall be designed to resist the dynamic pressure distributions as defined in the *Geotechnical Design Manual* Chapter 15.

The wall panel shall have sufficient structural capacity to resist the maximum design rupture load for the wall reinforcement designed in accordance with the *Geotechnical Design Manual* Chapter 15.

The static load is not included because it is not located at the panel connection.

10.3.3 Precast Concrete Barrier

10.3.3.A Concrete Barrier Type F and Type 2

"Concrete Barrier Type F" (see Standard Plans C-60.10 or C-60.15) may be used on bridges for median applications or for temporary traffic control based on the following guidelines:

1. The use of this barrier is limited to TL-3 conditions based upon the height not being sufficient to contain the test vehicle for TL-4 conditions.
2. For temporary applications, no anchorage is required if there is 3 feet or greater slide distance between the back of the traffic barrier and an object and 3 feet or greater to the edge of the bridge deck or a severe drop off (see *Design Manual*).
3. For permanent applications in the median, no anchorage will be required if there is a 6 foot or greater slide distance between the traffic barrier and the traffic lane.
4. For temporary applications, dual-sided barrier shall not be placed closer than 9 inches to the edge of a bridge deck or substantial drop-off and shall be anchored (see Standard Plans K-80.35).
5. When used to retain soil the provision of Section 10.3.1.A shall apply.
6. When transitioning to different height barrier off the structure roadside safety considerations shall be employed .

"Concrete Barrier Type 2" (see Standard Plan K-80.32) may be used on bridges for temporary traffic control or for partial replacements when matching existing barrier based on the following guidelines:

1. No anchorage is required if there is 3 feet or greater slide distance between the back of the traffic barrier and an object and 3 feet or greater to the edge of the bridge deck or a severe drop off (see *Design Manual*).
2. For temporary applications, the dual-sided barrier shall not be placed closer than 9 inches to the edge of a bridge deck or substantial drop-off and shall be anchored (see Standard Plan K-80.35).
3. When used to retain soil the provisions of Section 10.3.1.A shall apply.

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10.3.3.B Concrete Barrier Type F Narrow Base and Concrete Barrier Type 4

"Concrete Barrier Type F Narrow Base" (see the Standard Plan C-60.10), is not a free standing traffic barrier. This barrier shall be placed against a rigid vertical surface that is at least as tall as the traffic barrier. For temporary use this barrier may be anchored to the bridge deck. (Standard Plan K-80.37). The barrier shall not be placed closer than 6-inches to the edge of the bridge deck or a severe drop-off. The "Concrete Barrier Type F Narrow Base" is not designed for soil retention.

"Concrete Barrier Type 4" (see the Standard Plan K-80.34), is not a free standing traffic barrier and is only suitable in temporary conditions. This barrier shall be placed against a rigid vertical surface that is at least as tall as the traffic barrier. The barrier shall not be placed closer than 6-inches to the edge of the bridge deck or a severe drop-off. The "Concrete Barrier Type 4" is not designed for soil retention.

10.3.4 Miscellaneous Items

Standard concrete barrier (see Standard Plans C70.10 & C80.10) and Differential Grade Concrete barriers are limited to median use when placed directly on a Structure and require roadway or base course material for a minimum of 2-feet vertical measured from lower roadway surface in other applications. See WSDOT *Design Manual* Chapter 1610 for additional placement and use criteria for standard concrete barrier.

For walls placed behind Differential Grade Concrete barriers, Moment Slab Traffic Barrier, and standard concrete barrier, provide a minimum distance of 5-feet of widening with a 20:1 or flatter slope from the back of barrier to the inner face of wall.

For design of walls (except for MSE walls) which are not integral with the barrier and are placed behind Differential Grade Concrete barriers, Moment Slab Traffic Barrier, and standard concrete barrier, the minimum horizontal vehicular collision load (CT) for extreme event limit state shall be the Equivalent Static Load, ESL (10 kips for TL-3, 15 kips for TL-4, and 23 kips for TL-5).

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1610.05(4) High-Tension Cable Barrier Curb Placement

Avoid the placement of curb in conjunction with high-tension cable barrier systems. Currently, there are no known acceptable cable barrier systems that have been successfully crash tested with this feature present.

1610.06 Concrete Barrier

Concrete barriers are identified as either rigid, rigid anchored, or unrestrained rigid systems. They are commonly used in medians and as shoulder barriers. These systems are stiffer than beam guardrail or cable barrier and impacts with these barriers tend to be more severe. Consider the following when installing concrete barriers:

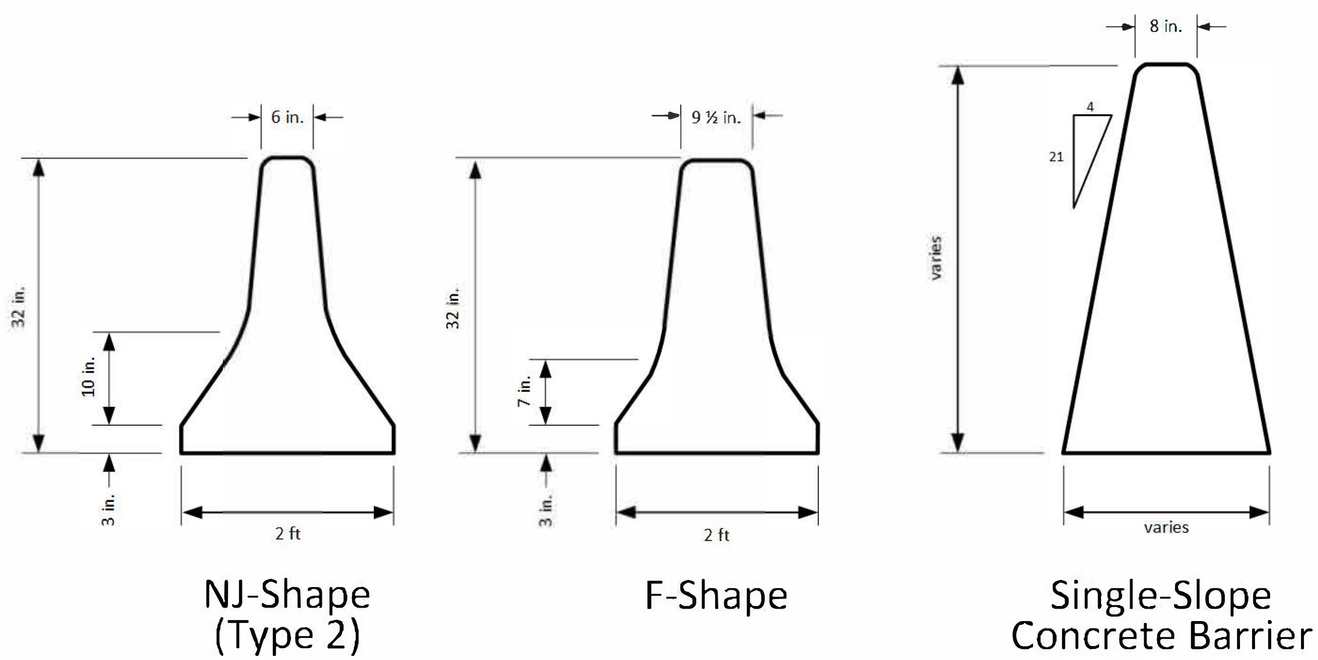
- For slopes 10H:1V or flatter, concrete barrier can be used anywhere outside of the shoulder.
- Do not use concrete barrier at locations where the foreslope into the face of the barrier is steeper than 10H:1V.
- Light standards mounted on top of precast concrete median barrier must not have breakaway features. (See the concrete barrier light standard section in the *Standard Plans*.)
- When considering concrete barrier use in areas where drainage and environmental issues (such as stormwater, wildlife, or endangered species) might be adversely impacted, contact the HQ Hydraulics Office and/or the appropriate environmental offices for guidance. Also, refer to Section 1610.02.

1610.06(1) Concrete Barrier Shapes

Concrete barriers use a single-slope or safety shape (New Jersey or F-Shape) to redirect vehicles while minimizing vehicle vaulting, rolling, and snagging. A comparison of these barrier shapes is shown in Exhibit 1610-17.

The single-slope barrier face is the recommended option for embedded rigid concrete barrier applications.

Exhibit 1610-17 Concrete Barrier Shapes



The New Jersey shape and F-shape barriers are commonly referred to as "safety shapes." The New Jersey shape and F-shape have an initial overall height of 32 inches.

As part of the implementation of MASH-compliant hardware, WSDOT has transitioned from using New Jersey shape barrier (Type 2 barrier) for precast concrete barrier to using F-shape concrete barrier (Type F barrier) instead. F-Shape (Type F) barrier is used in permanent or temporary installations. New Jersey shape (Type 2) barrier is only allowed to be used in temporary installations.

Existing runs of serviceable Type 2 barrier permanently installed are allowed to remain in place (see Section 1610.03(2) for more information about the serviceability of concrete barrier). Use Type F when replacing existing Type 2 concrete barrier. If an existing run of Type 2 barrier requires extending, use Standard Plan C-60.30 Concrete Barrier Transition Type F to (32") Type 2 (Precast), and complete the barrier extension using Type F barrier. When removing and resetting Type 2 barrier, contact HQ Design for more details.

1610.06(1)(a) Safety Shape Barrier

Concrete Barrier Type F (see the *Standard Plans*) is a freestanding precast barrier that has the F-shape on both sides. The F-Shape barrier is used in permanent or temporary installations. It can be used for both median and shoulder installations. Unanchored units are connected with steel pins through metal loops. For permanent unanchored Type F barrier installations, this barrier is placed on a 10:1 or flatter paved surface with 3-feet minimum of 10:1 or flatter paved surface provided beyond the back of the barrier for deflection. For temporary unanchored Type F barrier installations, this barrier is placed on a 10:1 or flatter paved or compacted unpaved surface with a minimum of 3-feet of the 10:1 or flatter respective surface provided beyond the barrier for deflection. Do not anchor Type F barrier on a compacted unpaved surface. See Exhibit 1610-3 for deflection requirements.

Concrete Barrier Type 2 (see the *Standard Plans*) is a freestanding precast barrier that has the New Jersey shape on both sides. The Type 2 barrier is only used in temporary installations. It can be used for both median and shoulder installations. Unanchored units are connected with steel pins through wire rope loops. For temporary unanchored Type 2 barrier installations, this barrier can be placed on a 10:1 or flatter paved surface or compacted unpaved surface with a minimum of 3-feet of the 10:1 or flatter respective surface provided beyond the barrier for deflection. Do not anchor Type 2 barrier on a compacted unpaved surface. See Exhibit 1610-3 for deflection requirements.

The cost of precast safety shape barrier is significantly less than the cost of the cast-in-place barriers. Therefore, consider the length of the barrier run and the deflection needs to determine whether transitioning to precast barrier is desirable. If precast safety shape barrier is used for the majority of a project, use the single slope barrier for small sections that need cast-in-place barrier (such as for a light standard section). See standard plans for precast concrete barrier transitions between different shapes of concrete barrier.

Type F narrow base is a precast, single-faced F-Shape barrier. These units are not freestanding and are to be placed against a rigid structure (or anchored to the pavement in temporary installations). If Type F narrow base barriers are used back-to-back, fill any gap between them to prevent tipping.

Type F barrier can be anchored where a more rigid barrier is needed. The barrier can be anchored in permanent or temporary installations on asphalt pavement, concrete pavement, or bridge decks (Anchoring methods and the required distances of 10:1 or flatter pavement beyond the back of barrier are shown in the *Standard Plans*). Consult with the WSDOT BSO when anchoring permanent precast concrete barrier to a rigid (Portland cement concrete) pavement or bridge deck. Type 2 barrier can be anchored where a more rigid barrier is needed.

The barrier can be anchored in temporary installations using Type 1 and Type 2 anchors for rigid concrete pavement, and Type 3 anchors for asphalt pavement (Anchoring methods and the required distances of 10:1 or flatter pavement beyond the back of barrier are shown in the *Standard Plans*). Consult with the WSDOT BSO when anchoring precast concrete barrier to a bridge deck.

Precast barrier used on the approach to bridge rail is to be connected to the bridge rail by installing loops or a loop bar embedded into the bridge rail with epoxy resin and as detailed in the *Standard Plans*.

Place unrestrained (unanchored) precast concrete barrier on slopes of 5% (20H:1V) or flatter where possible. The maximum slope for placement of concrete barrier is 10% (10H:1V).

1610.06(1)(b) Single-Slope Barrier

Single-slope barrier is an embedded concrete barrier system with a constant 10.8° sloped face (or 21:4 slope). The single-slope barrier is used in permanent installations. Single-slope barrier is available in various heights as shown in the *Standard Plans*. Single-slope concrete barrier can be cast-in-place or precast. Single-slope barrier is considered a rigid system provided that:

- precast barrier is embedded a minimum of 3-inches in the roadway wearing surface (asphalt or concrete) on both sides;
- precast barrier is embedded a minimum of 10-inches in compacted base material (e.g., CSBC, select borrow, gravel borrow, native soil, etc.) on both sides;
- precast barrier is embedded a minimum of 10-inches when embedded in roadway wearing surface (asphalt or concrete) on one side and compacted base material (e.g., CSBC, select borrow, gravel borrow, native soil, etc.) on the other side; and,
- cast-in-place barrier is embedded a minimum of 3-inches in the roadway wearing surface (asphalt or concrete) or compacted base material (e.g., CSBC, select borrow, gravel borrow, native soil, etc.) on both sides.

Single-slope barrier can only be used: (1) in median applications, (2) in shoulder applications (placed at the edge of roadway meeting fill or cut slope requirements or placed offset from the roadway in front of a fill or cut slope), or (3) on top of an MSE wall. All single-slope barrier, other than median applications, requires 2-feet minimum vertical depth of roadway wearing surface and/or base material (e.g. HMA, CSBC, select borrow, gravel borrow, native soil, etc.) measured from lowest grade next to barrier faces.

When placed in front of a fill slope, provide a minimum distance of 2-feet of widening with a 20H:1V or flatter slope from the back of barrier to the slope break point (see Exhibit 1610-18).

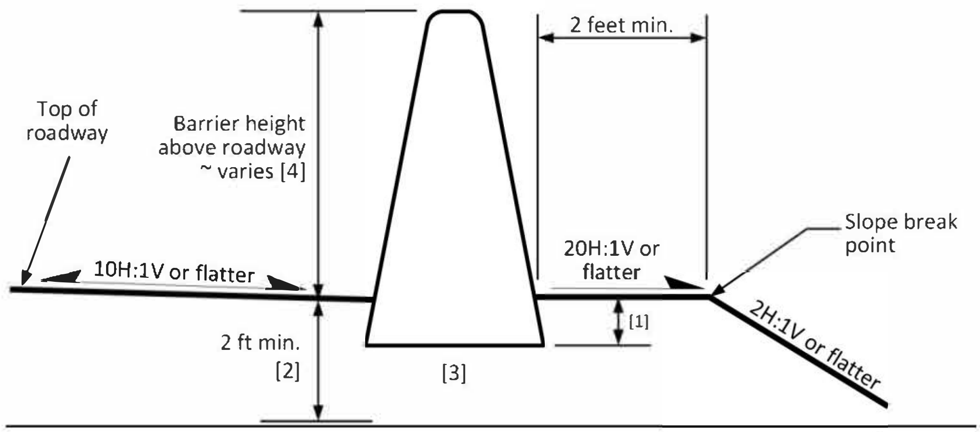
When placed on top of an MSE wall, provide a minimum distance of 5-feet of widening with a 20:1 or flatter slope from the back of barrier to the back of the wall facing (see Exhibit 730-12). Contact HQ Bridge when placing a barrier on an MSE wall to ensure proper wall/parapet design.

For new installations in asphalt, concrete, or compacted base material; the minimum height of the single-slope barrier above the roadway is 2 feet 10 inches which allows a 2-inch tolerance for future overlays. The minimum total height of the barrier section is 3-feet-6 inches (including embedment). The single-slope barrier can be installed with grade separation between roadways as follows:

- For cast-in-place barrier with a minimum 3-inch embedment, or pre-cast barrier installed in asphalt or concrete with a minimum 3-inch embedment; a grade separation of up to 4-inches is allowed when using a 3-foot-6-inch tall barrier section, a grade separation of up to 7-inches is allowed when using a 4-foot tall barrier section, and a grade separation of up to 10-inches is allowed when using a 4-foot-6-inch tall barrier section as shown in the *Standard Plans*.

- For pre-cast barrier installed in compacted base material with a minimum 10-inch embedment; a grade separation of up to 4-inches is allowed when using a 4-foot-tall barrier section, and a grade separation of up to 10-inches is allowed when using a 4-foot-6 inch tall barrier section as shown in the Standard Plans.
- The barrier is to have a depth of embedment equal to or greater than the grade separation as shown in the Standard Plans. Contact the WSDOT BSO for grade separations greater than 10-inches.

Exhibit 1610-18 Single-Slope Barrier Placement – In Front of Fill Slope (New 2024)



Note: See Exhibit 1239-4 for shoulder widening/grading details associated with concrete barrier.

[1] See Section 1610.06(1)(b) for single-slope barrier minimum embedment depth requirements.
[2] Minimum 2-feet depth of roadway wearing surface and/or base material placed underneath barrier (measured from lowest grade next to barrier faces).
[3] See Section 1610.06(1)(b) for single slope barrier grade separation requirements (if used).
[4] See Section 1610.06(1)(b) and Section 1610.06(1)(c) for single-slope barrier height requirements.

1610.06(1)(c) High-Performance Concrete Barrier

High-Performance Concrete Barrier (HP Barrier) is a rigid barrier with a minimum height of 3-foot-6-inch above the roadway surface. This barrier is designed to function more effectively during heavy-vehicle crashes. This taller barrier may also offer the added benefits of reducing headlight glare and reducing noise in surrounding environments. WSDOT HP Barrier utilizes the single-slope shape. (See the *Standard Plans* for barrier details.)

Use HP Barrier in freeway medians of 22 feet or less. Also, use HP Barrier on Interstate or freeway routes where crash history suggests a need or where roadway geometrics increase the possibility of larger trucks hitting the barrier at a high angle (for example, on-ramps for freeway-to-freeway connections with sharp curvature in the alignment).

Consider the use of HP Barrier at other locations such as highways with narrow medians, near highly sensitive environmental areas, near densely populated areas, over or near mass transit facilities, or on vertically divided highways.

1610.06(1)(d) Low-Profile Barrier

Low-profile barrier designs are available for median applications where the posted speed is 45 mph or below. These barriers are normally used in urban areas. They are typically 18 to 20 inches high and offer sight distance benefits. For barrier designs, terminals, and further details, contact the HQ Design Office.

1610.06(1)(e) Scupper Barrier (New 2024)

Scupper barrier designs are available for both Type F (Standard Plan C-60.15) and Single-Slope (Standard Plan C-70.15) concrete barriers. Scupper barriers are designed with openings located at the base of the concrete barrier that allow water to pass through. This may present long-term maintenance issues due to scuppers becoming clogged with debris. See the Hydraulics Manual for drainage design guidance on scupper barrier. Use of scupper barrier in both permanent and temporary applications requires Region Hydraulic Engineer approval. It is recommended to contact region hydraulics early in the design process to determine suitability. See Sections 1610.06(1)(a) or 1610.06(1)(c) for design and placement guidance associated with single slope or Type F barriers.

1610.06(1)(f) Concrete Barrier Transitions

At times, runs of concrete barrier will require a shape and/or stiffness transition to another type of concrete barrier/bridge rail. The following list provides a brief description of the most common types of concrete barrier transitions:

Bridge Transitions: When single-slope or F-Shape faced bridge barrier is used on bridges or structures and precast barrier is selected for use on the approaches to the bridge or structure; a transition section is needed to provide gradual stiffening from the less rigid precast barrier system to the more rigid bridge rail/bridge barrier system. In addition, a transition is needed to ensure that no vertical edges of barrier are exposed to oncoming traffic due to the difference in shapes and height between the two different barrier systems. Note: See Standard Plans for concrete barrier bridge transitions. See the Bridge Design Manual for details on bridge rails/bridge barrier.

Roadside and Median Shape Transitions: Use a transition section when it is necessary to change the shape of the barrier within a single run (i.e., Type F to Single Slope, Type 2 to Type F) of barrier. Transition designs will differ when used on roadside/wide median applications (barrier subject to vehicle impacts on one side only), or narrow median applications (barrier subject to vehicle impacts on both sides). Note: See Standard Plans for concrete barrier transitions between different shapes of concrete barrier.

Stiffness Transitions: Use an anchoring transition section when changing the stiffness of the barrier system within a single run of barrier but not the barrier shape (i.e., Type F anchored to Type F unanchored). This type of transition requires a change in anchoring pin configuration when moving from an unanchored barrier system to an anchored barrier system. There is no other change to the barrier other than the anchoring pin configuration. Note: See Standard Plans for barrier stiffness transitions.

For aesthetic reasons, avoid changes in the shape of the barrier face within a project or corridor whenever possible.

1610.06(2) Concrete Barrier Height

Pavement overlays are allowed to be placed in front of concrete barriers per the following allowable minimum height guidance for each type of barrier:

- Allow no less than 32-inches from the new pavement surface to the top of standard height (not high performance) single-slope barrier.
- Allow no less than 36-inches from the new pavement surface to the top of high performance single-slope barrier.

- Overlays are not allowed in front of safety shape barriers. Safety shape barriers must be adjusted to maintain their 32-inch height, or they must be replaced when an overlay is being placed in locations with these types of barrier.

Note: When placing overlays in front of single slope concrete barriers, ensure that the overlay does not cause the barrier grade separation height to exceed the depth of barrier embedment (see Section 1610.06(1)(b) and Standard Plan C-70.10 or C-80.10 for more information).

1610.06(3) Concrete Barrier Terminals

Whenever possible, bury the blunt end of a concrete barrier run into the backslope of the roadway. If the end of a concrete barrier run cannot be buried in a backslope or terminated as described below, terminate the barrier using a guardrail terminal and transition or an impact attenuator (see Chapter 1620).

To bury the blunt end of the barrier into a backslope, the following conditions must be met:

- The backslope is 3H:1V or steeper
- The backslope extends minimum of 4 feet in height above the edge of shoulder
- Flare the concrete barrier into the backslope using a flare rate that meets the criteria in Section 1610.03(7)
- Provide a 10H:1V or flatter foreslope into the face of the barrier and maintain the full barrier height until the barrier intersects with the backslope. This might create the need to fill ditches and install culverts in front of the barrier face.

Note: Do not place a mound of soil or base material over the blunt end of a concrete barrier run. Install blunt ends of concrete barrier runs requiring mitigation into the backslope of a roadway, terminate with a guardrail transition and terminal, or terminate with an impact attenuator as described in this section.

The 7-foot-long Type F barrier terminal (precast) and the 10- to 12-foot single-slope barrier terminal (precast or cast-in-place) may be used in the following conditions:

- Outside the Design Clear Zone.
- On the trailing end of the barrier when it is outside the Design Clear Zone for opposing traffic.
- On the trailing end of one-way traffic.
- Where the posted speed is 25 mph or below.

See the *Standard Plans* for barrier terminal details.

1610.06(4) Concrete Barrier Placement in Front of Bridge Piers

Existing barrier in front of bridge piers may remain in place in preservation (P1, P2, P3) projects. For all other projects, contact the HQ Bridge Traffic Barrier Specialist when an existing or proposed bridge pier is in the Design Clear Zone, regardless of whether a barrier currently exists.

1610.07 Bridge Traffic Barriers

Bridge traffic barriers redirect errant vehicles and help to keep them from going over the side of the structure. See the *Bridge Design Manual* for information regarding bridge barrier on new bridges and replacement bridge barrier on existing bridges.

When considering work on a bridge traffic barrier consult the WSDOT Bridge and Structures Office (BSO).

The standard bridge traffic barrier is a single slope traffic barrier, 3 foot 6 inch in height for Test Level 4 (TL-4) and 3 foot 9 inch in height for Test Level 5 (TL-5). See *Bridge Design Manual* section 10.2.1 for selection of the appropriate test level for bridges and structures.

For corridor continuity, a 2 foot 10 inch tall single slope; a 3 foot 9 inch tall F-shape, 3 foot 6 inch tall F-shape; or 2 foot 8 inch tall F-Shape traffic barrier may be used. Barriers with reveal heights less than 3 foot 6 inch may be used with a pedestrian railing attached to the top for a total height of 3 foot 6 inches. This also meets requirements for worker fall protection.

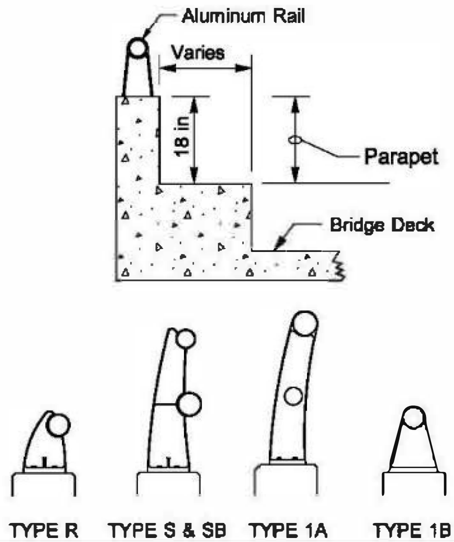
Approach barriers, transitions, and connections are usually needed on all four corners of bridges carrying two-way traffic and on both corners of the approach end for one-way traffic. See Section 1610.04(6) for guidance on beam guardrail transitions. See standard plans for concrete barrier bridge transitions.

Bridge railing attaches to the top of the bridge barrier. When bridge barrier is included in a project, the bridge rails, including crossroad bridge rail, are to be addressed. Consult the WSDOT BSO regarding bridge rail selection and for design of the connection to an existing bridge.

Consider the following:

- Use an approved, NCHRP 350 or MASH crash-tested bridge traffic barrier on new bridges or bridges to be widened. The *Bridge Design Manual* provides examples of typical bridge rails. The BSO's minimum crash test level for all state and interstate bridges is a TL-4.
- An existing bridge rail on a roadway with a posted speed of 30 mph or below may remain in place if it is not located on a bridge over a National Highway System (NHS) highway. When Type 7 bridge rail is present on a bridge over an NHS highway with a posted speed of 30 mph or below, it may remain in place regardless of the type of metal rail installed. Other bridge rails are to be evaluated for strength and geometrics. (See Section 1610.07(1) for guidance on retrofit techniques.)
- The Type 7 bridge rail is common. Type 7 bridge rails have a curb, a vertical-face parapet, and an aluminum top rail. The curb width and the type of aluminum top rail are factors in determining the adequacy of the Type 7 bridge rail, as shown in Exhibit 1610-19. Consult the WSDOT BSO for assistance in evaluating other bridge rails.
- When considering an overlay on a bridge, consult the WSDOT BSO to verify the overlay depth can be placed on the bridge deck based on the type of traffic barrier. There may be instances where the height of the bridge barrier will not allow for the planned overlay depth without removal of existing pavement.

Exhibit 1610-19 Type 7 Bridge Rail Upgrade Criteria



Aluminum Rail Type	Curb Width	
	9 Inches or Less	Greater Than 9 Inches*
Type R, S, or SB	Bridge rail adequate	Bridge rail adequate
Type 1B or 1A	Bridge rail adequate	Upgrade bridge rail
Other	Consult the WSDOT BSO	

*When the curb width is greater than 9 inches, the aluminum rail must be able to withstand a 5-kip load.

1610.07(1) Bridge Barrier Retrofit

If the bridge barrier system does not meet the criteria for strength and geometrics, modifications to improve its redirectional characteristics and its strength may be needed. Consult the WSDOT BSO to determine which retrofit method described below can be completed.

1610.07(1)(a) Concrete Safety Shape

Consult the WSDOT BSO to determine whether the existing bridge deck and other superstructure elements are of sufficient strength to accommodate this bridge barrier system and provide design details for the retrofit. Retrofitting with a new concrete bridge barrier is costly and requires authorization from Program Management when no widening is proposed.

1610.07(1)(b) Thrie Beam Retrofit

Retrofitting the bridge barrier with thrie beam is an economical way to improve the strength and redirectional performance of a bridge barrier. The thrie beam can be mounted to steel posts or the existing bridge barrier, depending on the structural adequacy of the bridge deck, the existing bridge barrier type, the width of curb (if any), and the curb-to-curb roadway width carried across the structure. Exhibit 1610-20 shows typical retrofit criteria.

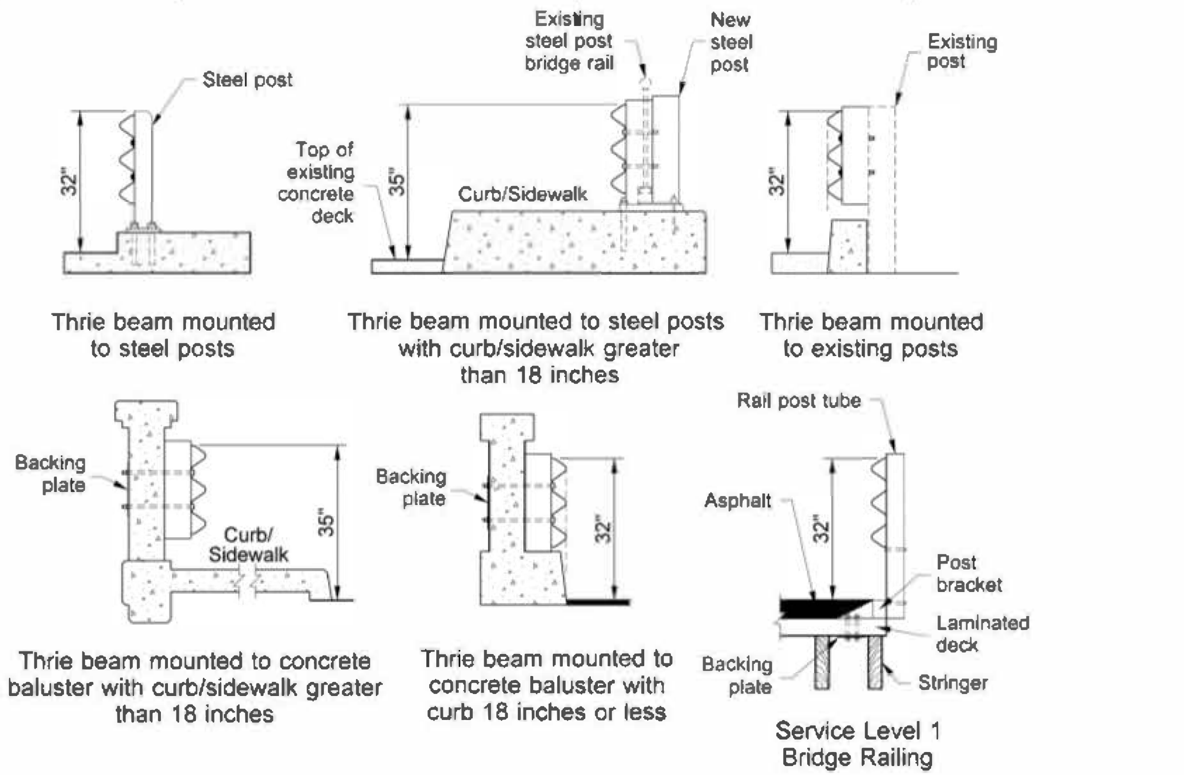
Note that Bridges designated as historical landmarks may not be candidates for thrie beam retrofitting. Contact the Environmental Services Office regarding bridge historical landmark status.

Consider the Service Level 1 (SL-1) system on bridges with wooden decks and for bridges with concrete decks that do not have the needed strength to accommodate the thrie beam system. Contact the WSDOT BSO for information needed for the design of the SL-1 system.

If a thrie beam retrofit results in reduction in sidewalk width ensure ADA compliance is addressed, see Chapter 1510.

Exhibit 1610-20 Thrie Beam Rail Retrofit Criteria

<table>
<tr><th rowspan="2">Curb Width</th><th rowspan="2">Bridge Width</th><th colspan="2">Concrete Bridge Deck</th><th rowspan="2">Wood Bridge Deck or Low- Strength Concrete Deck</th></tr>
<tr><th>Concrete Bridge Rail (existing)</th><th>Steel or Wood Post Bridge Rail (existing)</th></tr>
<tr><td><18 inches</td><td></td><td>Thrie beam mounted to existing bridge rail [2] and blocked out to the face of curb. Height = 32 inches.</td><td>Thrie beam mounted to steel posts [2] at the face of curb. Height = 32 inches</td><td rowspan="3">• Service Level 1e Bridge Rail. [2]e
• Height = 32 inches.e
• Curb or wheele guard needs to bee removed.e</td></tr>
<tr><td>>18 inches</td><td>> 28 ft (curb to curb)</td><td colspan="2">Thrie beam mounted to steel posts[2] at the face of curb. [1] Height = 32 inches.</td></tr>
<tr><td>>18 inches</td><td>< 28 ft (curb to curb)</td><td>Thrie beam mounted to existing bridge rail.[2]
Height = 35 inches.</td><td>Thrie beam mounted to steel posts [2] in line with existing rail.
Height = 35 inches.</td></tr>
</table>



Notes:

[1]e To maximize available curb/sidewalk width for pedestrian use, thrie beam may be mounted to thee bridge rail at a height of 35 inches.e

[2]e Contact the WSDOT BSO for design details on bridge rail retrofit projects.e

*****FORM W, *Traffic Impact Days******

To be signed by authorized Proposer representative

Location	Traffic Impact Days
Chuckanut Creek I-5 NB	150 Calendar Days
Chuckanut Creek I-5 SB	120 Calendar Days
Chuckanut Creek Old Samish Rd	275 Calendar Days
UNT to Lake Creek I-5 NB & SB	95 Calendar Days
UNT to Lake Creek I-5 SB Ramps	30 Calendar Days
Lake Creek I-5 NB	70 Calendar Days
Lake Creek I-5 SB	70 Calendar Days
Middle and North UNT to Friday Creek I-5 NB (Mainline Only)	80 Calendar Days
Middle and North UNT to Friday Creek I-5 SB (Mainline Only)	80 Calendar Days
Middle and North UNT to Friday Creek I-5 NB Ramps & Shoulders	54 Calendar Days
Middle and North UNT to Friday Creek I-5 SB Ramps & Shoulders	52 Calendar Days
Middle UNT to Friday Creek Lake Samish Rd	40 Calendar Days
South UNT to Friday Creek I-5 NB	0 Calendar Days
South UNT to Friday Creek I-5 SB	0 Calendar Days
South UNT to Friday Creek Lake Samish Rd	0 Calendar Days

For each location listed above, the Proposer shall enter the number of Traffic Impact Days as described in Section 3.3.4. of the ITP.

The Traffic Impact Days recorded on this form will be used to establish technical credits as described in Section 3.3.4 of this ITP and for calculating Liquidated Damages as described in Section 1-08.9 of the General Provisions.

Signed ______________________________ Date: __________________________

Printed Name: __________________________ Title: __________________________