MINNESOTA DEPARTMENT OF TRANSPORTATION
Engineering Services Division
Technical Memorandum No. 13-02-TS-01
January 15, 2013

To: Electronic Distribution Recipients

From: Jon M. Chiglo, P.E.
Division Director, Engineering Services

Subject: Design Guidelines for High-Tension Cable Barriers (HTCB)

Expiration
This is a new Technical Memorandum and shall remain in effect until January 15, 2018 unless superseded prior to that date.

Implementation
The guidelines contained in this Memorandum are effective immediately for MnDOT projects provided its application does not jeopardize letting dates of projects in the design phase.

Local road authorities are encouraged to adopt these or similar guidelines for high-tension cable barrier applications beyond the trunk highway system.

Introduction
High-Tension Cable Barrier (HTCB) is a flexible barrier system used on a roadside or as a median barrier to reduce the severity of run-off-the-road crashes. These systems typically consist of three or four cables under high tension supported by breakaway steel posts. The most common use of these systems has been in wide depressed medians.

HTCBs have greater deflection than W-beam, box-beam and concrete barriers, but where adequate deflection space is available, HTCB systems offer key advantages over these other systems. A primary advantage of HTCB is that it can be placed on slopes as steep as 1:4, meaning it can be placed down an inslope, farther away from the traveling public, allowing errant vehicles more room to regain control and avoid impact. Another prime advantage of HTCB is that, upon impact, it exerts less G-force on the occupants of the errant vehicle than semi-rigid and rigid barriers, typically lessening injury potential. Additionally, these systems are able to effectively contain and redirect the vehicle. In some cases, after a less severe and isolated hit, the cables will maintain their approximate heights and may be able to contain and redirect subsequent errant vehicles that impact the same location prior to the system's repair.

Purpose
The purpose of this Memorandum is to provide guidelines for designing high-tension cable barriers using:

- Federal Highway Administration (FHWA) approval letters for each of the proprietary systems meeting MnDOT's performance criteria.
- National Cooperative Highway Research Program (NCHRP) Report 711: Guidance for the Selection, Use, and Maintenance of Cable Barrier System.
- National Crash Analysis Center (NCAC) vehicle dynamics modeling data. Under the FHWA's roadside safety research program, the staff of the NCAC at George Washington University developed a methodology to provide a technical response to barrier deployment questions. Vehicle dynamics analyses were performed to develop guidelines for effective cable barrier placement on sloped medians.

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Guidelines

To aid design practitioners and bring consistency to the design approach in Minnesota, these design guidelines for HTCB have been developed. They are specific to vehicle approach surfaces with 1:4 and flatter slopes.

High-Tension Cable Barrier shall meet the following criteria:

1. Satisfy the requirements for test level 4 (TL-4) as defined by the criteria of NCHRP Report 350 on slopes 1:6 or flatter.
2. Satisfy the requirements for test level 3 (TL-3) as defined by the criteria of NCHRP Report 350 on slopes steeper than 1:6, up to 1:4.
3. Utilize four (4) pre-stretched cables.
4. Socket foundation may be either steel or concrete.
5. All end anchors and line post foundations shall be designed in accordance with the latest edition of the AASHTO LRFD Bridge Design Specifications, including all interims, herein referred to as "AASHTO LRFD."

Based on these requirements, three systems meet the above design criteria at the time of this memorandum's publication:

Manufacturer	Name of System	FHWA Approval Letter(s)	Date
BRIFEN	Brifen TL-4 (4-Rope) WRSF	FHWA HSA-10/B-82B FHWA HSA-10/B82-B1	3/27/2005 5/9/2006
GIBRALTAR	Gibraltar TL-4 Cable Barrier System	FHWA HAS-10/B137C FHWA HSA-10/B-137A1 (1)	7/12/2006 10/27/2006
TRINITY (CASS)	CASS-S3 (1:4 SLOPE) 4-CABLE GUARDRAIL SAFETY SYSTEM	FHWA HSSD/B-141F	10/1/2010

(1) FHWA letter FHWA HSA-10/B-137A TL-4 (3 CABLES) with approval date 9/9/2005, used as a reference for the modified version HAS-10/B-137A1, which added a fourth cable between the bottom two cables at a height of 25 inches.

All FHWA roadside hardware acceptance letters can be found here: http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/listing.cfm.

All designers should familiarize themselves with the acceptance letters for the above systems, particularly the measured dynamic deflection under crash-tested conditions as well as the line post spacing in each of the tests. HTCB project designs should be based on the FHWA acceptance letters and the following design guidance. After the design is finalized, the project manager or design engineer should contact the Design Standards Unit for consultation and informal design review. The design review will check placement and deflection parameters as presented in the FHWA approval letters and NCAC reports.

- **Total system safety improvement** – Within the limits of a median barrier project, all roadside hardware in the median that does not meet current standards (e.g. non-compliant end treatments, W-beam bullnoses) should be upgraded.

- **Length of Installation** – The minimum tested length of HTCB under the guidelines contained in NCHRP Report 350 is 300 feet. For this reason, if the available space is less than 300 feet, the designer should consider another barrier alternative at that location due to the reduced re-directional ability. The maximum length between end anchorages is about one mile.

- **Median crossovers for emergency vehicles** – The designer should inventory the number of emergency median crossovers within and near the project limits including bullnose guardrail installations that provide crossover opportunities. In conjunction with the minimum and maximum installation lengths above, the barrier system configuration should retain a

crossover frequency adequate for operations and emergency response but also keep the number of breaks in barrier coverage to a reasonable minimum. The design should be coordinated with the State Patrol and municipal and private emergency service providers (e.g. fire departments, ambulance and towing companies in the area) as well as with MnDOT Maintenance staff to determine which median openings are to be kept open or closed.

- **Length of Need (LON) and End Anchors** - The cable barrier system is composed of a basic LON section and end anchor systems at each end of the run of cable. End anchor systems are gating and should not be counted as part of LON. Designers should continue the tension cable guardrails 50 feet downstream of any hazard before connecting to the end anchors in order to more fully develop the re-directive and capture capabilities of the system.

- **Basic Placement Guidelines:**
    - HTCB systems should not be placed on slopes steeper than 1:4.
    - HTCB should not be used to shield any fixed object.
    - HTCB may be used to shield a steep side slope as long as adequate lateral offset to the slope break point can be provided and fixed objects are not within its likely deflection.
    - A minimum clear distance equivalent to the likely barrier deflection based on its crash-tested performance should typically be maintained between it and any opposing travel lane. Refer to the FHWA approval letters for deflection data. The designer must exercise engineering judgment in determining a likely in-service deflection, taking into consideration the system's line post spacing, distance from end anchorage, roadway and roadside geometry and any other applicable factors as compared to the crash test parameters. (Deflection increases with greater end anchorage spacing and line post spacing.) Various sources of data may be available depending on the cable system employed; contact the Design Standards Unit for additional information.
    - Placement in areas of a median ditch prone to soil saturation conditions should be avoided.

- **Lateral Placement Guidelines** – To minimize the risk of vehicle underrides or overrides, the following guidelines should be followed. They are based on the MnDOT typical flat-bottom (trapezoidal) ditch geometry. If site conditions or geometry preclude adherence to these criteria or median geometry is other than a flat-bottom ditch, please contact the Design Standards Unit for assistance.
    - A cable barrier system should generally be placed as far away from the travel lane as practical while maintaining the criteria as follows.
    - To avoid underrides, the barrier should not be placed within 8 feet, measured laterally, of the inslope / ditch bottom intersection point.
    - An exception to the criterion above is that, in medians with inslopes 1:6 or flatter, the barrier may be placed in the region within 1 foot laterally of the inslope / ditch bottom intersection point, providing soil conditions are suitable.
    - To avoid overrides by higher-profile passenger vehicles, where the inslope is steeper than 1:6, the barrier should not be placed in the region farther than 4 feet and nearer than 20 feet from the shoulder P.I.

- Adjacent to the high side of superelevation exceeding a 3 percent pitch, the barrier should be placed no farther than 2 feet from the shoulder P.I. where the inslope is steeper than 1:6 and no farther than 5 feet where the inslope is 1:6 or flatter.

- For installations adjacent to the low side of superelevation exceeding 6 percent, contact the Design Standards Unit for assistance.

- For roadside installations to shield steep side slopes, contact the Design Standards Unit for information regarding adequate offsets between the barrier and the slope break point.

- **Determining on which side of the median the High-Tension Cable Barrier should be placed** –
  - In non-symmetrical medians, it is preferable to place the HTCB on the side of the median with the flatter inslope.

  - High-tension cable barrier should typically be installed on the opposite side of the median from where most roadway departures occur. This will allow the errant vehicles to have more room to either recover or dissipate part of their impact energy traversing through the ditch before engaging the HTCB.

  - On horizontal tangent, if one roadway is higher than the other, using the above principle the guardrail should preferably be placed adjacent to the higher roadway.

  - Since roadway departures are more common on the outside of a horizontal curve, cable barriers on curves should normally be placed on the inside of the outside roadway curve as shown on Exhibit A. When a curved cable barrier is impacted, the tension in the barrier immediately decreases as cables are separated from the line post and become slack, resulting in deflection in excess of the barrier's design deflection. This factor needs to be taken into consideration where deflection is an issue in its lateral placement. Refer to the subsection "Line Post Spacing" for additional design considerations.

  - In narrower medians, the use of two cable barriers (one on each side of the median) or a more rigid barrier can be considered to minimize the possibility of vehicles crossing the narrow medians and impacting the other side of roadway into oncoming traffic. This may be particularly applicable through horizontal curves, where dynamic deflections are greater.

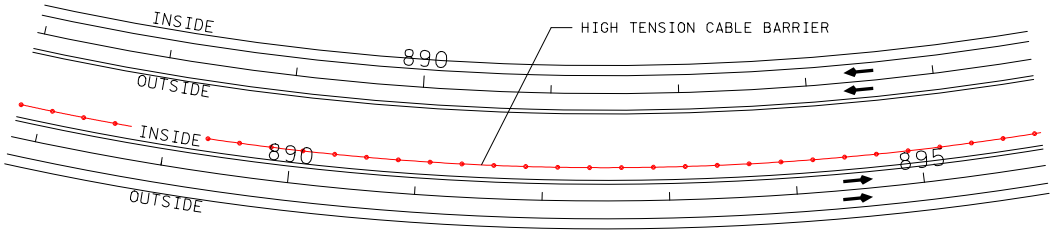


Exhibit A

- **Cable switching sides in the median –** Where the cable barrier switches from side of the median to the other in the manner shown in Exhibit B, end anchorages can be shielded from errant vehicles crossing the medians by overlapping the installations. This is recommended to reduce the risk of the entire system being disabled if an end anchorage is impacted as well as reduce the risk of cross-median departures at that location.

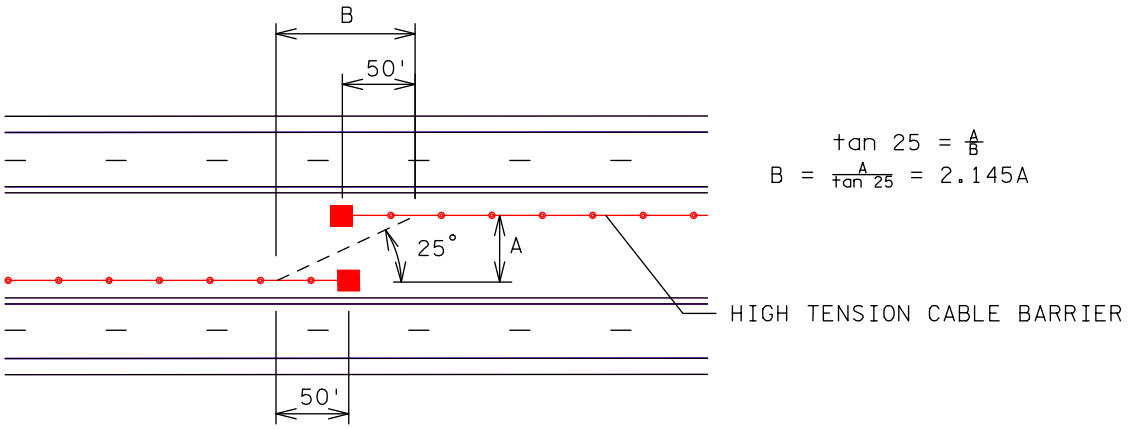


Exhibit B

- **Vertical Curve Placement** – When high-tension cables are installed lower in elevation than the end anchors, as may be the case in a sag vertical curve, upward vertical forces are exerted on the posts. Depending on the system selected, these forces could pull the posts out of the sockets or pull the cables off the posts, resulting in less cable tension and cables at the incorrect height in relation to the ground. For the above reasons, the designer should consult the manufacturer's recommendations and consider the following to reduce the upward forces:
  a. End anchors should be placed as close to the low points and high points of vertical curvature as practicable.
  b. End anchors should be placed at any point where there is a sudden change in vertical slope.
  c. Reduced post spacing should be considered through sharp vertical curves.
  d. Re-grading short sections of medians in areas of sharp vertical curvature should be considered.

- **Line Post Spacing** – The nominal line post spacing for all HTCB systems will be 10 feet regardless of the system and its crash-tested post spacing. Computer simulation indicates that dynamic deflection is lessened with tighter post spacing, and vehicle containment is likewise expected to be more consistent as well. For these reasons, the 10-foot post spacing should only be exceeded where extraordinary circumstances dictate. Reduced post spacing should be used within horizontal curves with radii less than 1,300 feet to counteract larger deflections that occur on curved roadways. Decreased post spacing is also effective in reducing the bending of line posts over time resulting from higher lateral pressures in curves.

- **Avoiding Utilities with Posts and Anchors –** Post spacing must be reduced as needed below the nominal 10-foot spacing to avoid any utilities. Longer-than-10-foot post spacing is not to be used to avoid utilities. All utilities in the anchor areas need to be field located.

- **Median Ditch Blocks and Existing Crossovers –** Designers should coordinate with their district hydraulics unit to investigate the possibility of flattening ditch blocks and existing crossovers before installing HTCB.

- **Locating End Anchor Systems at Pier Protection Systems on Tangent –** Because the deflection distances for cable barriers are relatively large, these systems are not MnDOT's prescribed treatment for shielding fixed objects such as bridge piers in a median. Where fixed objects are to be shielded, the cable barrier should be terminated and semi-rigid barrier used. See Exhibit C for example details and the recommended clearance between systems to facilitate maintenance access and emergency vehicle passage.

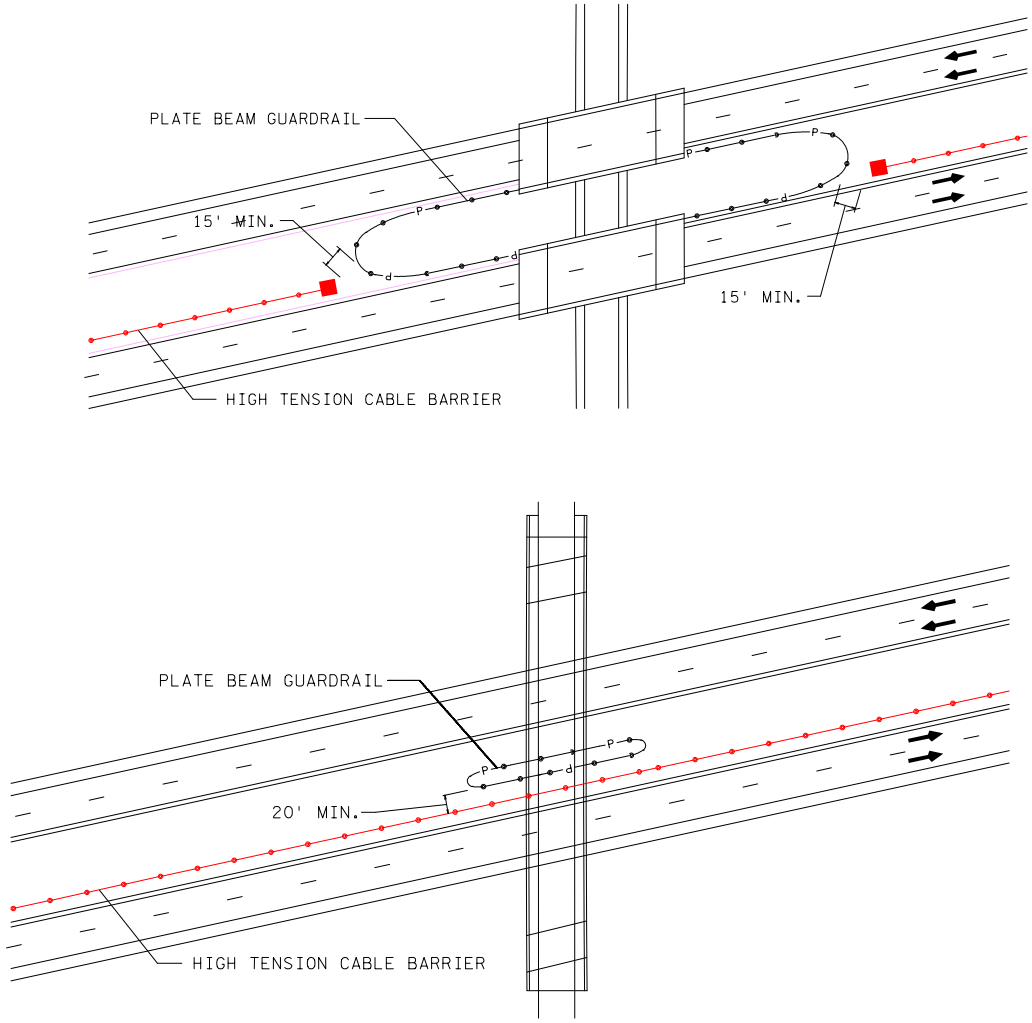


Exhibit C

- **Soil Conditions/Footing Design for End Anchors, line post Steel Socket Foundation and Concrete Foundation** - Once the location of the cable guardrail has been defined, each proposed End Anchor location will be investigated to determine soil strengths for the

foundation design. A minimum of one Standard Penetration Test (SPT) Boring or Cone Penetration Test (CPT) Sounding will be taken at each anchor location to a minimum depth of 25 ft. The boring or sounding will be within 25 ft. horizontally and 2 ft. vertically from the proposed anchor location. Support or resistance provided by the top 3 feet of soil shall not be included in the design of end anchors. Line post locations will be investigated to determine that assumed design soil strength values are met. Line post investigations will be conducted between anchor points at evenly spaced locations no further than 1500 feet apart. The borings or soundings will be advanced to the anticipated depth of the line post installation or a minimum depth of 10 feet. The drilling or direct pushing of each boring or sounding will meet the requirements as outlined in the State's "Consultant Specifications for Subsurface Investigation & Geotechnical Analysis and Design Recommendations" found in the MnDOT Foundations Unit Website at http://www.mrr.dot.state.mn.us/geotechnical/foundations/tcontract/consultdrillreport.doc

The MnDOT Foundations Unit or a geotechnical consultant will prepare a report containing the borings or soundings. The report will also address if the soils encountered at the points investigated for the line posts meet or exceed the strengths assumed for the standard line post designs or if a special design will be required. This report will be made available to all bidding contractors so they can design the End Anchors and line post Steel Socket Foundation (See attachment 3) and Concrete Foundation (See attachment 2) per existing soil conditions.

- **Grading Requirements** – Include pay items for all grading necessary to bring slopes and grades into accordance with the requirements in this memo. Include a note in the plan stating, "Any required grading shall be done before guardrail posts are set."

- **Cable splices –** It is important to ensure that splice hardware provides for connections that are superior in strength to the cable itself. Splices may not be located at the posts. Provide swaged fittings for all cable connections.

- **Line Post Plumbness** – All line posts shall be plumb with the sockets; refer to manufacturer's specification for more details.

- **Erosion Control Considerations** – HTCB median barrier projects entail considerable soil disturbance due to heavy equipment operating in the median as well as common associated miscellaneous construction. All projects must have SWPPP items (narrative, details, and plan locations) incorporated regardless of the need for a formal permit (See Attachment 4).

- **Consult the manufacturers of these systems** – For unique situations, it is recommended to contact the representative of these TL-4 systems. Currently, the three approved systems are as listed below. **However, close attention should be given to each system's deflection vs. the available space in the project site as well as how their proposed deflection data were calculated**:

BRIFEN
Brifen*USA Inc.
Bill Trousdale
(866) 427-4336
www.brifenusa.com

GIBRALTAR
Gibraltar Cable Barrier Systems, L.P.
Ron Faulkenberry
(800) 495-8957
www.gibraltartx.com

Trinity (CASS)
Trinity Highway Products, LLC
2525 Stemmons Freeway
Dallas, TX 75207
(800) 527-6050
http://highwayguardrail.com/

Questions
Any questions regarding the technical provisions of this Technical Memorandum can be addressed to any one of the following:

- **Michael Elle at (651) 366-4622, Design Standards Engineer**
- **Hatem Qamhieh at (651) 366-4706, Project Manager / Asst. Design Standards Engineer**

Any questions regarding publication of this Technical Memorandum should be referred to the Design Standards Unit, DesignStandards.DOT@state.mn.us. A link to all active and historical Technical Memoranda can be found at http://techmemos.dot.state.mn.us/techmemo.aspx.

To add, remove, or change your name on the Technical Memoranda mailing list, please visit the web page http://techmemos.dot.state.mn.us/subscribe.aspx

Attachments:
1. (Plan) Construction Notes
2. Cable Line Post – Concrete Foundation (Standard Plate 8342)
3. Cable Line Post – Steel Socket Foundation (Design Detail)
4. Erosion/Sediment Control and Turf Establishment
5. Special Provisions
6. Public Interest Finding (PIF)

-END-

Attachment 1
TM 13-02-TS-01
January 15, 2013

CONSTRUCTION NOTES

1. All drainage inlets within 200 feet of any disturbed soil in the median shall be provided with appropriate inlet protection prior to disturbance. Inlet protection shall be incidental unless otherwise specified in the contract.

2. All material removed and not reused on this project shall become the property of the contractor and be disposed of outside MnDOT Right of Way in accordance with Spec. 2104.

3. Salvage and installation of culvert marker posts are incidental.

4. Any required grading shall be done before guardrail posts are set.

5. Roads shall be kept clean of sediment. Use a street sweeper with pick-up type, non-dust generating power broom as often as necessary to keep roads visibly clean within 24 hours of activity that generates sediment tracking or before opening the affected lane to traffic, whichever comes first. All street sweeping work, including street sweeper, shall be incidental.

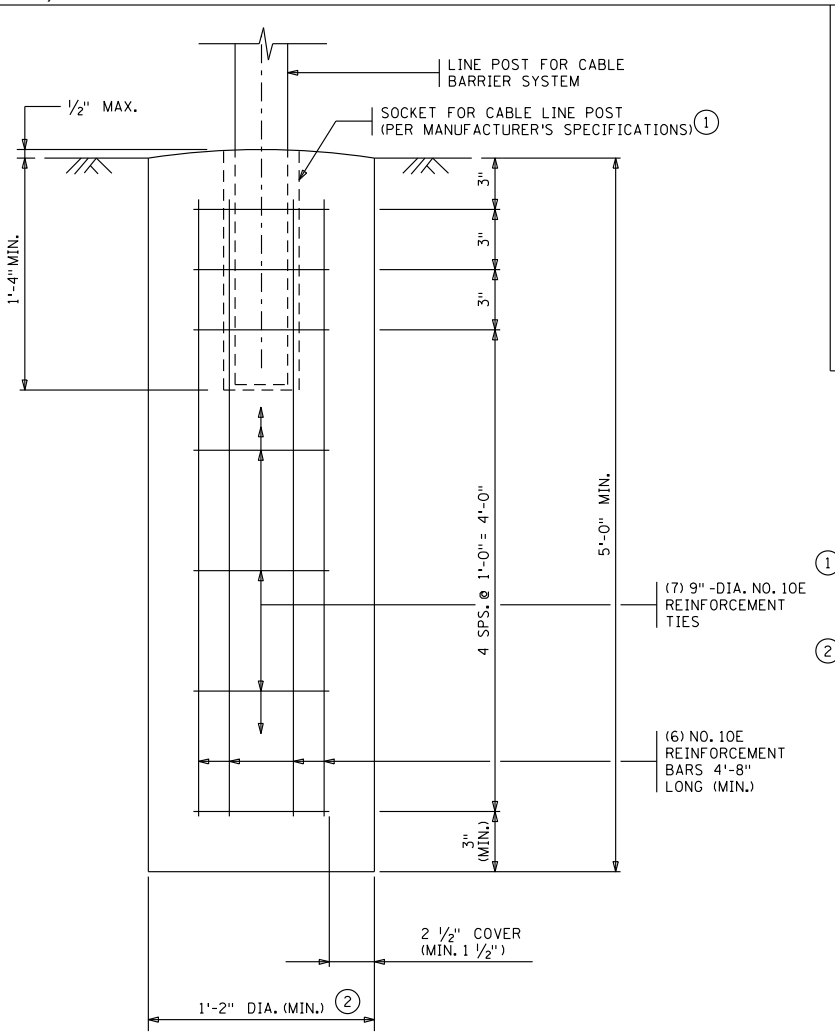
6. Turf establishment shall consist of:
    - Seed Mixture 250 with an application rate of 70 pounds per acre or Seed Mixture 25-141 with an application rate of 59 pounds per acre.
    - Fertilizer Type 3 with an application rate of 200 pounds per acre, analysis 22-5-10, 0% CL.
    - Mulch Material Type 1 with an application rate of 1.5 tons per acre.
    - Hydraulic Soil Stabilizer Type 5 with an application rate of 750 pounds per acre.

7. Post foundations shall be flush with the ground line posts shall be installed plumb according to each manufacturing company.

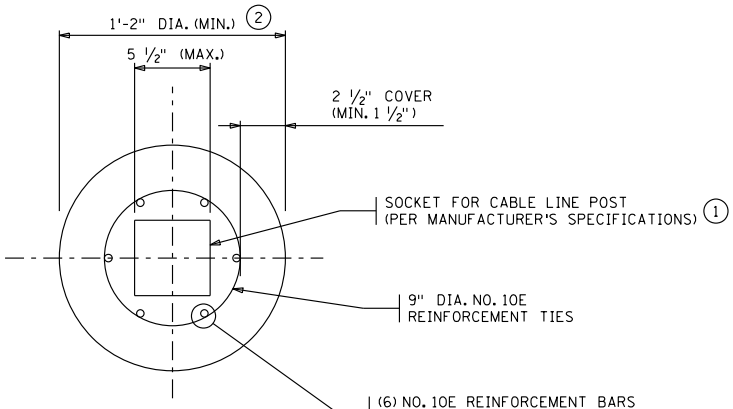
8. For all construction activities within designated noxious and invasive weed-infested areas as shown in the plan, see special provisions.

9. Any required mowing for High Tension Cable Barrier (HTCB) construction is incidental.

Attachment 2
TM 13-02-TS-01
January 15, 2013



ELEVATION VIEW



PLAN VIEW

DESIGN DATA

2012 AND CURRENT INTERIM AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

DESIGN FORCE: MAX PLASTIC MOMENT = 9000 ft-lb

MATERIAL DESIGN PROPERTIES:
REINFORCED CONCRETE:
f'c = 4 ksi n = 8
Fy = 60 ksi FOR REINFORCEMENT

NO. 10E REINF. BARS 4'-8" LONG (MIN.) (6 REQ'D)

NO. 10E REINFORCEMENT TIES (7 REQ'D)

MINIMUM SOIL PROPERTIES:
COARSE GRAINED SOIL: Φ = 30°
FINE GRAINED SOIL: C = 1000 lb/SQ.FT.

CONCRETE MIX NO. 3Y43

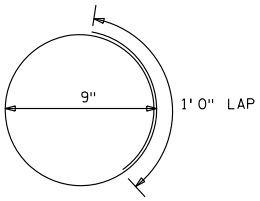
GENERAL NOTES:

THE BAR SIZE IS THE APPROXIMATE NOMINAL DIAMETER OF THE BAR IN MILLIMETERS (mm).

ALL REINFORCEMENT BARS SHALL BE EPOXY COATED.

(1) EMBED THE POST SOCKET WITHIN THE REBAR CAGE WITHIN 1" OF THE CENTER OF THE CONCRETE FOUNDATION.

(2) PROVIDE PROTECTION TO THE HOLE FROM CAVE-IN OR COLLAPSE, IF NECESSARY, WITH PERMANENT OR TEMPORARY CASING OR FORMING.



NO. 10E TIE

APPROVED AUGUST 7, 2012

STATE DESIGN ENGINEER

STATE OF MINNESOTA
DEPARTMENT OF TRANSPORTATION

HIGH-TENSION CABLE BARRIER LINE POST FOUNDATION

CONCRETE DESIGN

SPECIFICATION REFERENCE	STANDARD PLATE NO.
2554	8342A

Attachment 3
TM 13-02-TS-01
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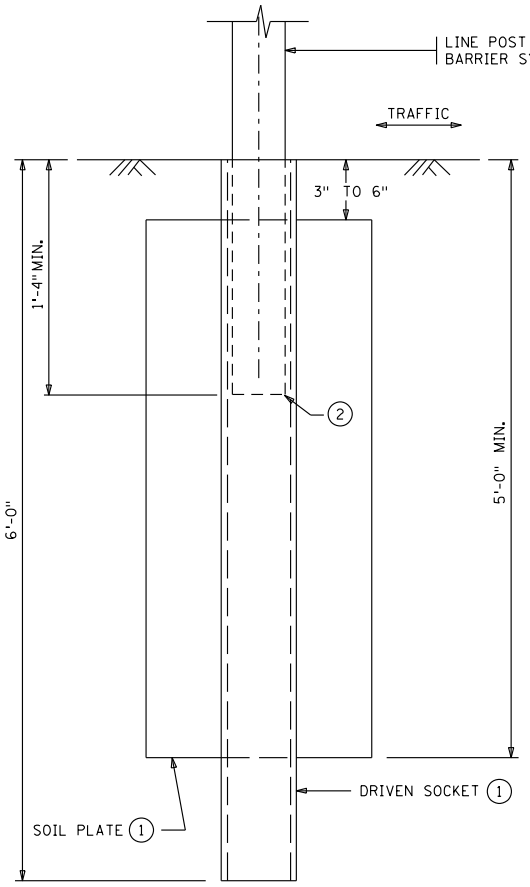
DESIGN DATA

2012 AND CURRENT INTERIM AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

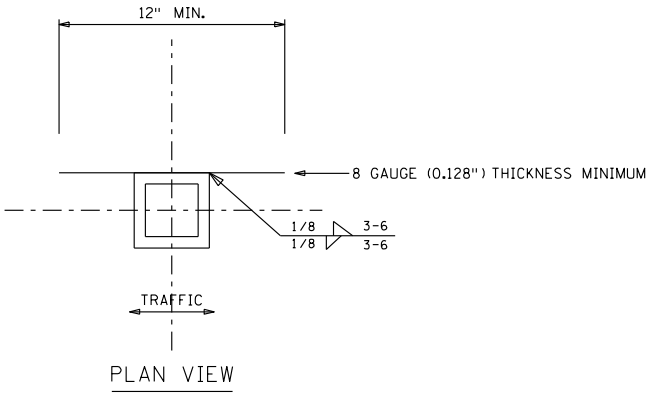
DESIGN FORCE: MAX PLASTIC MOMENT = 9000 ft-lb

MATERIAL DESIGN PROPERTIES:
STRUCTURAL STEEL:
Fy = 36000 p.s.i.
STRUCTURAL STEEL Mn/DOT 3306

MINIMUM SOIL PROPERTIES:
COARSE GRAINED SOIL: Φ = 30°
FINE GRAINED SOIL: C = 1000 lb/SQ.FT.



ELEVATION VIEW



PLAN VIEW

1. GALVANIZE ALL STEEL COMPONENTS AFTER FABRICATION PER MNDOT SPEC. 3392 AND 3394.
2. ANCHORING THE LINE POST TO PREVENT VERTICAL MOVEMENT OF THE LINE POST WILL BE PROVIDED BY THE POST SUPPLIER.

CONTRACTOR SHALL SUBMIT DRIVEN SOCKET DESIGN FOR MnDOT ENGINEER'S APPROVAL.

	REVISED 6/27/2012	CABLE LINE POST STEEL SOCKET FOUNDATION
STATE PROJ. NO.	(TH) SHEET NO. OF	SHEETS

Attachment 4
TM 13-02-TS-01
January 15, 2013

Tension cable Guardrail Project BMPs for Erosion / Sediment Control and Turf Establishment

Erosion Considerations – All projects shall have incorporated SWPPP items (narrative, details, and plan locations) regardless of the need for a formal permit.

Provide for 2573.530 Storm Drain Inlet Protection (Each). Examples of acceptable types of drop inlet protection include being ringed with Spec. 3897 item Filter Log Type Compost Log or Filter Log Type Wood Fiber Bioroll.

The Design Project Manager should coordinate with the construction Project Engineer to use Turf Establishment by the "Lump Sum". If the project's disturbed area is more than 2.5 acres, a Special Provision must supersede the Standard Specifications for Construction to allow for lump sum payment.

All disturbed areas shall be seeded with Seed Mixture 250 at 70 lbs/ac or Seed Mixture 25-141 at 59 lbs/ac after smooth shaping.

Consult with the Hydraulics Engineer / Water Resource Engineer (WRE) and the construction Project Engineer to determine the amount of anticipated median disturbance and provide adequate protection.

- All disturbances in the median ditch bottom conveyance system to a point as high as 6 inches above the ditch grade flow line shall be temporarily or permanently stabilized with Spec. 3885, pay item 2575.523 Erosion Control.

- Use blankets Category 00, 2575.523 Erosion Control Blankets Category 0, or 2575.523 Erosion Control Blankets Category 1 – whichever is specified in the plan – within 24 hours of the disturbance.

- All disturbances above the median ditch bottom conveyance system shall be temporarily or permanently stabilized within 14 days after post holes are bored with pay item 2575.511 Mulch Material Type 4 (Ton).

- All median ditches/conveyance system with more than 30 lineal feet of ultimate disturbance (planned or unplanned) and greater than 1.5 percent grade shall require spec 3897 Filter Logs installed as filter ditch checks, item 2573.540 Filter Log Type Compost Log (Lin Ft) or 2773.540 Filter Log Type Wood Fiber Bioroll (Lin Ft), spaced according to the accepted erosion control practice (spacing in feet = 50 divided by % ditch grade)

Noxious Weeds – Maintenance will locate the limits of noxious weeds for each project. Delineate these locations and include any needed guidance from the Office of Environmental Stewardship in the construction plan and special provisions to prevent noxious weeds from spreading to other areas. (See special provisions 2575 for more details.)

S-1 (2554) TENSION CABLE GUARDRAIL

Use SP2005-255 (FLANGED CHANNEL SIGN POSTS) with this write-up.
REVISED 10/5/12
SP2005-208

This work shall consist of constructing High-Tension Cable Barrier (HTCB) in accordance with MnDOT 2554, as directed by the Engineer, and the following:

S-1.1 High-Tension Cable Barrier shall meet the following criteria:

1) Satisfy the requirements for test level4 (TL-4) as defined by the criteria of NCHRP Report 350 for 1:6 slopes or flatter.
2) Satisfy the requirements for test level 3 (TL-3) as defined by the criteria of NCHRP Report 350 on slopes steeper than 1:6 up to 1:4.
3) Utilize four (4) pre-stretched cables.
4) Socket foundation may be either steel or concrete.
5) All end anchors and line post foundations shall be designed in accordance with the latest edition of the AASHTO LRFD Bridge Design Specifications, including all interims, herein referred to as "AASHTO LRFD."

S-1.2 Independently fasten each of the cables to the end-anchor.

S-1.3 Follow manufacturers' recommendations for vertical tolerance of cables with respect to the ground level.

S-1.4 The alignment, post spacing and location of the HTCB shall be according to the Plan. Line posts shall be plumbed within the sockets. Any socket that doesn't produce a plumb post shall be removed and replaced.

S-1.5 Avoid all utilities by adjusting the post spacing longitudinally, while maintaining the post spacing required in the Plans.

S-1.6 Do not locate turnbuckles at any post in the assembly. Provide swaged fittings for all cable connections.

S-1.7 The Contractor shall replace any edge drains damaged during the drilling or excavation for posts or end anchors as per MnDOT 2502. Reroute any edge drains encountered but not damaged around the post location. Payment for such replacement or rerouting (as applicable) shall be paid for under MnDOT 1403.

S-1.8 Tension the HTCB according to the manufacturer's recommendations at the time of installation. The Contractor shall check and adjust the tension approximately three (3) weeks after installation. No additional compensation will be provided for any subsequent tensioning actions.

S-1.9 Design driven sockets within any curved sections to resist the additional lateral component of the tension forces from the cable.

S-1.10 A Minnesota Licensed Professional Engineer will design the end anchors and intermediate line post foundations in accordance with the latest edition of the AASHTO LRFD. The Plan will contain all the necessary details and design information, including required embedment depth, to construct end anchors, line posts, and line post foundations. The soil parameters used in the design will be based on the borings taken at the end anchor locations during the site investigation except that the soil strengths used in the design will not exceed a friction angle of 35° for the end anchors and 30° for the intermediate line posts for cohesion-less soils or 1000 pounds per cubic foot for cohesive soils for the end anchors and intermediate line posts. Support or resistance provided by the top 3 feet of soil shall not be included in the design of end anchors.

Design of end anchors, line posts and line post foundations shall meet the following requirements:

- Design load shall be based on the PLASTIC MOMENT CAPACITY of the cable supporting posts.

- Maximum lateral deflection, under design load, at the top of end anchor, concrete foundation, or steel socket foundation to be one inch.
- End anchors, concrete foundations and steel socket foundations shall be in accordance with AASHTO LRFD strength and serviceability requirements under normal load cases. These foundations shall survive the loads due to the vehicular impact induced loads. These loads shall not be treated as extreme loads.
- The bottom of end anchors, concrete foundations and steel socket foundations shall be at least 5 feet below the finished grade to meet frost depth requirements.
- The acting forces and moments on the anchors and steel sockets shall be derived from the most current version of L-Pile or similar software for analysis of piles under lateral loads in different horizontal directions, based on the true structure configurations, such as socket with soil plate.

Prior to installing the cable median barrier, the Contractor shall have _____ (working days, calendar days) to provide the Engineer with two (2) sets of Manufacturer prepared design calculations and notes in accordance with AASHTO LRFD, shop drawings, and construction specifications certified by a Minnesota Licensed Professional Engineer. The Contractor shall allow at least twenty one (21) calendar days for the review process and shall not begin installation until receiving approval. The shop drawings and calculations shall detail the End Anchors and line post Steel Socket Foundation and/or Concrete Foundation. The recommended depths for the End Anchors, line post Steel Socket Foundation and/or Concrete Foundation and the design of the End Anchors and line post Steel Socket Foundations shall be approved and certified by a Minnesota Licensed Professional Engineer. This information shall be sent by the construction Project Engineer to the MnDOT Bridge Office and Foundations Office listed below for their review and comment prior to installation. The time required to get the shop drawings approved will not be allowed as justification for extension in the contract time.

Materials & Road Research
1400 Gervais Ave
Maplewood, MN 55109
Gary Person 651/366-5598
Gary.Person@state.mn.us

Bridge Office
3485 Hadley Avenue North
Oakdale, MN 55128-3307
Jihshya Lin 651/366-4490
Jihshya.Lin@state.mn.us

S-1.11 Steel socket foundations shall be designed in accordance with the provisions of AASHTO LRFD including the lateral soil pressure due to the design loads on the top of the foundation and shall include the use of soil plates to resist foundation tipping or movement on both tangent and curved alignments. Install steel socket foundations with a drop hammer capable of producing plumb post without resulting in damage or mushrooming of the foundation components. The socket for concrete line post foundations shall be installed inside the foundation rebar cage. The top of the rebar cage shall be secured 3 inches below the planned top of concrete, prior to concrete placement. Refer to MnDOT Standard Plate 8342 for additional details. Remove steel or concrete line post foundations not at the proper height or alignment and install a new foundation.

S-1.12 Galvanize socket for cable line post after fabrication per MnDOT 3392 and 3394.

S-1.13 Delineate HTCB installations with retro reflective sheeting. Apply the sheeting to the last five (5) posts at each end of the terminal. Apply the sheeting throughout the remainder of the installation at a maximum of 50 feet. The sheeting shall meet the requirements of ASTM Type III or IV sign sheeting. The sheeting shall provide at least seven square inches when viewed on a line parallel to the roadway centerline. Attach the sheeting near the top of the post as recommended by the manufacturer of the cable system. Apply the sheeting to both sides of the post for median installations. Apply the sheeting only to the side of the post facing traffic for roadside installations. The sheeting shall be yellow or white and shall be the same color as the adjacent edge line.

S-1.14 Install snow plow marker (X4-5) with a 2 lb./ft. delineator post 10 feet long driven into the ground a minimum of 48 inches. Extend post a minimum of 5 feet above the ground line and 6 inches adjacent to end anchorage assembly. Install marker at the beginning and end of each run. Snowplow markers and post shall be incidental to the HTCB.

S-1.15 MEASUREMENT AND PAYMENT

The Engineer will measure the number of Anchorage Assemblies by the number installed. Payment will be made under Item 2554.521 (Anchorage Assembly – Tension Cable) at the Contract bid price per each, which shall be payment in full for all costs involved necessary to complete the work as specified

The Engineer will measure the length of Tension Cable Guardrail furnished and installed center of end-anchor to center of end-anchor, complete in place as specified. Payment will be made under Item 2554.603 (Tension Cable Guardrail) at the Contract bid price per meter [**linear foot**], which shall be payment in full for all costs involved necessary to complete the work as specified.

S-2 (2554) TENSION CABLE GUARDRAIL WARRANTY

Designer needs to make sure that the District has identified who will be responsible for checking the Warranty Work. If HTCB is part of the overall project: use S-.2 and indicate the value of the bond. If HTCB is the major portion for the project: use S-.3.

NEW WRITEUP 10/5/12

SP2005-208.1

The Contractor shall provide a one-year warranty for the Tension Cable Guardrail required in Section S-2554 (TENSION CABLE GUARDRAIL) of these Special Provisions.

S-2.1 DEFINITIONS AND TERMS

Final Construction Acceptance (FCA). The date when the warranted Tension Cable Guardrail is complete and the roadway is open to the public without restrictions. This date constitutes the start of the warranty period.

Warranty Bond. A surety that guarantees that the warranty requirements are met.

Warranty Period. The Warranty Period shall be **one (1) year**, starting at the Final Construction Acceptance (FCA).

Warranty Work. Corrective actions taken to bring the warranted work into Contract compliance for release of the warranty bond.

S-2.2 WARRANTY BOND

Amount and Term. The Contractor must furnish a single-term warranty bond in the amount of $__,___. The bond shall be furnished to the Department at the same time as the other Contract Bonds specified in MnDOT 1305. The effective starting date of the warranty bond must be the FCA. The warranty bond will be released at the end of the Warranty Period or after all warranty work has been completed, whichever is last. The form of the warranty bond shall be acceptable to the Contracting Authority.

OR

S-2.3 WARRANTY BOND

Amount and Term. The Contractor must furnish a single-term warranty bond in the amount of the Contract. The bond shall be furnished to the Department at the same time as the other Contract Bonds specified in MnDOT 1305. The effective starting date of the warranty bond must be the FCA. The warranty bond will be released at the end of the Warranty Period or after all warranty work has been completed, whichever is last. The form of the warranty bond shall be acceptable to the Contracting Authority.

Minnesota Department of Transportation

Transportation Building
395 John Ireland Blvd, M.S. 692
St Paul, MN 55155

Office of Project Management and Technical Support
Mail Stop 675
Tel: 651-366-4826
Fax: 651-366-4699

June 12, 2012

Derrell Turner
Division Administrator
Federal Highway Administration
Suite 500
Galtier Plaza
380 Jackson St.
St. Paul, Minnesota 55101-2904

Subject: Request for Public Interest Finding for Proprietary Items

Type of Work: High Tension Cable Barrier

Dear Mr. Turner:

The Minnesota Department of Transportation (MnDOT) is requesting a Public Interest Finding to allow MnDOT to specify specific products for High Tension Cable Barrier (HTCB) on projects on State Trunk Highways, per 23 CFR 635.411(c).

The Department has been working to standardize the specifications and plan details for when High Tension Cable Barrier is required. The desire of the Department is to provide geographical consistency for type of barrier installed as well as cost effectiveness. Statewide, MnDOT will specify a total of three products for use. MnDOT would like to designate two products for each outstate district, with all three products being allowed in the Metro Area.

Regional consistency is desirable to properly manage the amount of training and expertise required for maintenance staff. Maintenance crews for each district will need to only be trained in the repair of the systems for their geographic areas. And each maintenance area will be required to only carry parts for the specified barrier. Response time for repairs should be minimized when responding to hits.

The following table indicates which systems MnDOT has selected for use on State Trunk Highways:

Manufacturer	Name of System	FHWA Approval Letter	Test Level	FHWA Approval Date
BRIFEN	Brifen TL-4 (4-Rope) WRSF	FHWA HSA-10/B-82B FHWA HSA-10/B82-B1	TL-4 (4 CABLES) TL-4 (4 CABLES)	3/27/2005 5/9/2006
GIBRALTAR	Gibraltar TL-4-4 Cable Barrier System	FHWA HSA-10/B-137A (1) FHWA HSA-10/B-137A1	TL-4 (3 CABLES) TL-4 (4 CABLES)	9/9/2005 10/27/2006
TRINITY (CASS)	CASS-S3 (4:1 SLOPE) 4-CABLE GUARDRAIL SAFETY SYSTEM	FHWA HSSD/B-141F	TL-4 (4 CABLES)	10/1/2010

(1) FHWA letter HSA-10/B-137A used as a reference for the modified version HAS-10/B-137A1 which added a fourth cable between the bottom two cables at a height of 25 inches.

MnDOT is proposing that the following products be specified for each District.

District	System Selections
District 1	Brifen and Trinity (CASS)
District 2	Brifen and Trinity (CASS)
District 3	Brifen and Gibraltar
District 4	Brifen and Gibraltar
Metro	Brifen, Gibraltar and Trinity (CASS)
District 6	Brifen and Gibraltar
District 7	Brifen and Trinity (CASS)
District 8	Brifen and Trinity (CASS)

Each specific District would only install systems from the above list.

The public interest finding would begin on July 1, 2012 and end on July 1, 2015. Before the PIF is renewed, the following items will be reviewed with FHWA, Minnesota Division. The information will be provided by MnDOT's Design Standards Unit, Office of Project Management and Technical Support.

- Cost: comparison of average contract prices prior to the PIF vs. average contract prices during the PIF time period. The purpose of this is to ensure that adequate competition is being maintained.
- New products: evaluate any new/improved cable barrier systems that have come on the market during the PIF time period. These could be proprietary or non-proprietary. Identify systems that have passed current (MASH) crash test standards.

The Department believes that the cost and time savings that will be experienced is such that the public interest would best be served, and we request your concurrence.

Sincerely,

Michael T. Ginnaty, P.E.
State Design Engineer

Approved: 7/3/12

For FHWA