



Standard Construction Details and Standard Specifications Updates: The Roadside Barrier Edition

October 27, 2020



Agenda

- Morning Session
 - Standard Specifications Update – Guardrail and Barrier
- Afternoon Session
 - Crash Testing and MASH
 - DeIDOT's MASH Compliance
 - Standard Construction Details – Guardrail
 - Standard Construction Details – Concrete Barrier



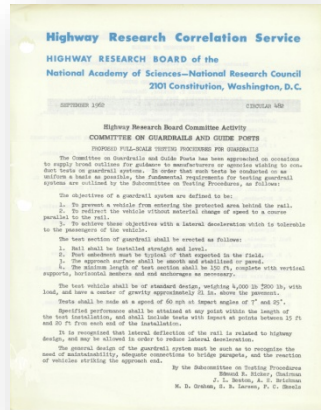
Crash Testing and MASH

Crash Testing

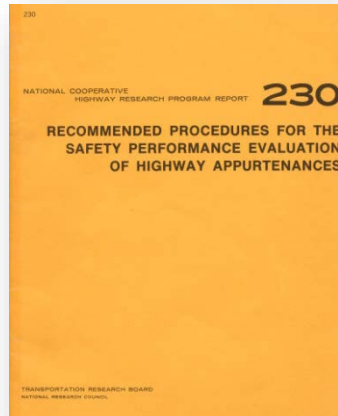
- FHWA policy requires that all roadside appurtenances used on the NHS meet the performance criteria contained in the AASHTO Manual for Assessing Safety Hardware (MASH)
 - Applies to:
 - Traffic barriers
 - Barrier terminals
 - Crash cushions
 - Bridge railings
 - Sign and light pole supports
 - Work zone hardware
- Some form of crash testing has been occurring since the 1930s



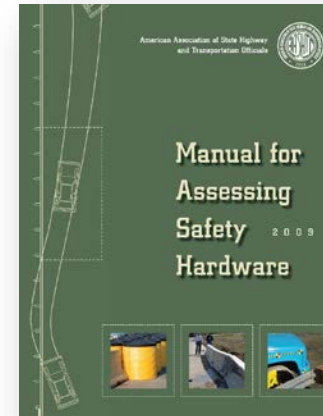
Crash Testing History



1974

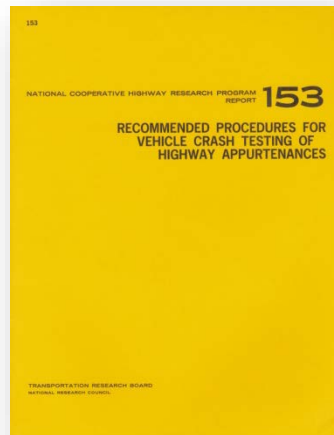


1993

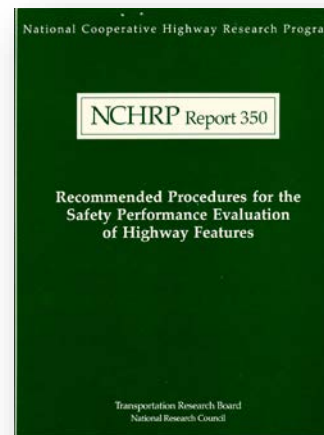


2016

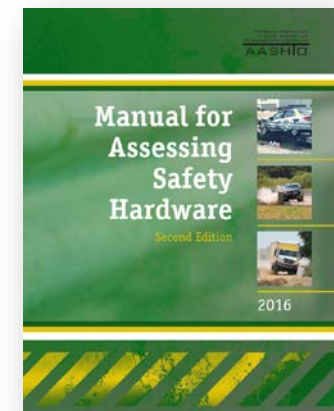
1962



1980

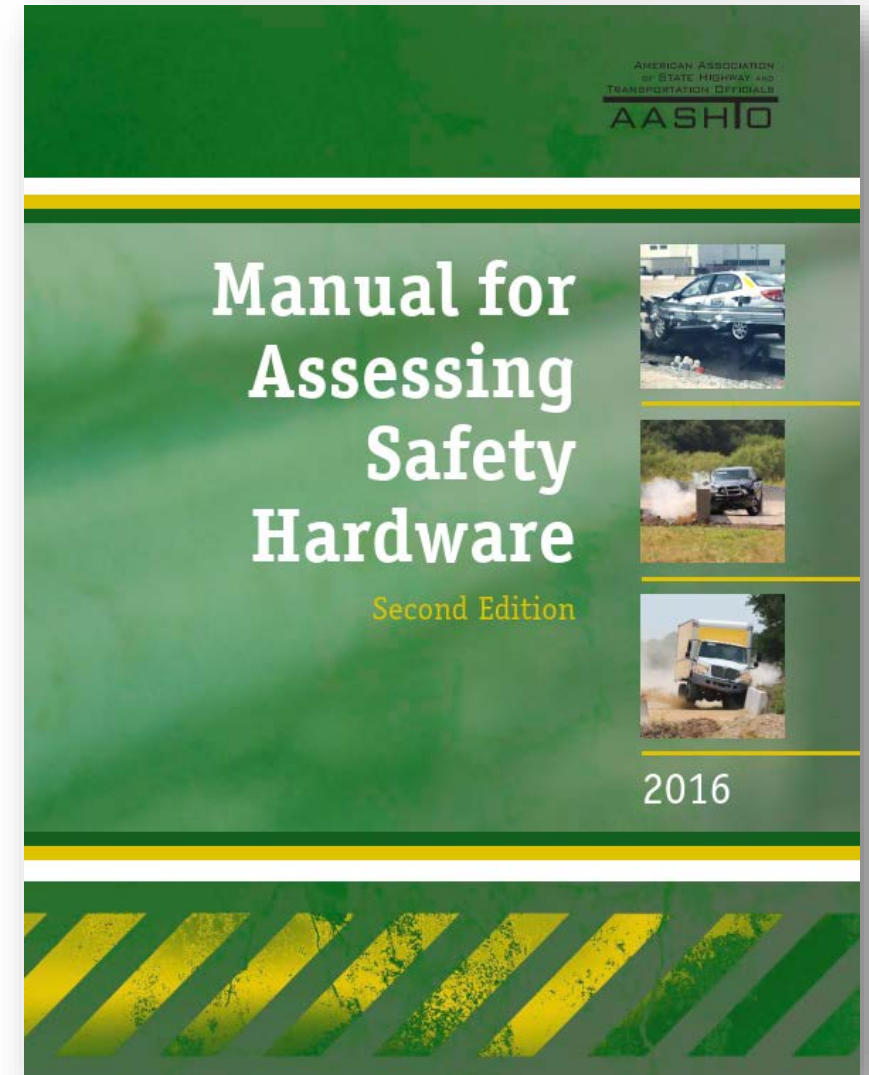


2009



MASH

- What is MASH?
 - AASHTO Manual for Assessing Safety Hardware
 - 1st Edition published in 2009 to replace NCHRP Report 350
 - National guidelines for crash testing of roadside safety hardware
 - Developed under NCHRP Project 22-14(02)
 - 2nd Edition published in 2016
 - Errata issued in June and July 2020
- Purpose of MASH
 - Uniform testing guidelines
 - Recommended testing criteria for evaluation of crash tests







MASH vs. NCHRP 350

- Differences under MASH
 - Updated test vehicles to reflect current vehicle fleet
 - Heavier small cars
 - Heavier pick-up trucks
 - Higher bumper heights
 - Changes in centers of gravity
 - Updated inconsistencies in test matrices
 - Account for real-world conditions
 - Updated evaluation criteria to reduce subjectivity
 - Deformation of passenger compartment thresholds

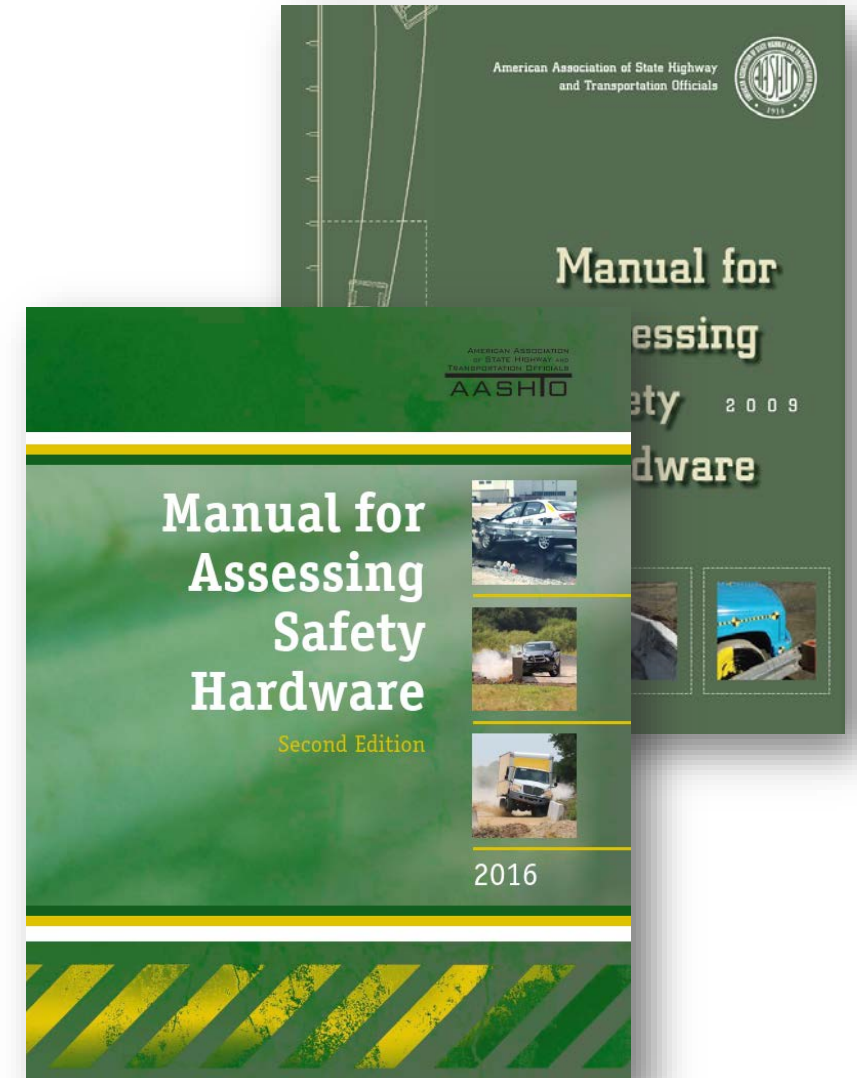


MASH Test Levels

| TEST LEVEL | Test VEHICLE Type – (weight Lb.) | SPEED mph | ANGLE OF IMPACT | |
|------------|---|------------------|------------------|---|
| 1 | PASSENGER CAR – (1809 to 2,420) ← | 31 | 25 (20) ← |  |
| | PICKUP TRUCK – (4409 to 5,000) ← | 31 | 25 | |
| 2 | PASSENGER CAR – (2,420) | 44 | 25 |  |
| | PICKUP TRUCK – (5,000) | 44 | 25 | |
| 3 | PASSENGER CAR – 2420 | 62 | 25 |  |
| | PICKUP TRUCK – 5000 | 62 | 25 | |
| 4 | PASSENGER CAR – (2,420) | 62 | 25 |  |
| | PICKUP TRUCK – (5,000) | 62 | 25 | |
| | SINGLE UNIT TRUCK – (17636 to 22,000) ← | 56 (50) ← | 15 | |
| 5 | PASSENGER CAR – (2,420) | 62 | 25 | |
| | PICKUP TRUCK – (5,000) | 62 | 25 | |
| | TRACTOR VAN TRAILER – (79,300) | 50 | 15 | |
| 6 | PASSENGER CAR – (2,420) | 62 | 25 | |
| | PICKUP TRUCK – (5,000) | 62 | 25 | |
| | TRACTOR TANK TRAILER – (79,300) | 50 | 15 | |

MASH 2009 vs. MASH 2016

- Major update:
 - Crash testing criteria for cable barriers on slopes
- Minor updates:
 - Soil strength testing
 - Improved documentation of vehicle damage
 - Longer tractor-trailer lengths



MASH Implementation

- 2009 MASH
 - Anticipated manufacturers would develop MASH-compliant devices
 - No sunset requirements of NCHRP 350 devices
 - Safety benefits not realized
- 2016 MASH
 - FHWA/AASHTO Joint Implementation Agreement
 - Sunset dates of NCHRP-350 roadside hardware
 - 12/31/2017: W-beam barriers and cast-in-place concrete barriers
 - 6/30/2018: W-beam terminals
 - 12/31/2018: Cable barriers, cable barrier terminals and crash cushions
 - 12/31/2019: Bridge rails, transitions, all other longitudinal barriers, all other terminals, sign supports and all other breakaway hardware
 - Specific requirements for work zone devices dependent on normal service life



Memorandum

Subject: **INFORMATION:** AASHTO/FHWA Joint Implementation Agreement for Manual for Assessing Safety Hardware (MASH) Date: JAN -7 2016

From: *Thomas D. Everett*
Thomas Everett
Director, Office of Program Administration In Reply Refer To:
HSST

Michael S. Griffith *Michael S. Griffith*
Director, Office of Safety Technologies

To: Division Administrators
Directors of Field Services
Federal Lands Highway Division Directors

Purpose

The purpose of this memorandum is to share information regarding the American Association of State Highway and Transportation Officials (AASHTO)/FHWA Joint Implementation Agreement for the AASHTO Manual for Assessing Safety Hardware (MASH). Recently, the agreement was successfully balloted by AASHTO's Standing Committee on Highways and approved by FHWA.

Information

On November 12th, 2015, FHWA issued a memorandum (http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/policy_memo/mo111215/) indicating that all modifications to NCHRP 350-tested devices will require testing under MASH in order to receive a Federal-aid eligibility letter from FHWA. In addition, a Federal Register Notice (<https://www.federalregister.gov/articles/2015/11/13/2015-28753/manual-for-assessing-safety-hardware-mash-transition>) was also issued regarding this action. This action provided a significant step forward to the implementation of MASH.

Through the AASHTO/FHWA partnership, the agreement was executed to define actions needed for full implementation of MASH over the course of several years. Per the agreement, the implementation of the forthcoming edition (anticipated Spring 2016) of the AASHTO Manual for Assessing Safety Hardware (MASH) will be as follows:

- The AASHTO Technical Committee on Roadside Safety will continue to be responsible for developing and maintaining the evaluation criteria as adopted by

MASH Compliance

- MASH Compliance is determined by the User Agency.
- Excerpts from an April 9, 2018 FHWA memo to Division Administrators, Federal Lands Division Engineers and Directors of Field Services:
 - The FHWA's longstanding policy is that all roadside safety hardware installed on the NHS be crashworthy.
 - Roadside safety hardware is eligible for Federal funding if it has been determined to be crashworthy by the user agency (i.e. State DOT).
 - It is each State's responsibility to determine crashworthiness and to approve new or modified roadside safety hardware meeting the State's specific needs.
 - The determination of crashworthiness of roadside safety hardware, acceptance for use on highway projects, and installation and maintenance are responsibilities handled at the State and local level.



Memorandum

Subject: **ACTION:** Evaluating a State DOT's Process to Determine Roadside Safety Hardware Crashworthiness on the National Highway System (NHS) Date: April 9, 2018

From: Michael S. Griffith *Michael S. Griffith* In Reply Refer To: HSA
Director, Office of Safety Technologies

To: Division Administrators
Federal Lands Division Engineers
Directors of Field Services

PURPOSE

The purpose of this memorandum is to provide guidance to the FHWA Division Offices to assist in their evaluation that a State DOT has an acceptable process for determining the crashworthiness of roadside safety hardware used on the National Highway System (NHS).

BACKGROUND

The FHWA's longstanding policy is that all roadside safety hardware installed on the NHS be crashworthy. To support this policy, the [joint implementation agreement](#) for the American Association of State Highway Transportation Officials (AASHTO) Manual for Assessing Safety Hardware (MASH) was adopted by AASHTO and FHWA. This agreement established dates for implementing AASHTO MASH as the criteria for determining crashworthiness of roadside safety hardware.

The FHWA continues to provide a voluntary service of reviewing crash test results and issues eligibility letters for *new* roadside safety hardware only. The FHWA no longer provides Federal-aid eligibility letters for modifications made to an AASHTO MASH-crash tested device. An eligibility letter is not a requirement for roadside safety hardware to be determined eligible for Federal funding. Roadside safety hardware is eligible for Federal funding if it has been determined to be crashworthy by the user agency (i.e., State DOT).

An FHWA eligibility letter should not be the sole basis for a State's determination of crashworthiness. It is each State's responsibility to determine crashworthiness and to approve new or modified roadside safety hardware meeting the State's specific needs. Each State should consider its own operational issues such as installation and



MASH Compliance at DeIDOT

MASH Compliance at DeIDOT

Status of DeIDOT meeting the FHWA/AASHTO Sunset Dates

- ✓ W-Beam Barrier
- ✓ W-Beam Terminals *Approved Products List*
https://deldot.gov/Business/prodlists/pdfs/APL_EndTerminals.pdf?cache=1603198531574
- ✓ Cast-in-Place Concrete Barrier
- ✓ Cable Barrier and Cable Barrier Terminals *2020 Standard Specifications require MASH compliant devices*
- ✓ Crash Cushions (Permanent Impact Attenuators) *Approved Products List*
https://deldot.gov/Business/prodlists/pdfs/APL_ImpactAttenuators.pdf?cache=1603198475022
- ✓ Bridge Railing
- ✓ Transitions
- ✓ All other longitudinal barriers } *2020 Standard Specifications require MASH compliant devices*
- ✓ All other terminals } *2020 Standard Specifications require MASH compliant devices*
- ✗ Sign supports } *NCHRP 350 Devices in use until suitable*
- ✗ Other Breakaway Hardware } *MASH compliant devices are available*
- ? Work Zone Devices *See Approved Products List for Delaware specific sunset dates*
https://deldot.gov/Business/prodlists/pdfs/APL_TTCDevices.pdf?cache=1603198772332



MASH Compliance at DeIDOT

- MASH Committee
 - Policy Implement forthcoming
 - Purpose of committee
 - Primary technical group regarding roadside safety hardware
 - Development of standard details regarding roadside safety hardware
 - Recommendations of roadside safety hardware for the Approved Products Lists
 - Review of crash testing paperwork
 - Establishment of Delaware specific sunset dates
 - Review/recommendation for approval of self-certification documents
 - Review/recommendations for approval of devices that are exempt from MASH certification

MASH Compliance at DeIDOT

- MASH Committee
 - Roadside safety hardware approval
 - If hardware has approved crash testing from a recognized national crash testing facility, device may be approved without self certification.
 - Hardware requiring self certification
 - Document why crash tested hardware cannot be used
 - Justification with appropriate engineering calculations regarding why the proposed hardware is acceptable
 - Prepared by the DeIDOT group that is the appropriate subject matter expert
 - Reviewed and voted on by the MASH Committee
 - If approved, signed by the DeIDOT SME, Committee Chair and forwarded to Chief Engineer for review and approval.



Whitman, Requardt & Associates, LLP
Engineers · Architects · Environmental Planners Est. 1915

MEMORANDUM

Date: July 21, 2020

To: James Osbourne, DeIDOT
From: David Nizamoff, P.E.
Adam Weiser, P.E., PTOE, RSP
Subject: DeIDOT Concrete Barrier Standard Construction Details
CC: Jeff VanHorn, DeIDOT Safety
Mark Buckalew, DeIDOT Construction
Barry Benton, GPI

Work Order Number: 032197.001
Contract Number: N/A
Project: DeIDOT MASH Standard Construction Details Update

In 2009, the American Association of State Highway Transportation Officials (AASHTO) published the *Manual for Assessing Safety Hardware* (MASH) which superseded NCHRP Report 350 *Recommended Procedure for Safety Performance Evaluation of Highway Features* as the guidelines for roadside safety hardware performance evaluation. In 2016, AASHTO published the second edition of MASH as well as agreed to a joint implementation agreement with the Federal Highway Administration (FHWA). The joint implementation agreement outlined the sunset dates for NCHRP 350 compliant roadside safety hardware and sunrise dates for MASH 2016 compliant roadside safety hardware for projects on the National Highway System (NHS). The agreement stated that "all w-beam and cast-in-place concrete barriers" would be MASH 2016 compliant for contracts let after December 31, 2017.

On May 28, 2017, the FHWA issued an open letter to the states which stated that "The FHWA's Federal-aid eligibility letters are provided as a service to the States and are not a requirement for roadside safety hardware to be eligible for federal-aid reimbursement." This letter also went on to state, "Since its official launch, questions about the AASHTO MASH criteria have been identified by a range of stakeholders. Until such time these questions are answered, and the transportation community has more experience with AASHTO MASH requirements, FHWA will require manufacturers and States to run all AASHTO MASH recommended crash tests in order to qualify for a FHWA Federal-aid eligibility letter." In addition, a letter from the FHWA to its Division Administrators issued on April 8, 2019 stated that "An eligibility letter is not a requirement for roadside safety hardware to be determined eligible for Federal funding. Roadside safety hardware is eligible for Federal funding if it has been determined to be crashworthy by the user agency (i.e., State DOT)." Both letters are attached to this memorandum.

DeIDOT's Engineering Support section has been working to update all guardrail and barrier standard construction details to be MASH compliant. DeIDOT historically has maintained standard construction details for cast-in-place and slip formed 32-inch tall F-shape concrete median barriers. The Department desires to add 36-inch and 42-inch F-shape median and roadside barriers and a 42-inch single slope barrier to its standard construction details. The purpose of this memorandum is to document the development of the new concrete barrier standard construction details and to provide a recommendation as to their crashworthiness in accordance with MASH standards.

Summary of testing on height determination by Test Levels: The Texas Transportation Institute (TTI) conducted research regarding bridge railing and barrier heights based on MASH crash testing procedures. Report TTI 9-1002.05¹ found that the minimum height for a Test Level 4 bridge railing or barrier is 30-inches. The research conducted a full-scale crash test on a 36-inch tall single slope bridge railing. The test, conducted using a single-unit truck, was passed successfully. The report indicates that while a single sloped barrier was used in the testing, the results are considered applicable to other safety shapes, e.g. the New Jersey shape and F-shape profiles. Based on this information, it was determined for the purposes of DeIDOT's Standard Construction Details, the minimum height for a TL-4 barrier would be 38-inches for median and roadside applications. In addition, a 42-inch tall TL-4 barrier detail was developed for

¹ TTI Report 9-1002.05 <https://static.tti.tamu.edu/tti.tamu.edu/documents/9-1002-5.pdf>

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Standard Construction Details: Guardrail

Guardrail Details

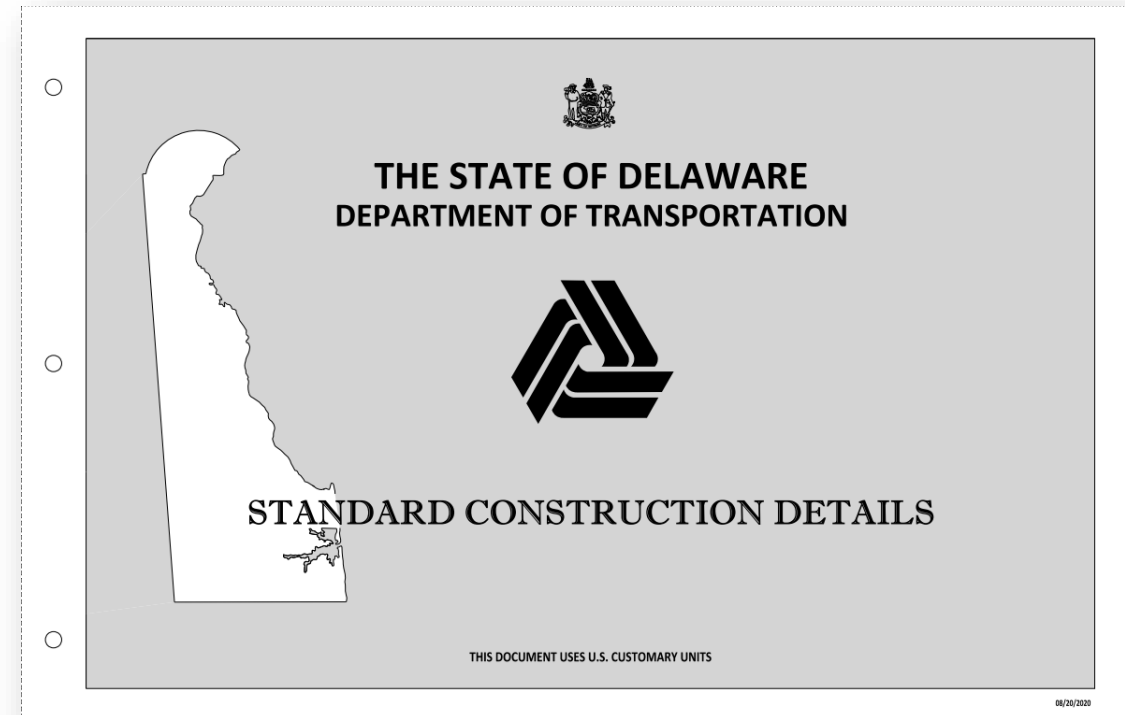
- Update Summary
 - Overall MASH compliance review
 - Updated existing details as needed
 - Eliminated non-compliant details
 - Maintained some NCHRP 350 compliant details as needed
 - Remove metric dimensions
 - New details
 - Type 1-31 Guardrail with Omitted Post
 - With and without curb
 - Type 1-31 Guardrail on Steep Slope
 - Type 3-31 Guardrail-to-Barrier Connection
 - Includes Concrete Buttresses
 - End Anchorage, Type 31
 - Buried-in-Backslope, Type 31



Guardrail Details

2020 Standard Construction Details: Guardrail

- B-1: Guardrail Applications
 - Type 1-31, 2-31, 3-31; Plan, Elevation and Section Views
 - Type 1-31 Guardrail with Omitted Post
 - Type 1-31 Guardrail on Steep Slope
- B-2: Grading for Guardrail End Treatments (Types 1, 2 and 3)
- B-3: Guardrail over Culverts (Types 1-31, 2-31 and 3-31)
- B-4: End Anchorage, Type 1-31
- B-7: W-Beam, Type 1-27 to Type 1-31 Transition Section
- B-8: Guardrail to Barrier Connection – Approach and Exit Type 31
- B-10: Guardrail to Barrier Connection – Type 3-31
- B-13: Hardware
- B-15: Guardrail Applications (Types 1-27, 2-27 and 3-27)
- B-17: Guardrail End Treatment, Type 4-27
- B-18: Curved Guardrail Section, Type 1-27
- B-20: Buried in Back Slope End Terminal, Type 1-31



Guardrail Applications

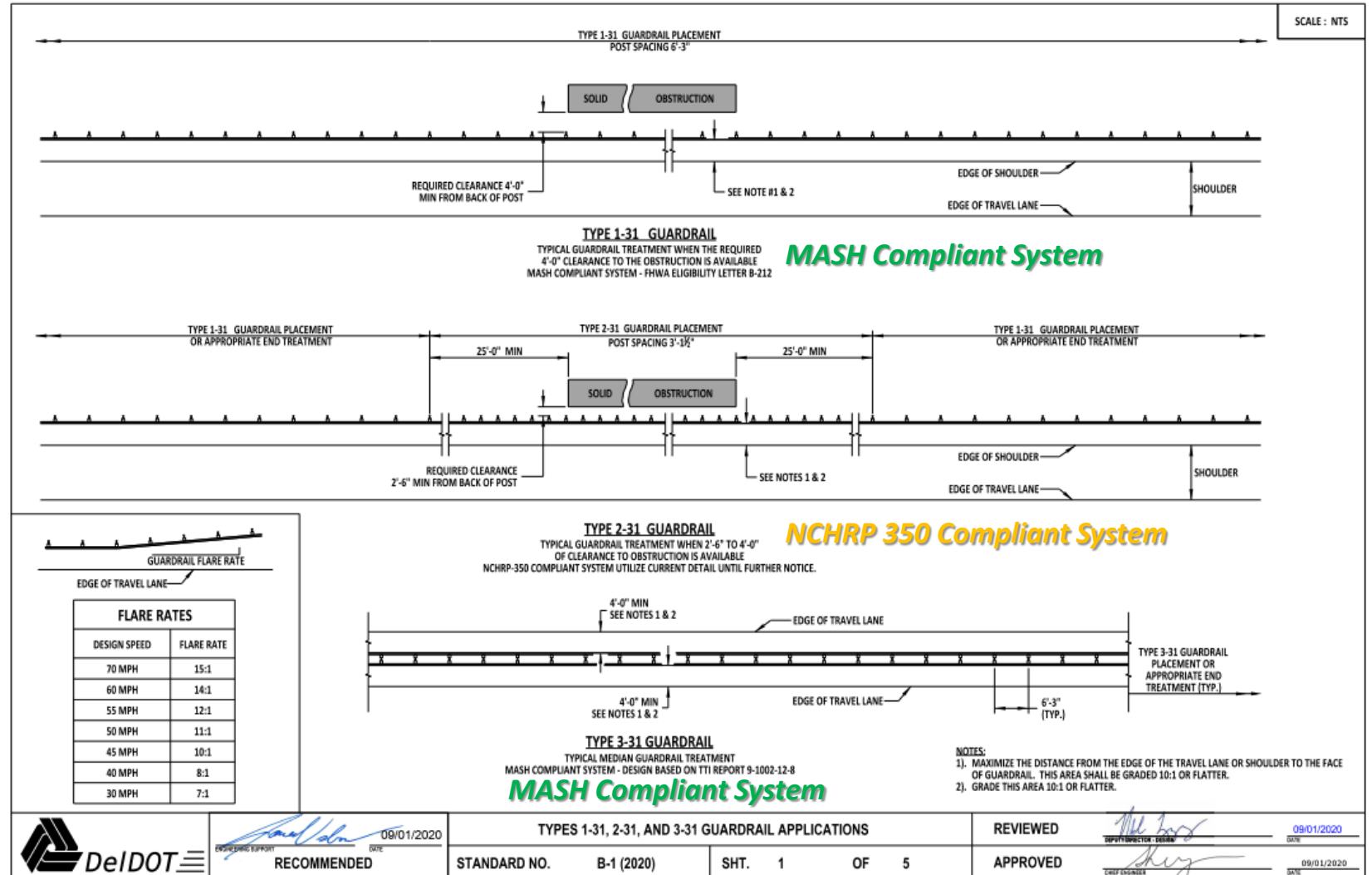
- Detail B-1: Guardrail Applications
 - Type 1-31
 - Also known as Midwest Guardrail System (MGS)
 - Standard guardrail application, basis for all other guardrail details
 - Guardrail height = 31"
 - Post spacing = 6'-3" or 75"
 - 12" Offset Blocks
 - Minimum clearance to obstruction = 4'-0"
 - Guardrail splices midspan
 - MASH Compliant system
 - Type 2-31
 - Half post spacing, 3'-1 ½" or 37.5"
 - Minimum clearance to obstruction = 3'-0"
 - Not compliant with MASH; testing still underway
 - Type 3-31
 - Median guardrail (double sided)
 - 8" Offset Blocks
 - Standard post spacing
 - MASH compliant system



Source: Midwest Roadside Safety Facility

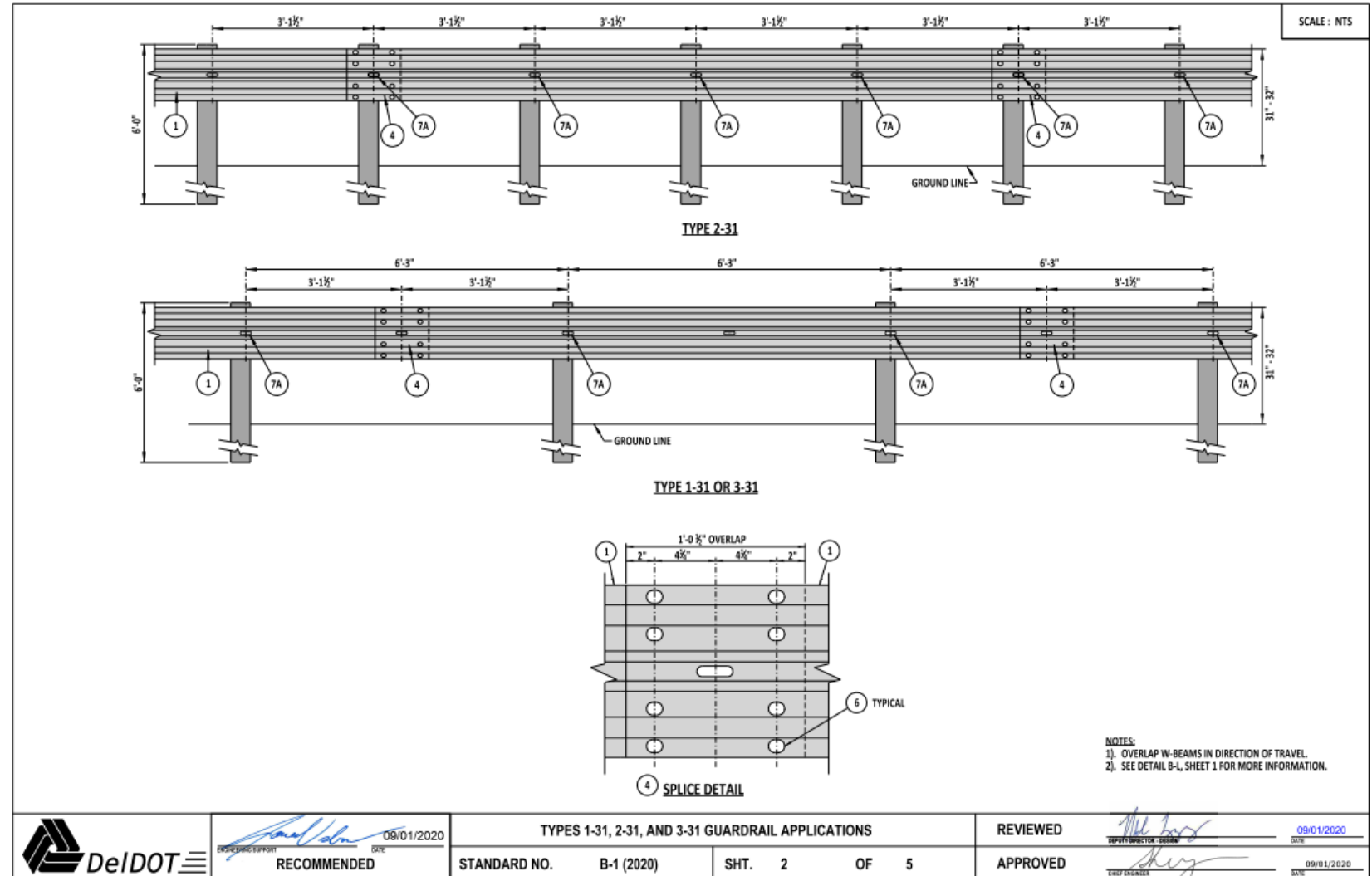
Guardrail Applications

- Detail B-1: Guardrail Applications



Guardrail Applications

- Detail B-1: Guardrail Applications



| | | | | | |
|--|-------------------------------|---|----------------------------|--|----------------------------|
| | 09/01/2020 RECOMMENDED | TYPES 1-31, 2-31, AND 3-31 GUARDRAIL APPLICATIONS | | | REVIEWED 09/01/2020 |
| | STANDARD NO. B-1 (2020) | SHT. 2 OF 5 | APPROVED 09/01/2020 | | |

Guardrail Applications

- Detail B-1: Guardrail Applications

SCALE: NTS

GUARDRAIL SECTION SHOULDER APPLICATION

GUARDRAIL SECTION MEDIAN APPLICATION

GUARDRAIL SECTION BEHIND CURB APPLICATION

| TYPE | POST SPACING | CLEAR AREA BEHIND POST |
|------|--------------|------------------------|
| 1 | 6'-3" | 4'-0" MIN |
| 2 | 3'-1½" | 2'-6" MIN |

NOTES:

- SEE STANDARD SPECIFICATION FOR OFFSET BLOCK MATERIALS.
- ON ROADWAYS WITH A POSTED SPEED LESS THAN OR EQUAL TO 50 MPH, WHERE THE FACE OF THE GUARDRAIL IS TO BE PLACED FLUSH WITH THE FACE OF THE CURB, THE HEIGHT OF THE CURB SHALL BE NO MORE THAN 6 INCHES. THE FACE OF THE GUARDRAIL SHALL BE INSTALLED FLUSH WITH THE FACE OF THE CURB OR NO MORE THAN 6 INCHES BEHIND THE FACE OF THE CURB.
- ON ROADWAYS WITH POSTED SPEEDS GREATER THAN 50 MPH, WHERE THE FACE OF THE GUARDRAIL IS TO BE PLACED FLUSH WITH THE FACE OF THE CURB, THE HEIGHT OF THE CURB SHALL BE NO MORE THAN 4 INCHES. THE FACE OF THE GUARDRAIL SHALL BE INSTALLED FLUSH WITH THE FACE OF THE CURB OR NO MORE THAN 6 INCHES BEHIND THE FACE OF THE CURB.
- H IS DEFINED AS THE MAXIMUM CURB HEIGHT FOR THE CURB/ GUARDRAIL APPLICATION.
- GUARDRAIL HEIGHT MEASURED FROM TOP OF CURB SHALL BE 31'-32". GUARDRAIL HEIGHT MEASURED FROM GROUND SURFACE DIRECTLY ADJACENT TO FACE OF RAIL SHALL BE NO MORE THAN 34".
- GUARDRAIL BEHIND CURB IS BASED ON MASH CRASH TEST REPORT TRP-03-237-10.

| POSTED SPEED | D | H (SEE NOTE 4) |
|--------------|---------------------------------------|----------------|
| < 45 MPH | 4'-0" MIN. - 12'-0" MAX. (SEE NOTE 6) | 6" MAX |



RECOMMENDED
DATE: 09/01/2020

TYPES 1-31, 2-31, AND 3-31 GUARDRAIL APPLICATIONS
STANDARD NO. B-1 (2020) SHT. 3 OF 5

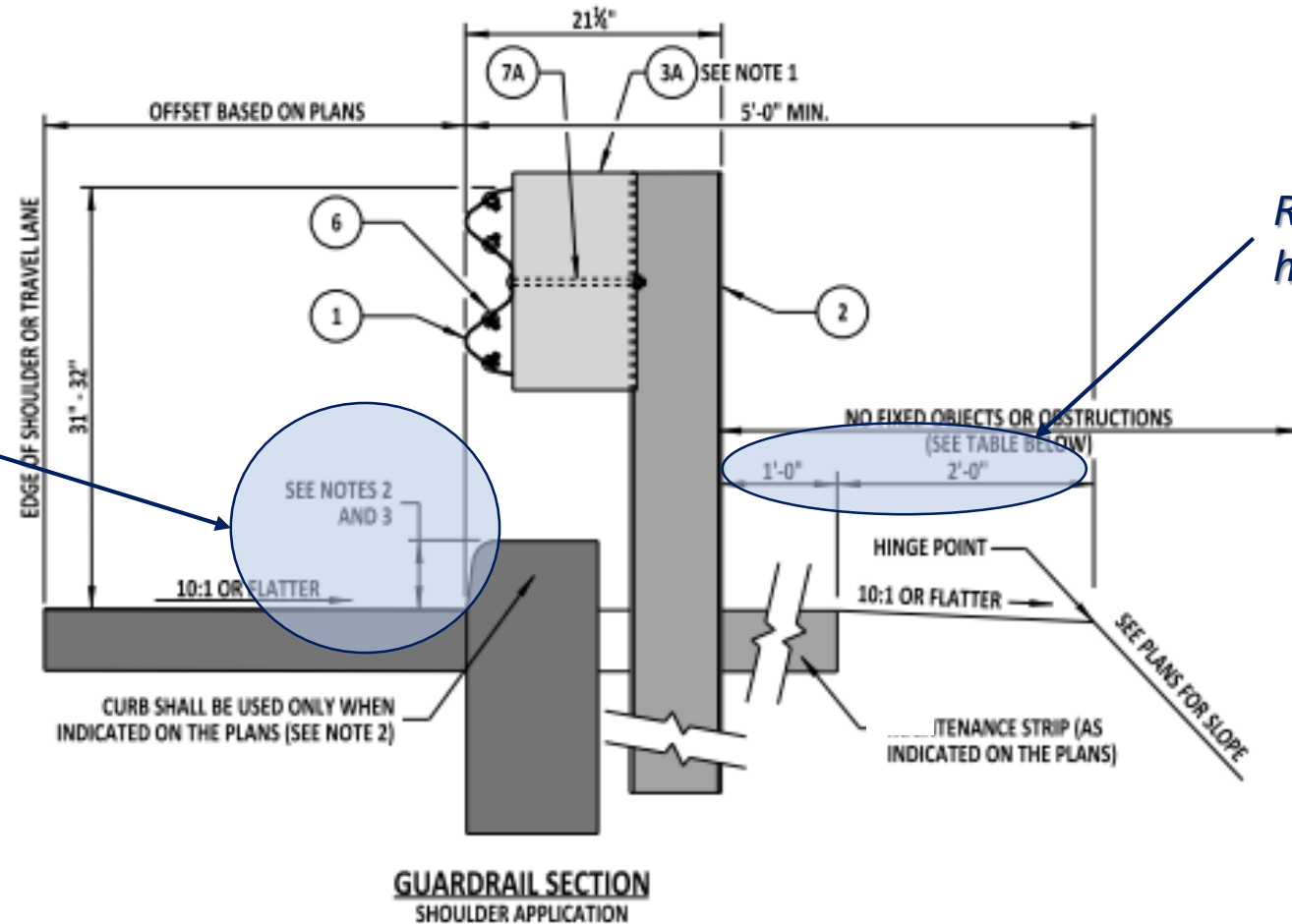
REVIEWED
APPROVED
DATE: 09/01/2020

Guardrail Applications

• Detail B-1: Guardrail Applications

- Posted speed \leq 50 MPH: Curb height \leq 6"
- Posted speed $>$ 50 MPH: Curb height \leq 4"
- Face of guardrail \leq 6" behind face of curb (flush is preferred)

Revised curb placement allowances

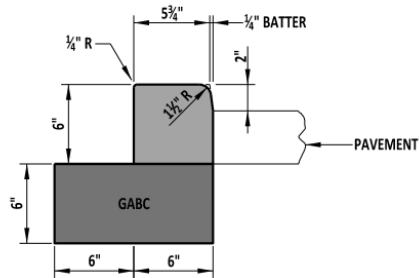


Revised offset to hinge point

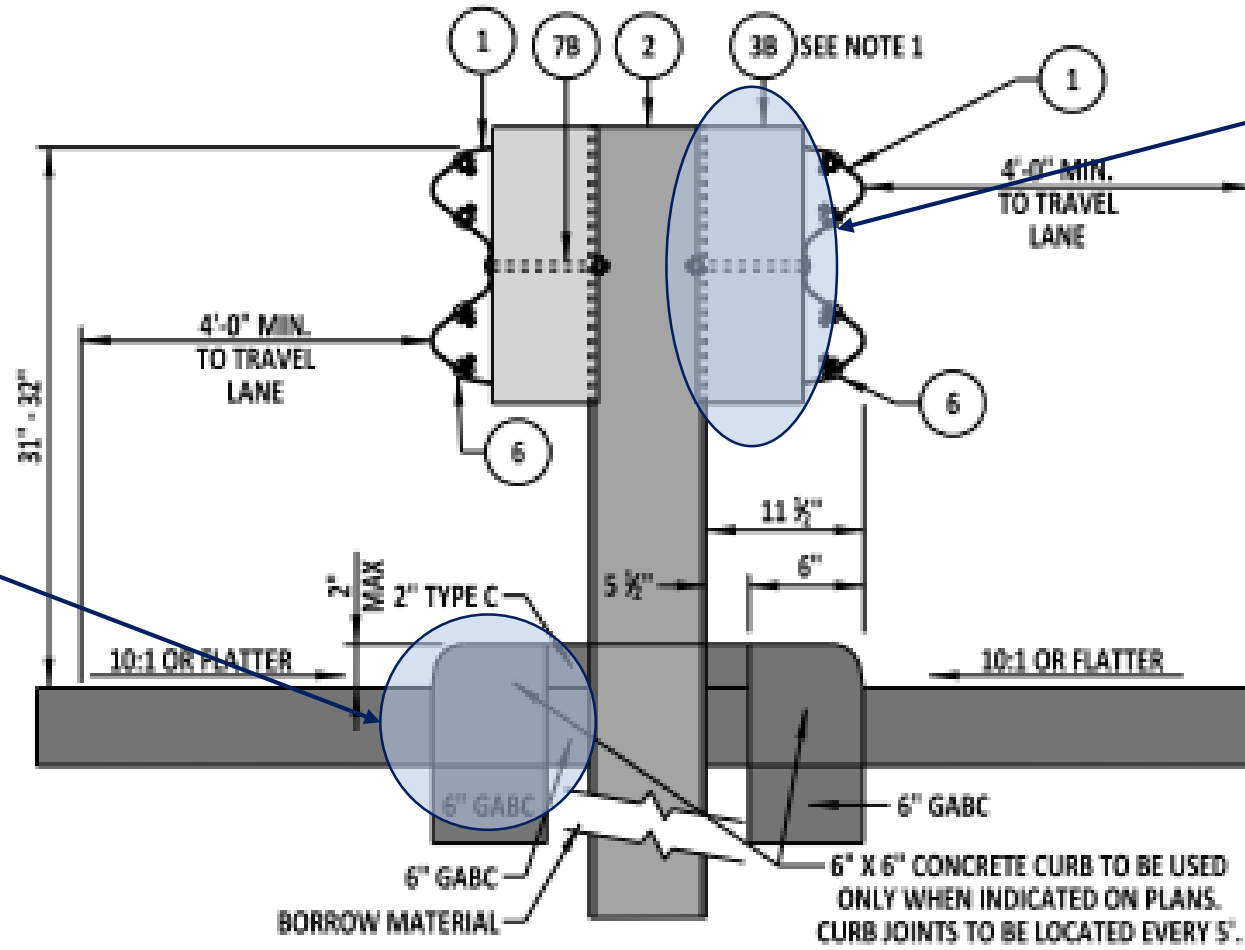
Guardrail Applications

- Detail B-1: Guardrail Applications

Type 1-2 Curb
(when required)
Detail C-1, sheet 4



PCC CURB
TYPE 1-2 GUARDRAIL MEDIAN CURB
INSTALL JOINTS AT 5'



8" Offset Blocks, only

6" GABC
6" GABC
6" X 6" CONCRETE CURB TO BE USED ONLY WHEN INDICATED ON PLANS. CURB JOINTS TO BE LOCATED EVERY 5'.
BORROW MATERIAL

GUARDRAIL SECTION
MEDIAN APPLICATION

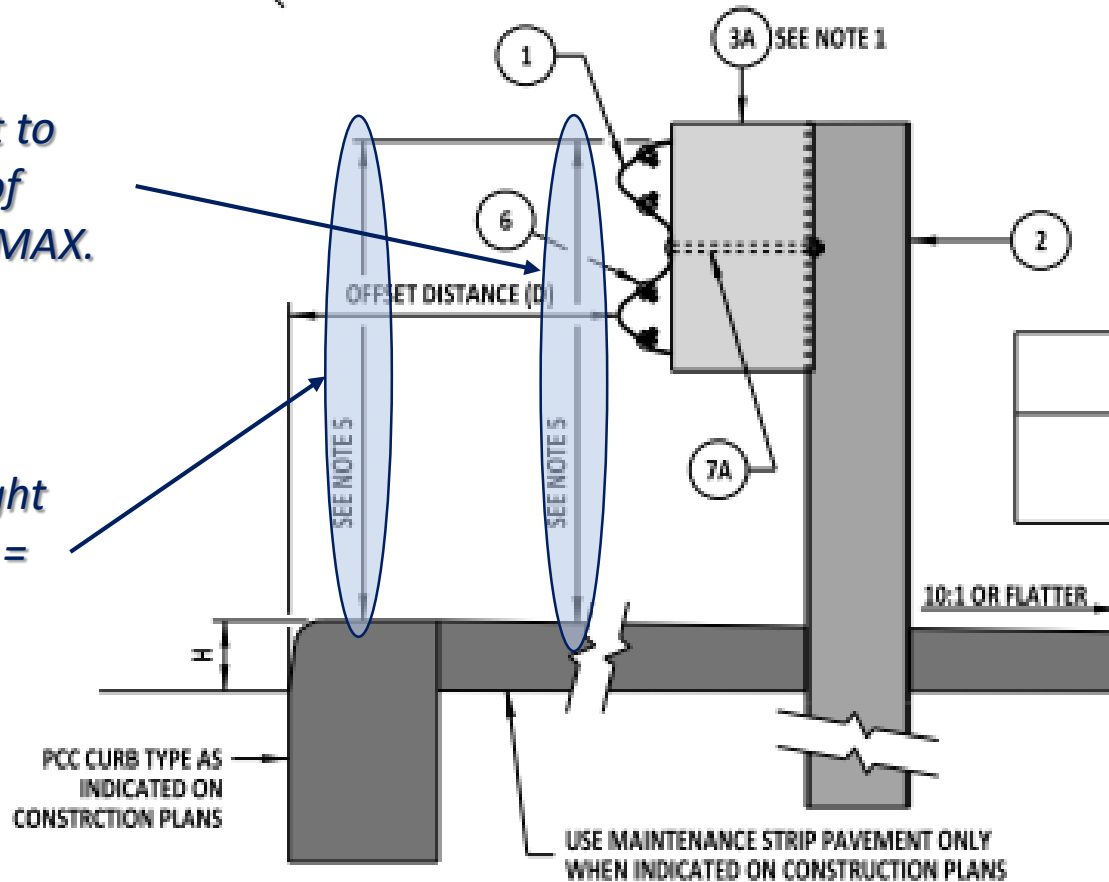
Guardrail Applications

- Detail B-1: Guardrail Applications

***This application ONLY for low speed conditions
<45 MPH***

Guardrail height to ground at face of guardrail = 34" MAX.

Guardrail height at top of curb = 31" – 32"



| POSTED SPEED | D | H (SEE NOTE 4) |
|--------------|---|-------------------|
| < 45 MPH | 4'-0" MIN. - 12'-0" MAX. (SEE NOTE 6) | 6" MAX |

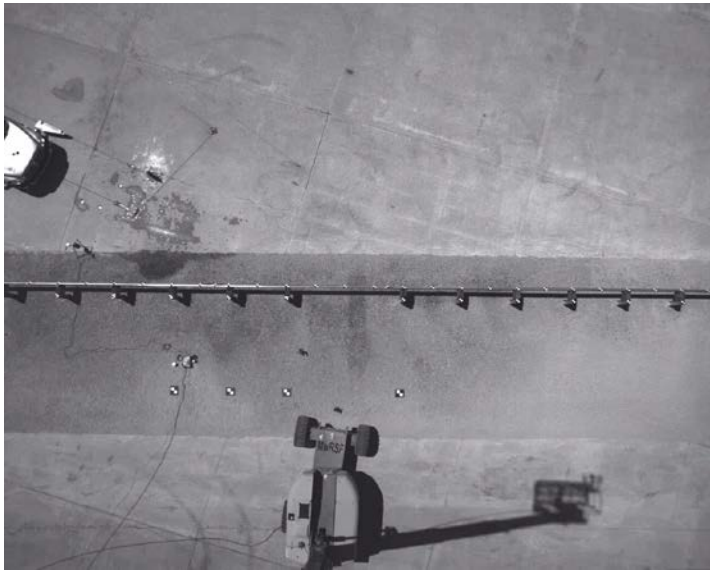
**GUARDRAIL SECTION
BEHIND CURB APPLICATION**



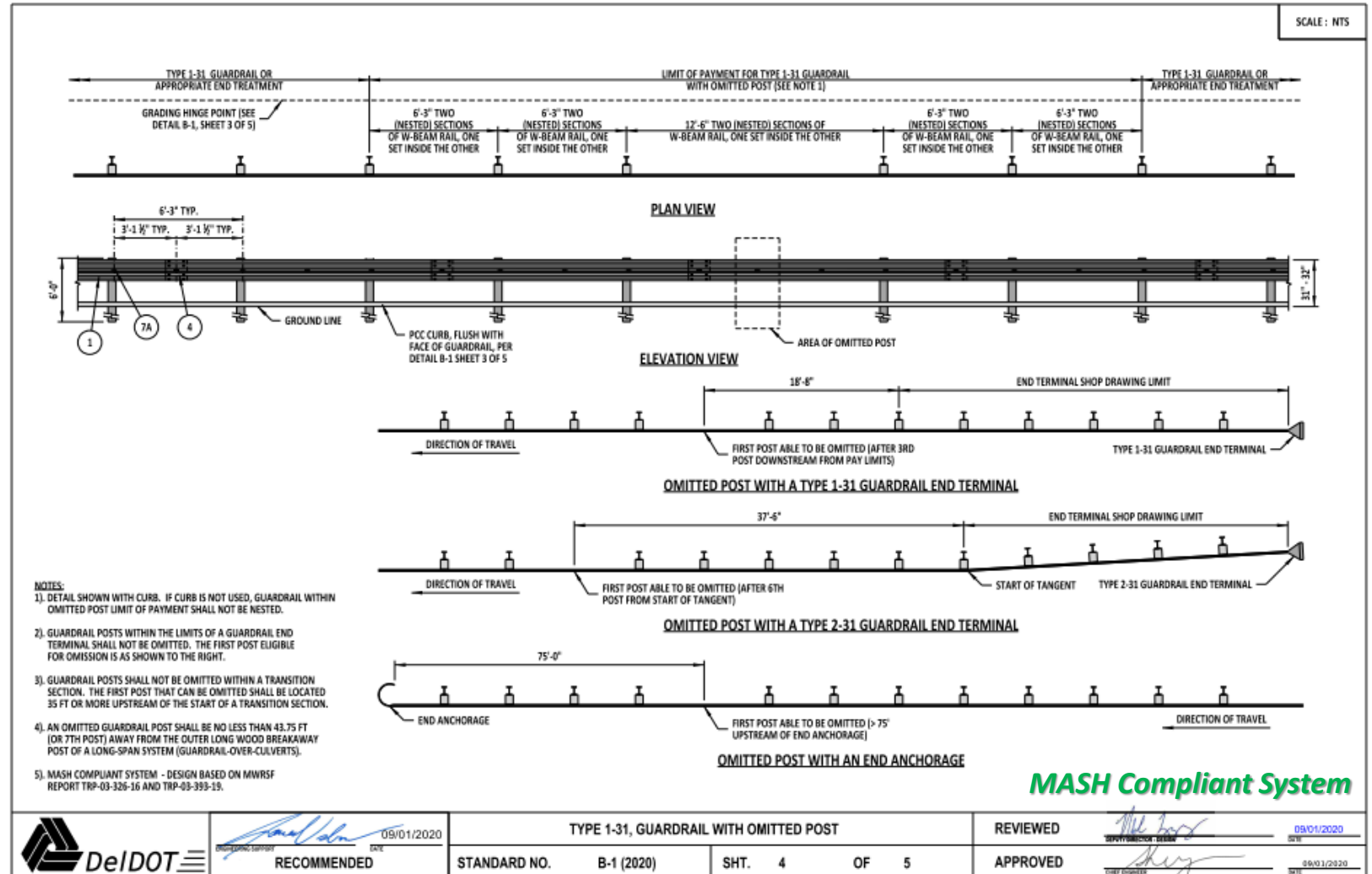
Source: Midwest Roadside Safety Facility

Guardrail Applications

- Detail B-1, Sheet 4: Type 1-31 Guardrail with Omitted Post



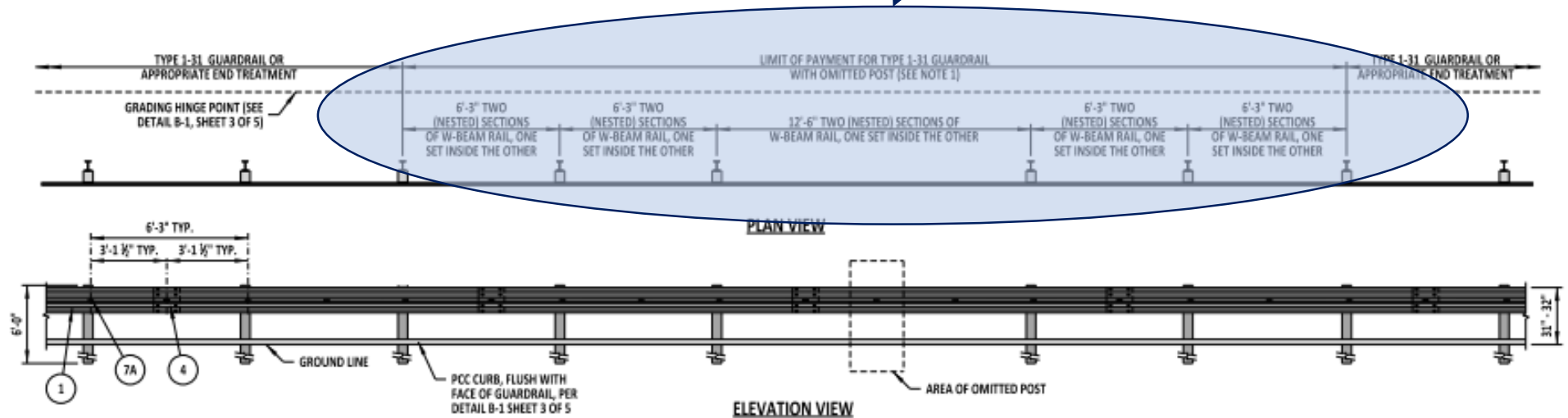
Source: Midwest Roadside Safety Facility



Guardrail Applications

- Detail B-1, Sheet 4: Type 1-31
Guardrail with Omitted Post

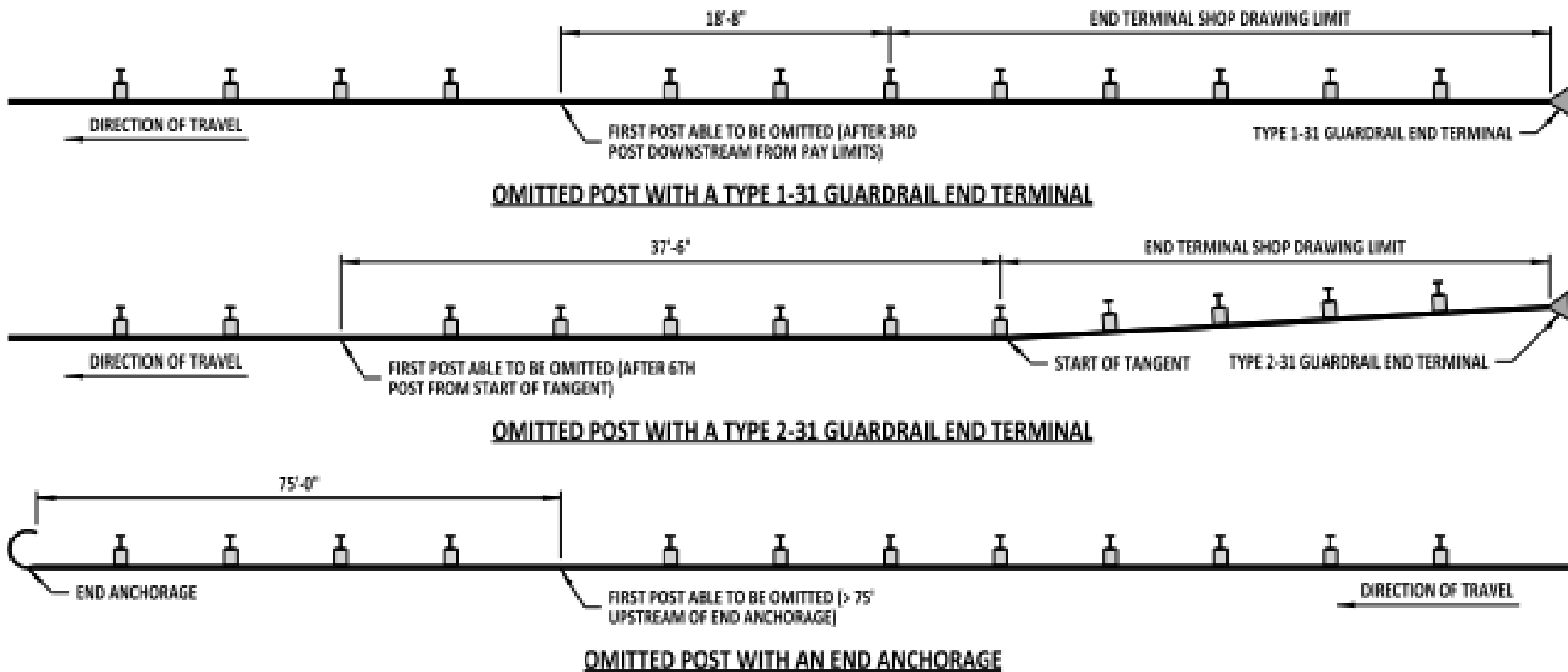
- Nested guardrail within limit of payment when curb is present*
- Guardrail is not nested when there is no curb*



Guardrail Applications

- Detail B-1, Sheet 4: Type 1-31 Guardrail with Omitted Post

Location of omitted post within proximity of an end terminal is critical

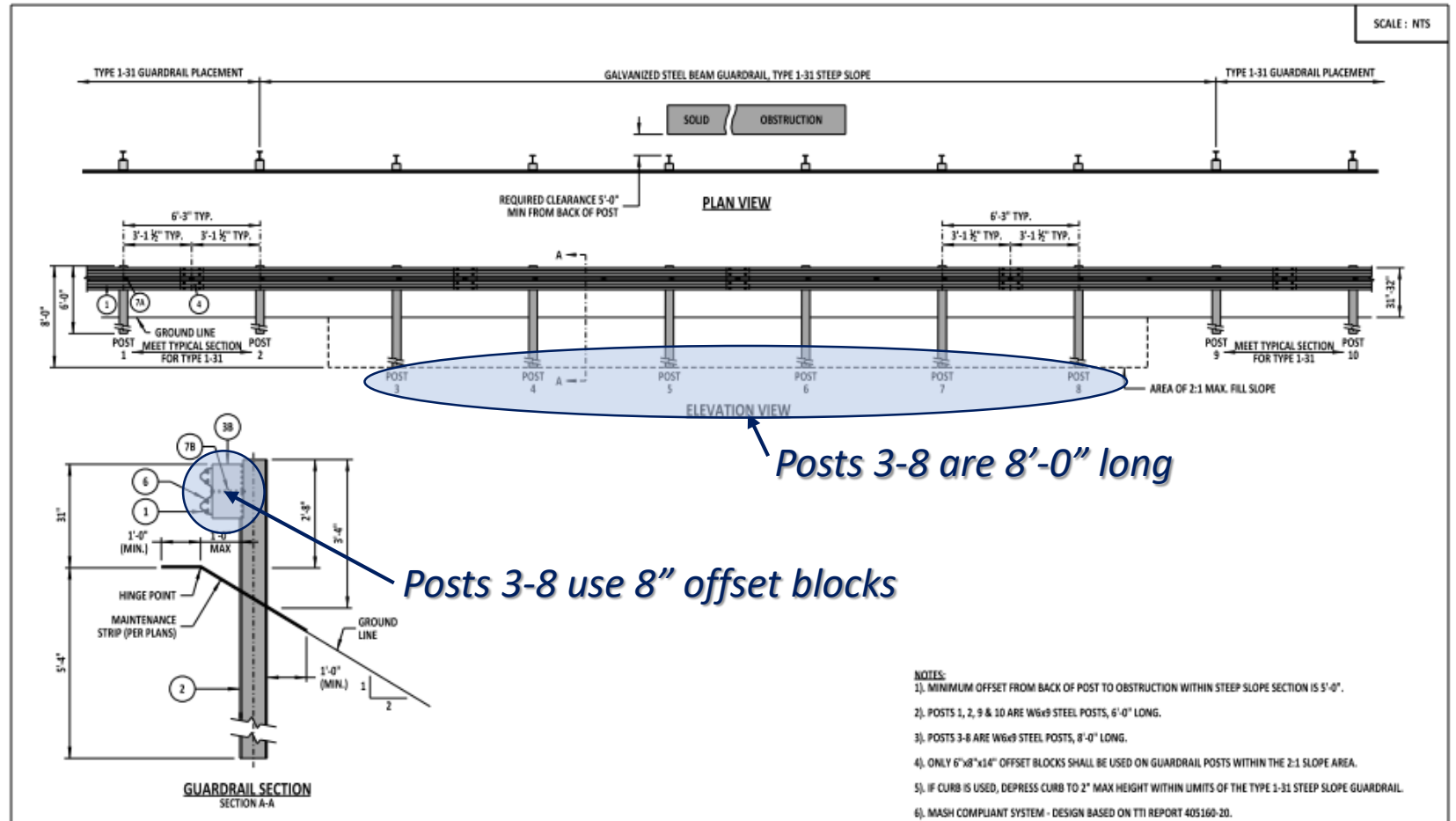


Guardrail Applications

- Detail B-1, Sheet 5: Type 1-31 on a Steep Slope



Source: Texas Transportation Institute



Posts 3-8 are 8'-0" long

Posts 3-8 use 8" offset blocks

MASH Compliant System

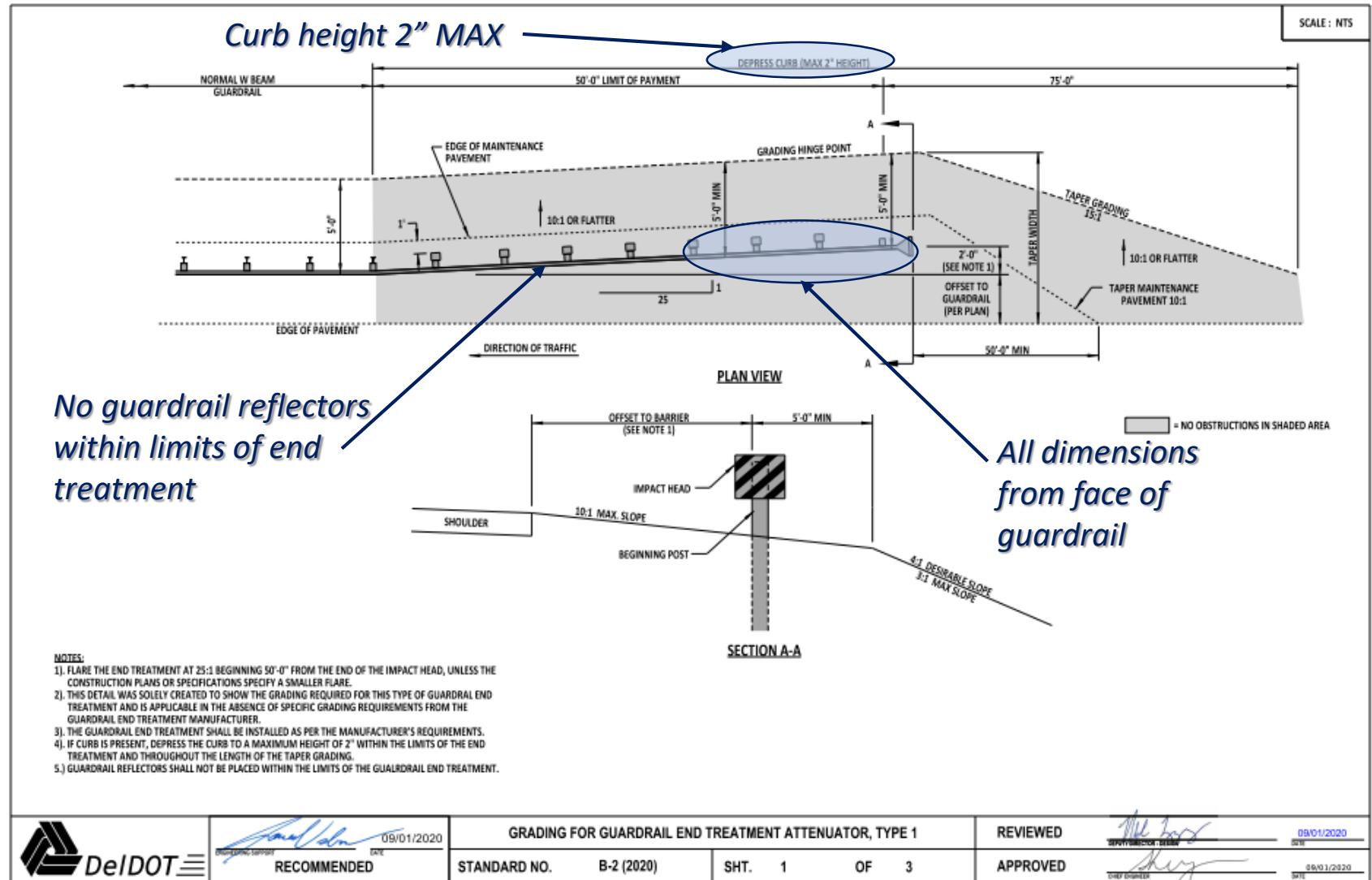
| | | | | | | | | |
|--|-------------|------------|---|------------|-------------|----------|--|------------|
| | | 09/01/2020 | GALVANIZED STEEL BEAM GUARDRAIL, TYPE 1-31, STEEP SLOPE | | | REVIEWED | | 09/01/2020 |
| | RECOMMENDED | | STANDARD NO. | B-1 (2020) | SHT. 5 OF 5 | APPROVED | | 09/01/2020 |



Grading for Guardrail End Treatments

- Detail B-2: Grading for Guardrail End Treatment, Type 1
 - See Approved Products List for allowable systems

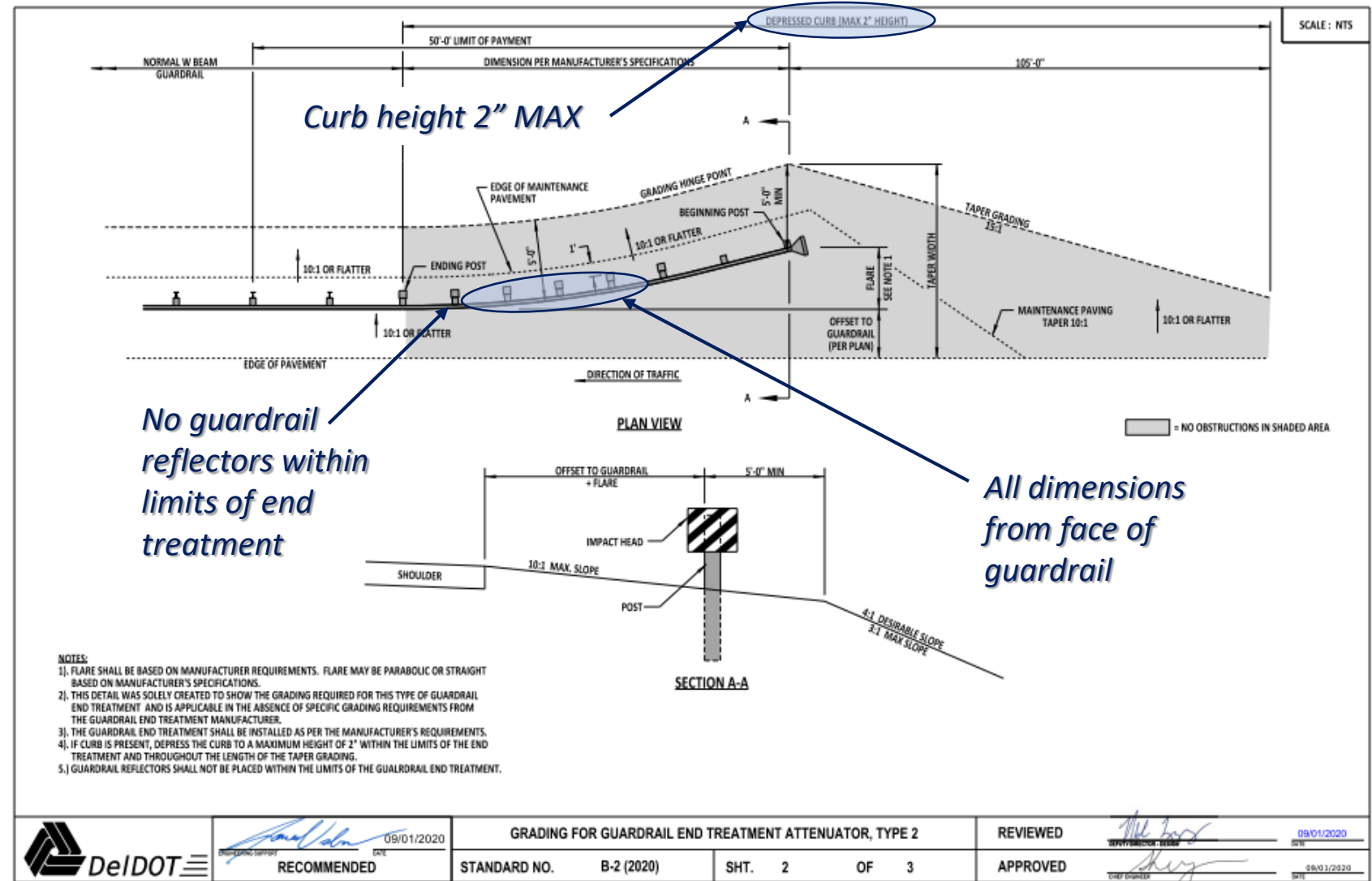
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Grading for Guardrail End Treatments

- Detail B-2: Grading for Guardrail End Treatment, Type 2
 - See Approved Products List for allowable systems

https://deldot.gov/Business/prodlists/pdfs/APL_EndTerminals.pdf?cache=1603391579291



No guardrail reflectors within limits of end treatment

All dimensions from face of guardrail

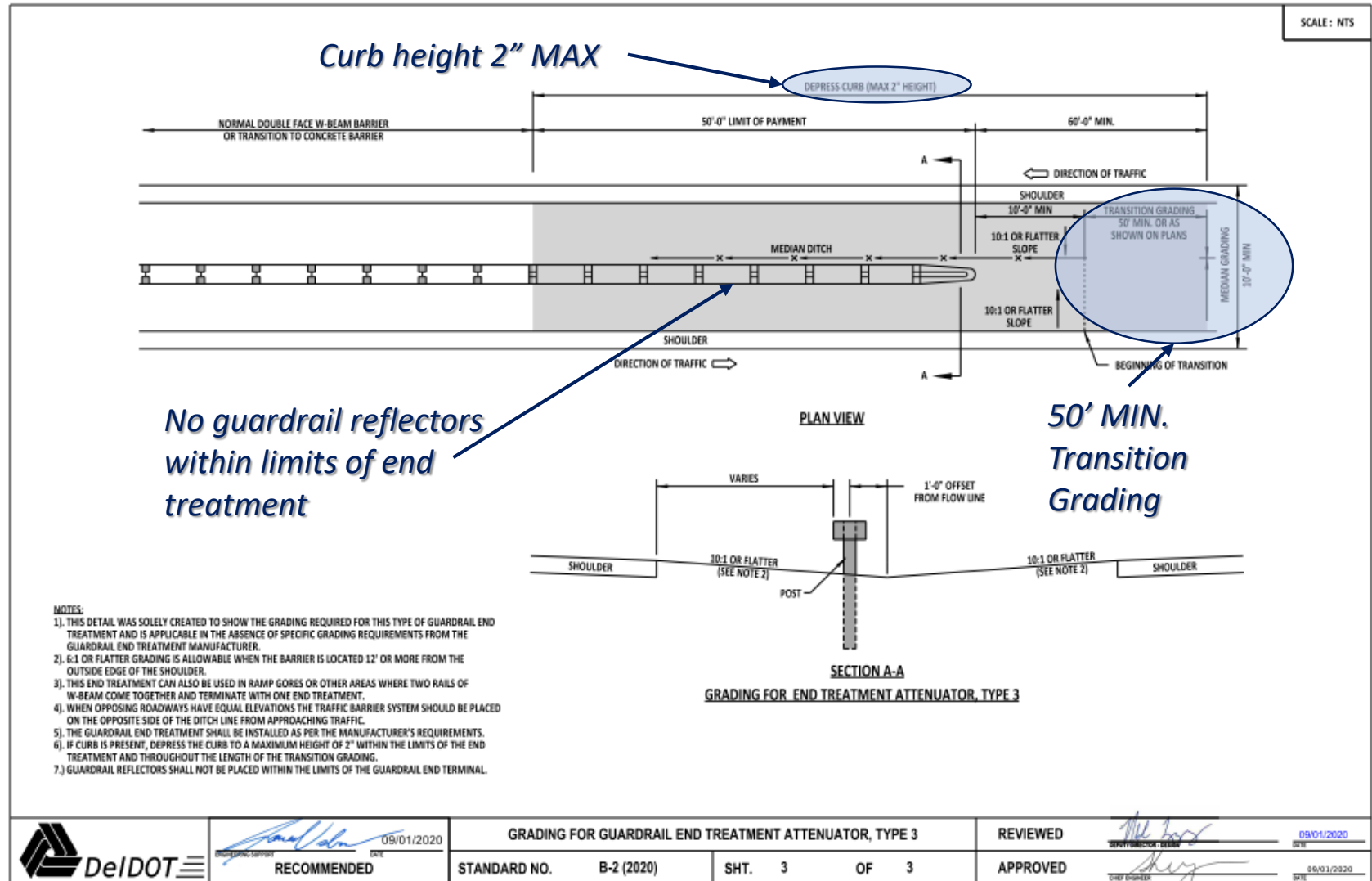


| | | | | |
|--|---------------------------|--|----------------------|----------------------|
| | 09/01/2020 RECOMMENDED | GRADING FOR GUARDRAIL END TREATMENT ATTENUATOR, TYPE 2 | | REVIEWED 09/01/2020 |
| | STANDARD NO. B-2 (2020) | SHT. 2 OF 3 | APPROVED 09/01/2020 | |

Grading for Guardrail End Treatments

- Detail B-2: Grading for Guardrail End Treatment, Type 3
 - See Approved Products List for allowable systems

https://deldot.gov/Business/prodlist/s/pdfs/APL_EndTerminals.pdf?cache=1603391579291



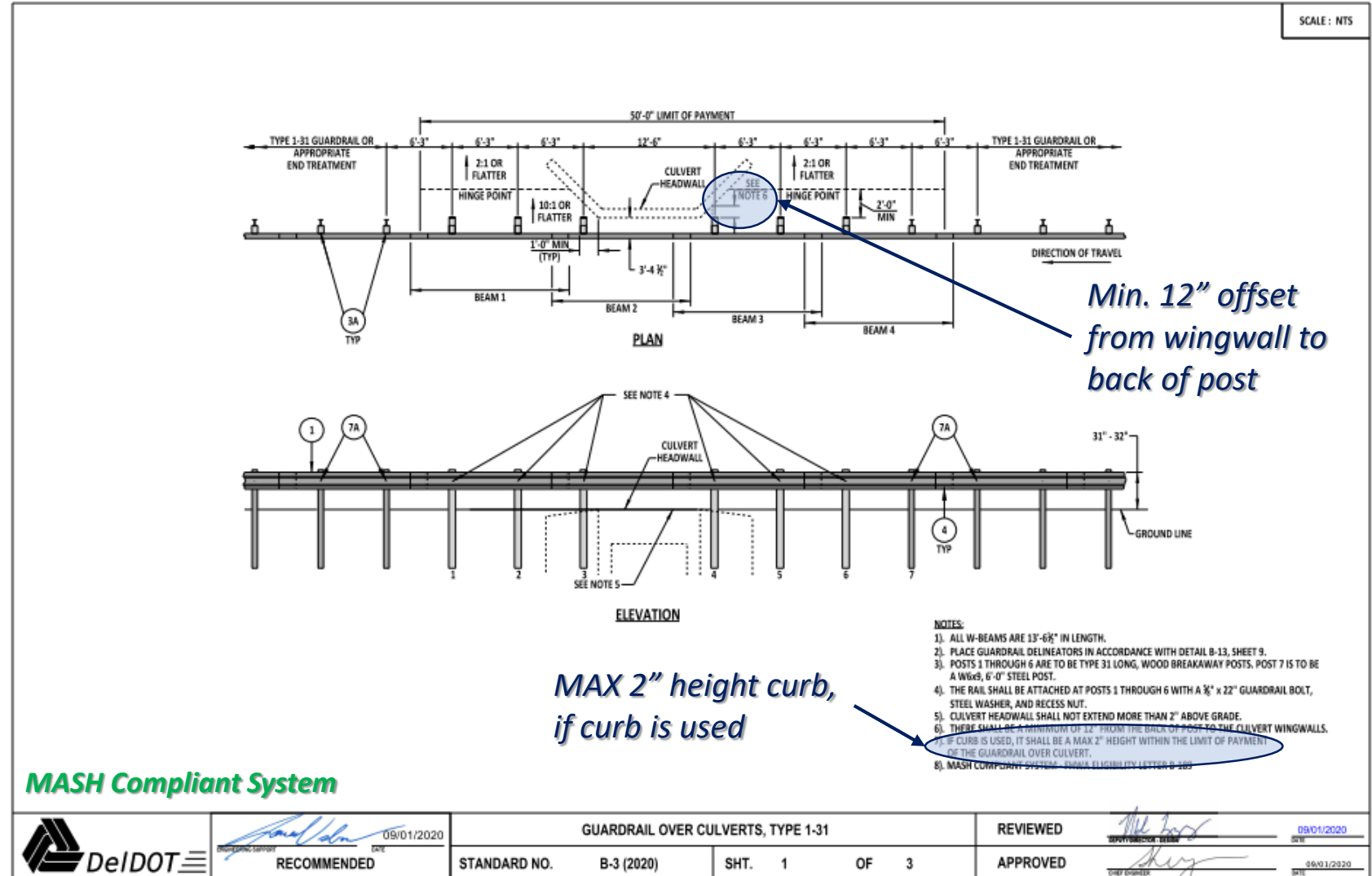
09/01/2020
RECOMMENDED

GRADING FOR GUARDRAIL END TREATMENT ATTENUATOR, TYPE 3
STANDARD NO. B-2 (2020) SHT. 3 OF 3

REVIEWED
APPROVED
09/01/2020
09/01/2020

Guardrail over Culverts

- Detail B-3: Guardrail over Culverts, Type 1-31



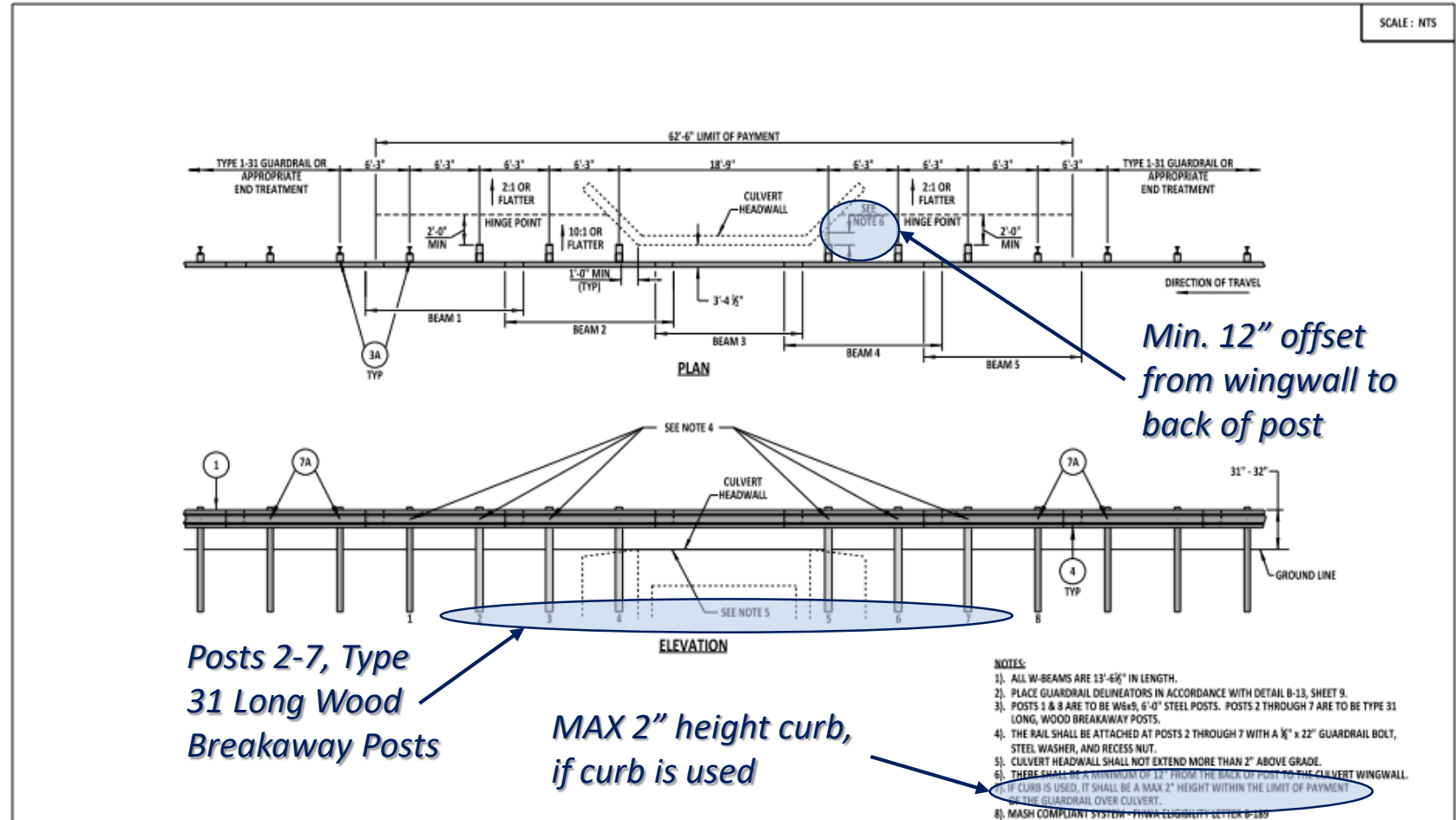
RECOMMENDED
DATE: 09/01/2020

GUARDRAIL OVER CULVERTS, TYPE 1-31
STANDARD NO. B-3 (2020) SHT. 1 OF 3

REVIEWED
APPROVED
DATE: 09/01/2020

Guardrail over Culverts

- Detail B-3: Guardrail over Culverts, Type 2-31



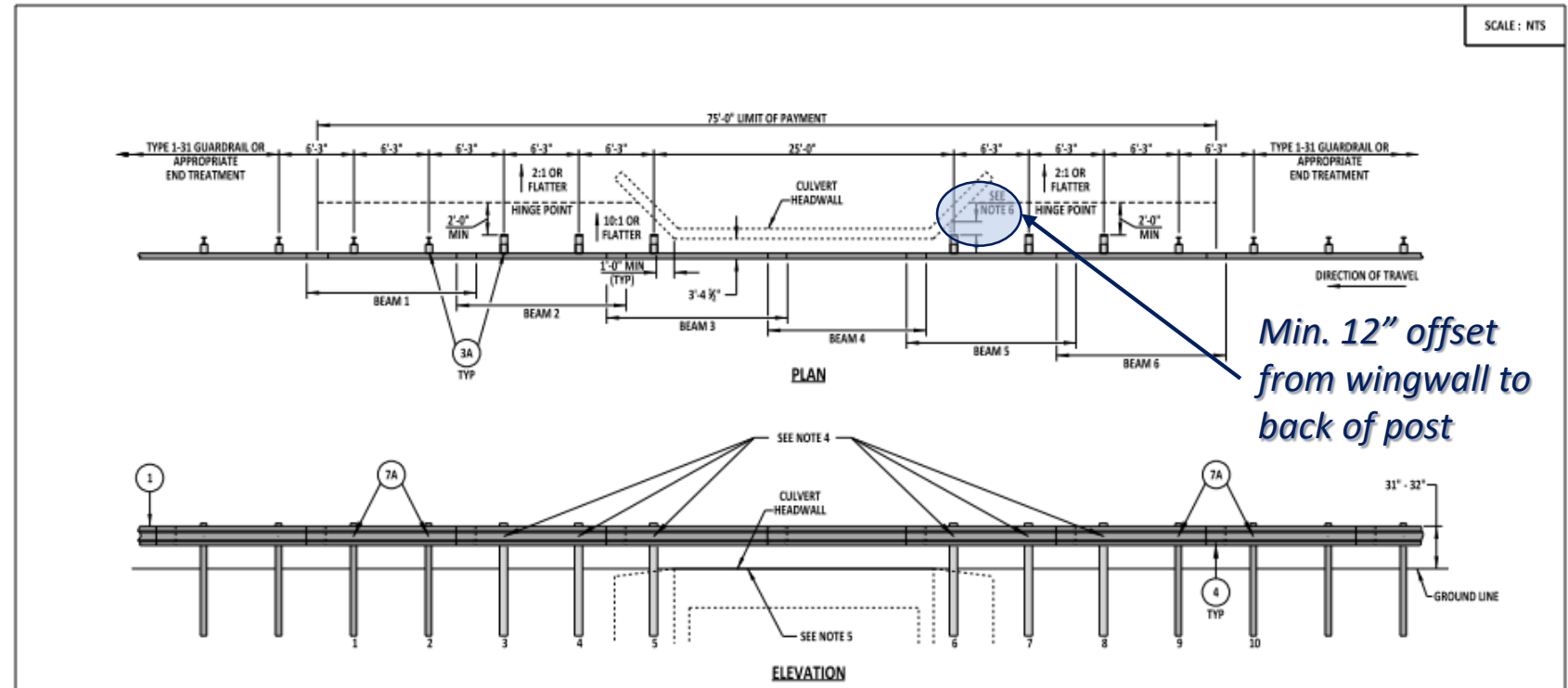
MASH Compliant System

| | | | | | | |
|--|-----------------|--------------------|------------------------------------|------------------------------------|--|------------------------------------|
| | RECOMMENDED | 09/01/2020 DATE | GUARDRAIL OVER CULVERTS, TYPE 2-31 | | | REVIEWED 09/01/2020 DATE |
| | STANDARD NO. | B-3 (2020) | SHT. 2 OF 3 | APPROVED 09/01/2020 DATE | | |



Guardrail over Culverts

- Detail B-3: Guardrail over Culverts, Type 3-31



Min. 12" offset from wingwall to back of post

MAX 2" height curb, if curb is used

- NOTES:**
1. ALL W-BEAMS ARE 13'-6 1/2" IN LENGTH.
 2. PLACE GUARDRAIL DELINEATORS IN ACCORDANCE WITH DETAIL B-13, SHEET 9.
 3. POSTS 1, 2, 9, & 10 ARE TO BE W6x9, 6'-0" STEEL POSTS. POSTS 3 THROUGH 8 ARE TO BE TYPE 31 LONG, WOOD BREAKAWAY POSTS.
 4. THE RAIL SHALL BE ATTACHED AT POSTS 3 THROUGH 8 WITH A 3/8" x 22" GUARDRAIL BOLT, STEEL WASHER, AND RECESS NUT.
 5. CULVERT HEADWALL SHALL NOT EXTEND MORE THAN 2" ABOVE GRADE.
 6. CURB SHALL BE A MINIMUM OF 12" FROM THE BACK OF POST TO THE CULVERT WINGWALLS.
 7. IF CURB IS USED, IT SHALL BE A MAX 2" HEIGHT WITHIN THE LIMIT OF PAYMENT OF THE GUARDRAIL OVER CULVERT.
 8. MASH COMPLIANT SYSTEM - CHECK ELIGIBILITY LETTER B-180

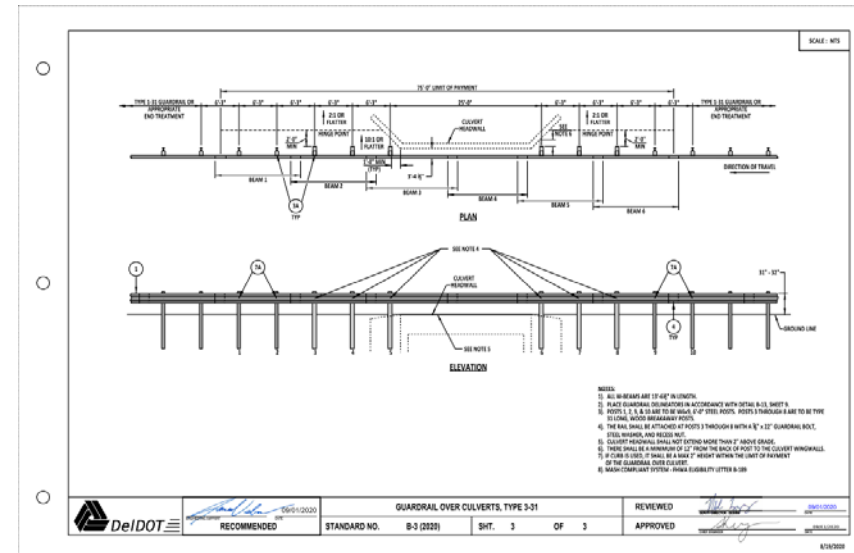
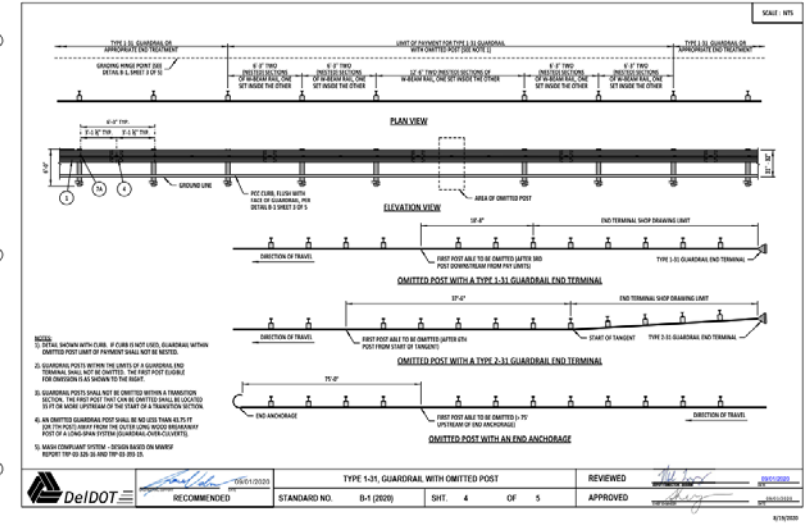
MASH Compliant System

| | | | | | |
|--|---------------------------|------------------------------------|----------------------|--|----------------------|
| | 09/01/2020 RECOMMENDED | GUARDRAIL OVER CULVERTS, TYPE 3-31 | | | REVIEWED 09/01/2020 |
| | STANDARD NO. B-3 (2020) | SHT. 3 OF 3 | APPROVED 09/01/2020 | | |



Design Considerations

- Guardrail with Omitted Post
 - Use only where one post needs to be omitted
 - Curb openings
 - Span an underground utility conflict
- Guardrail over Culvert
 - Use to span pipe or box culverts
 - Unsupported span lengths between 12'-6" and 25'-0"
 - Max span length 25'-0"

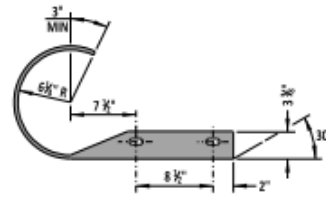


End Anchorage

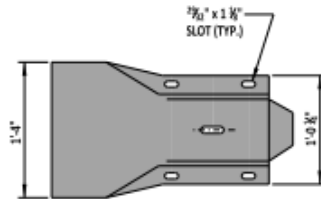
- Detail B-4: End Anchorage

New Detail

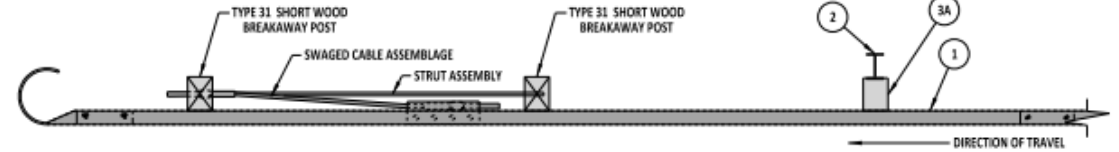
SCALE: NTS



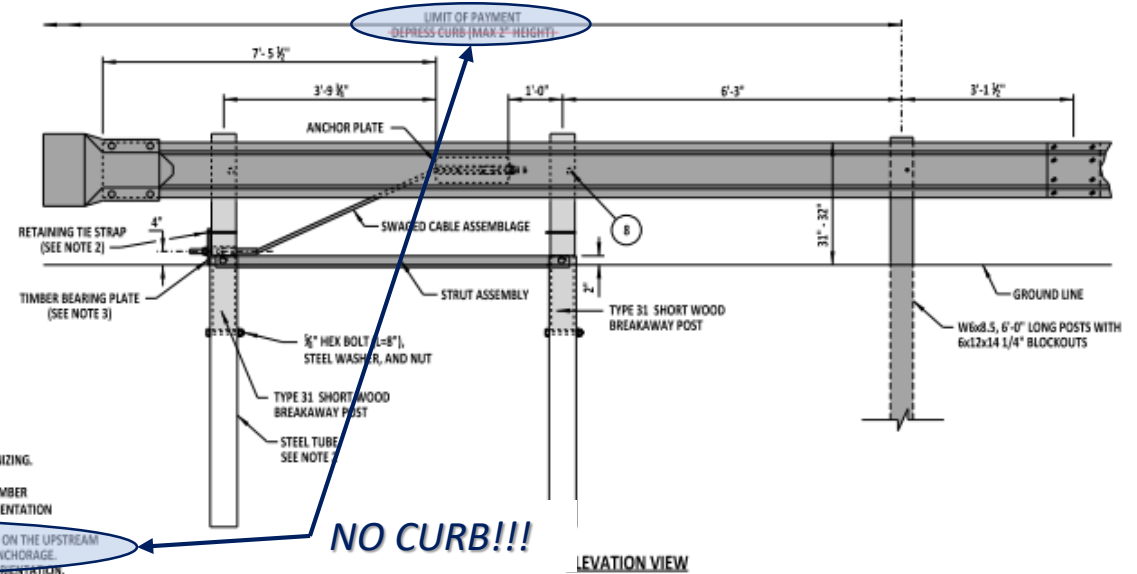
END SECTION PLAN



END SECTION ELEVATION



PLAN VIEW



ELEVATION VIEW

NOTES:

1. ADDITIONAL HOLES FOR ANCHOR PLATE SHALL BE DRILLED PRIOR TO GALVANIZING. (SEE STANDARD HARDWARE SHEET FOR HOLE SPACING INFORMATION).
2. PLACE A 3/8" WIDE GALVANIZED RETAINING TIE STRAP AROUND THE SHORT TIMBER BREAKAWAY POST AND TIMBER BEARING PLATE TO ENSURE THE PROPER ORIENTATION OF THE TIMBER BEARING PLATE.
3. CURB SHALL NOT BE INSTALLED WITH THE END ANCHORAGE. IF CURB IS USED ON THE UPSTREAM GUARDRAIL, CURB SHALL BE TERMINATED 56.25 FT UPSTREAM OF THE END ANCHORAGE.
4. REFER TO DETAIL B-4 SHEET 2 OF 2 FOR PROPOSED TIMBER BEARING PLATE ORIENTATION.
5. MASH COMPLIANT SYSTEM - FHWA ELIGIBILITY LETTER B-256
6. THIS SYSTEM SHALL NOT BE USED WHERE END ON IMPACTS ARE EXPECTED. IT IS SOLELY DESIGNED TO ACT AS A DOWNSTREAM END ANCHOR.

NO CURB!!!

MASH Compliant System



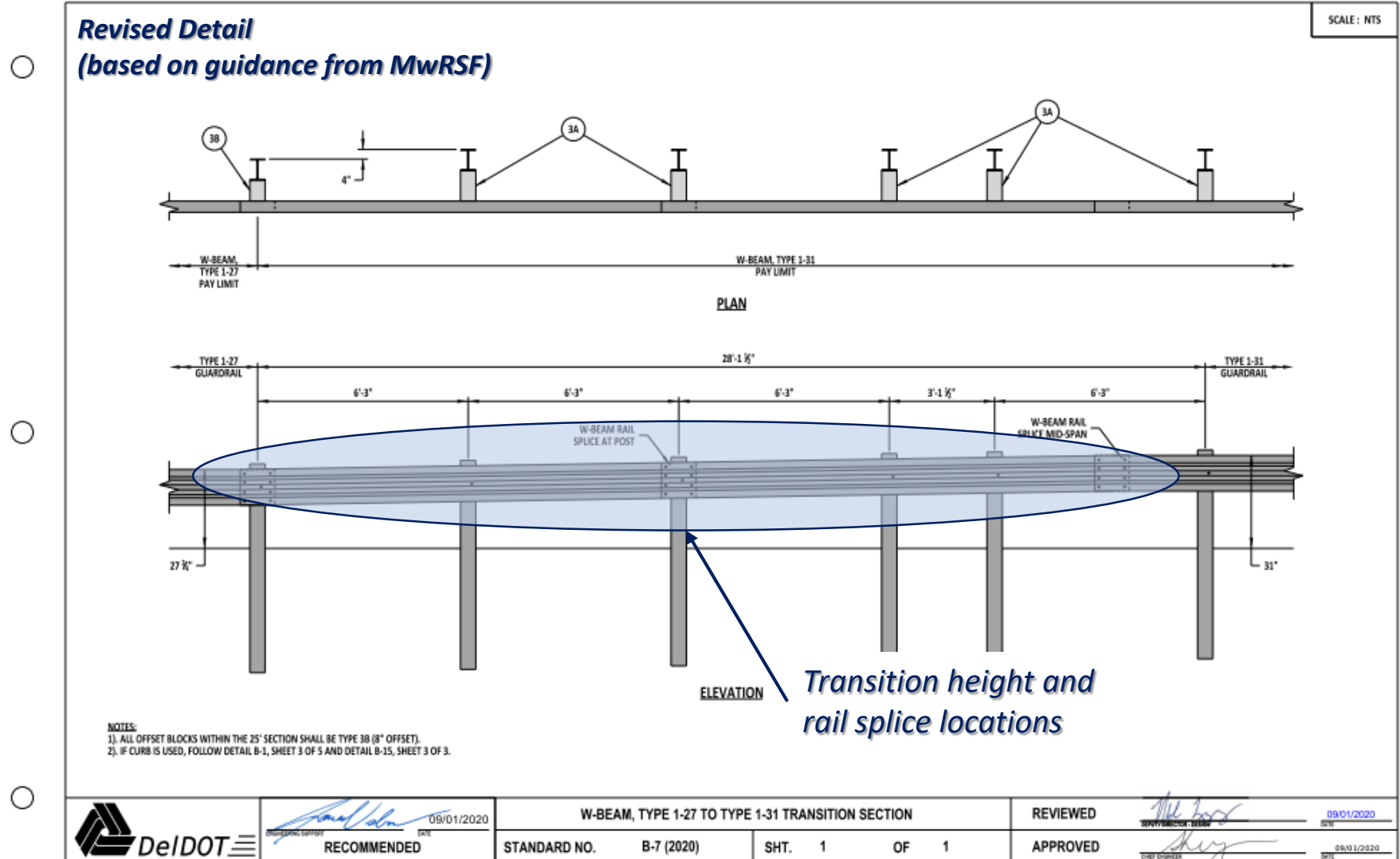
RECOMMENDED
DATE: 09/01/2020

END ANCHORAGE, TYPE 31
STANDARD NO. B-4 (2020) SHT. 1 OF 1

REVIEWED [Signature] DATE: 09/01/2020
APPROVED [Signature] DATE: 09/01/2020

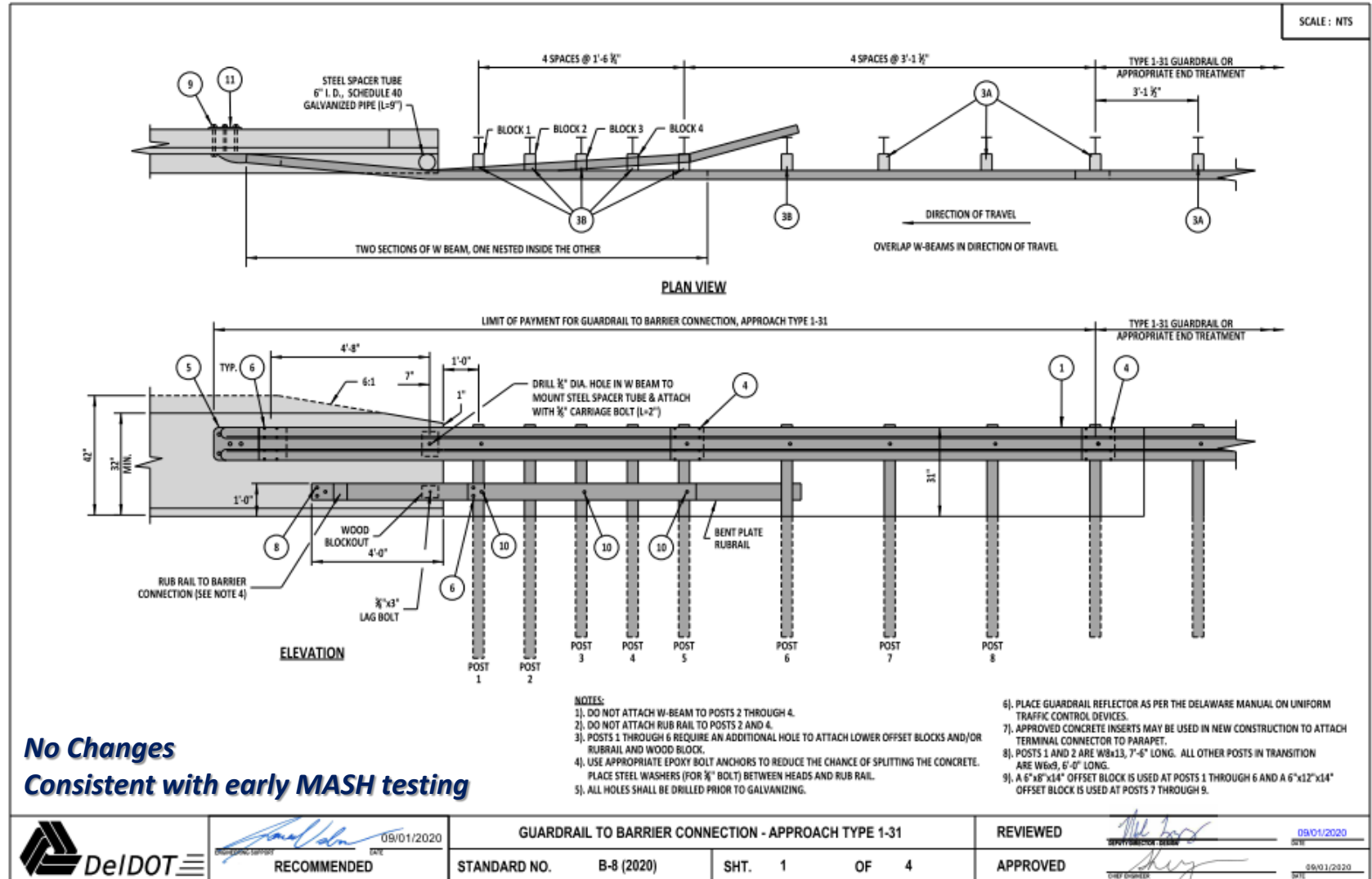
Guardrail Transitions

- Detail B-7: Transition from 1-31 to 1-27



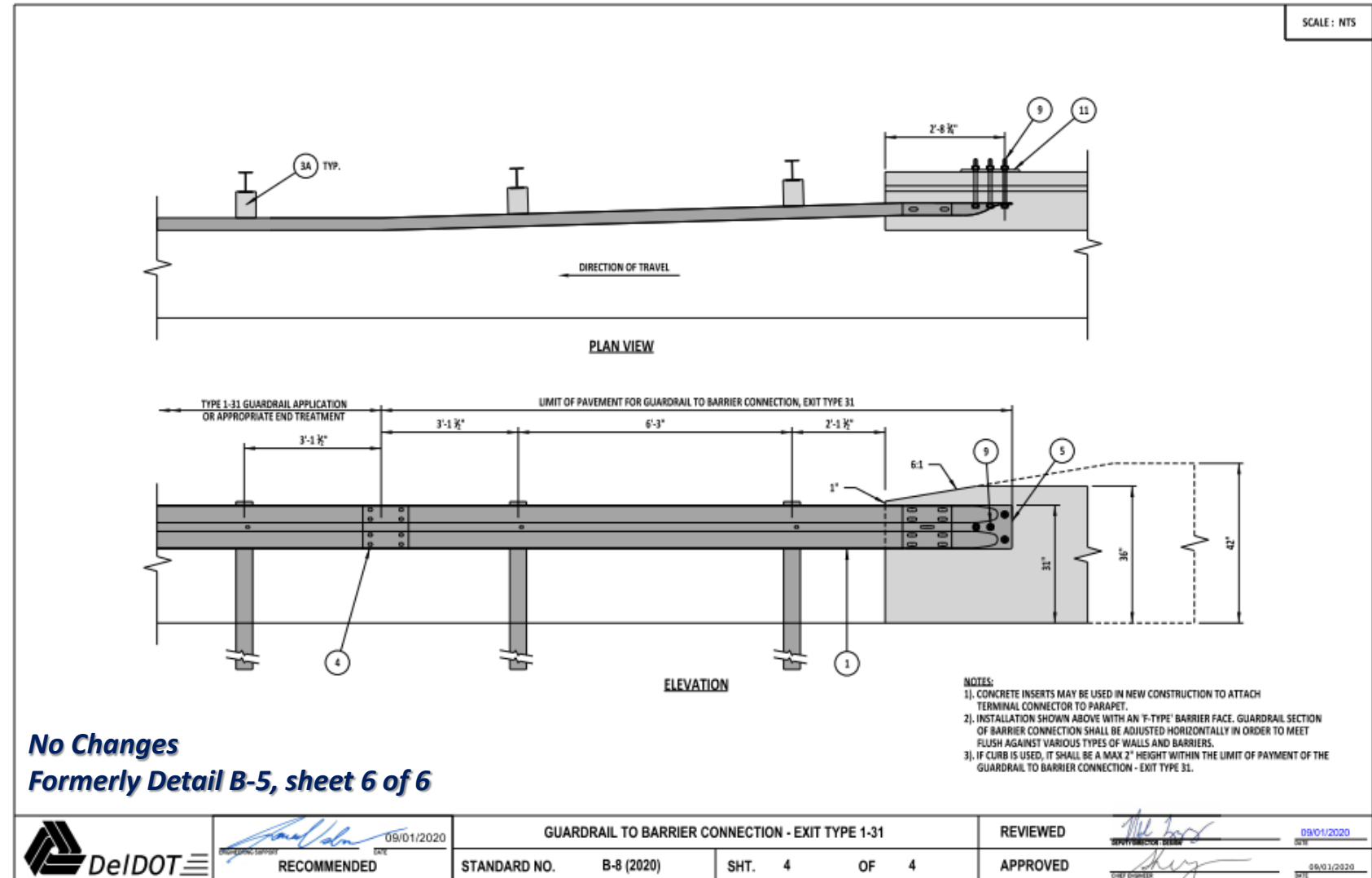
Approach Guardrail Transitions

- Detail B-8: Guardrail-to-Barrier Connection, Type 1-31



Approach Guardrail Transitions

- Detail B-8: Guardrail-to-Barrier Connection, Exit
 - Crash testing not required for this system
 - Standard Exit connection used where opposing traffic cannot strike end of concrete barrier.

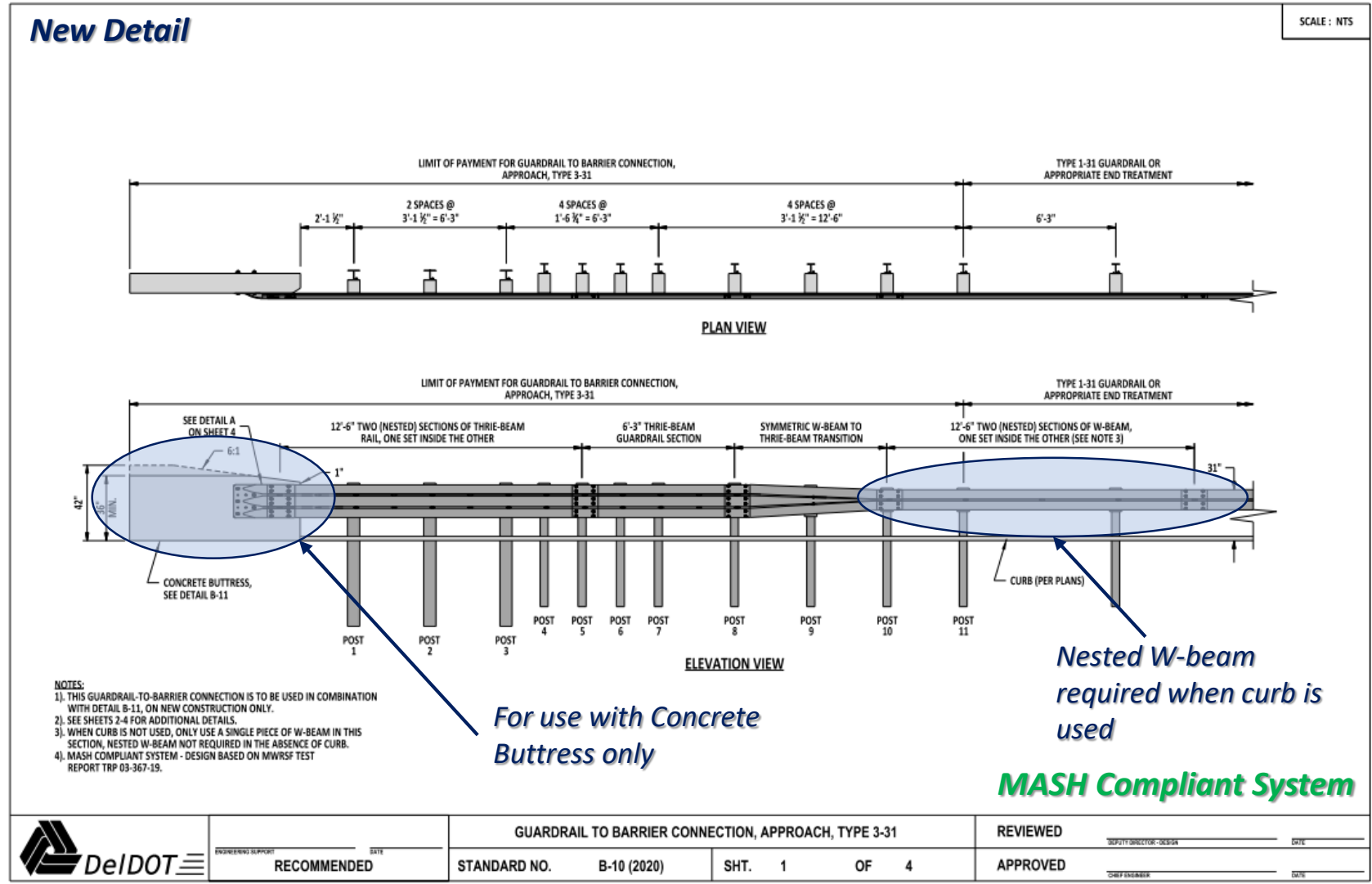


Approach Guardrail Transitions

- Detail B-10: Guardrail-to-Barrier Connection, Type 3-31

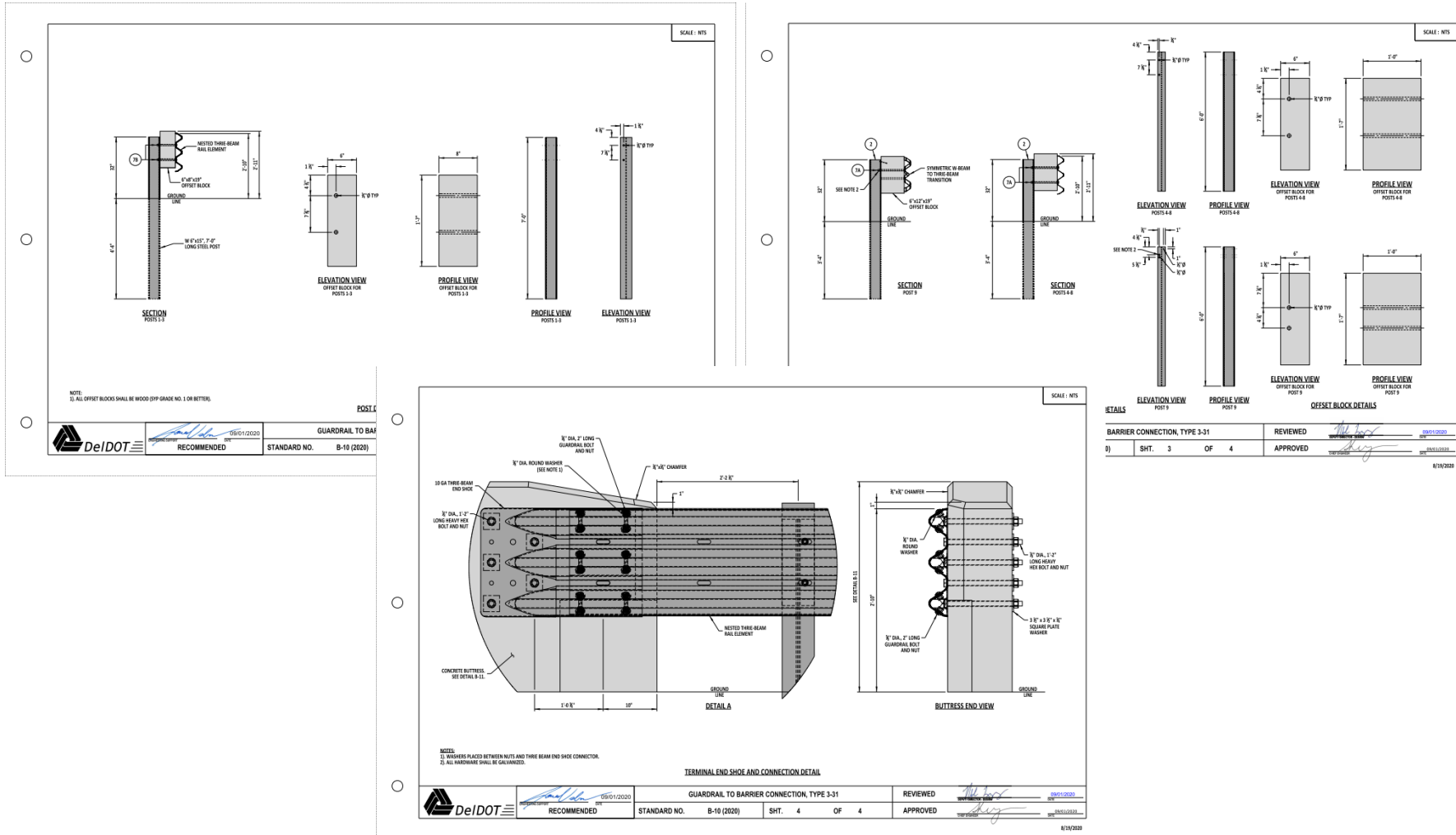


Source: Midwest Roadside Safety Facility



Approach Guardrail Transitions

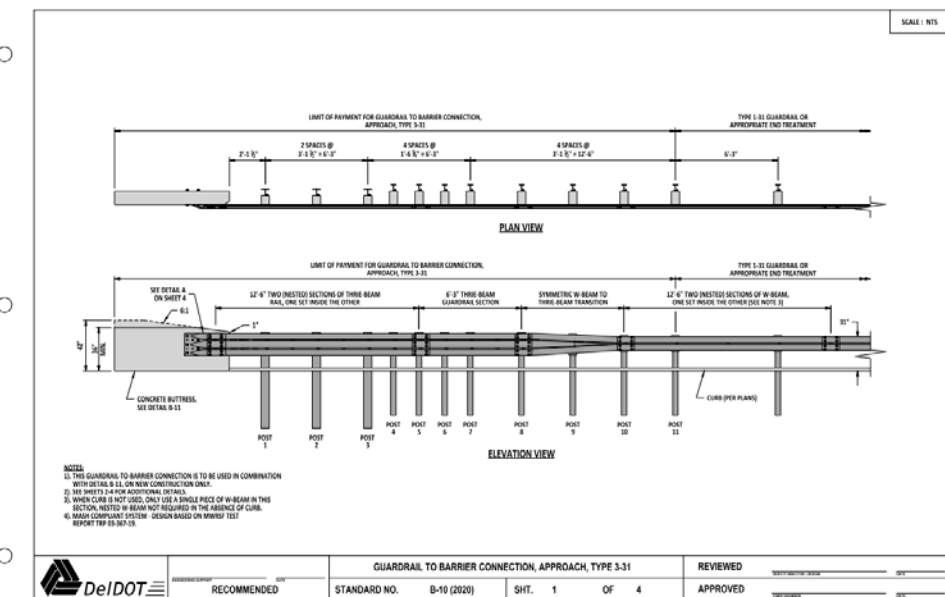
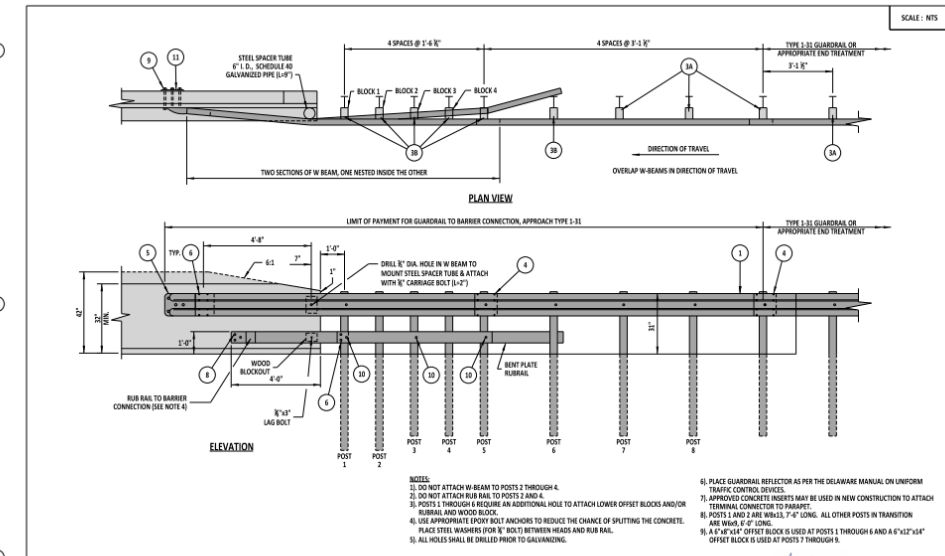
- Detail B-10: Guardrail-to-Barrier Connection, Type 3-31



Approach Guardrail Transitions

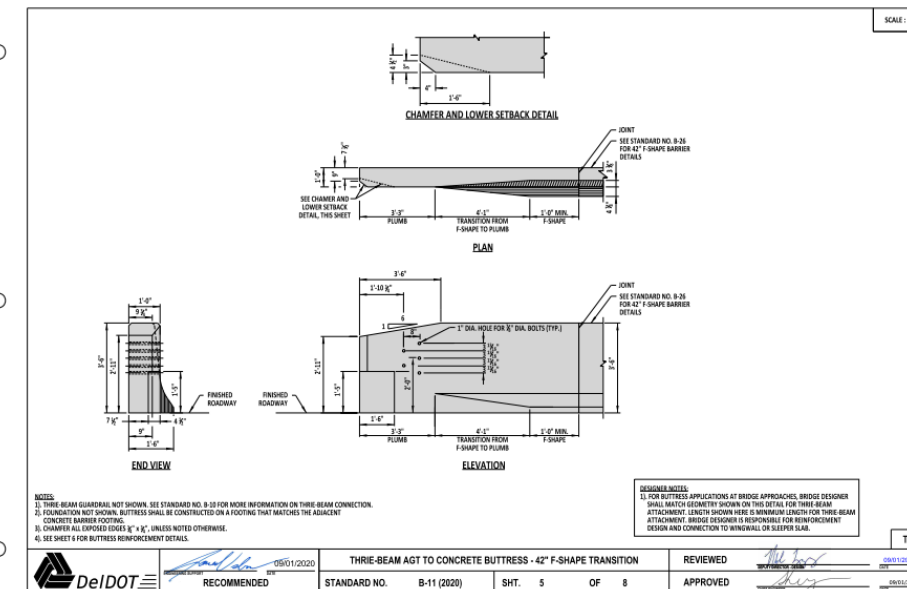
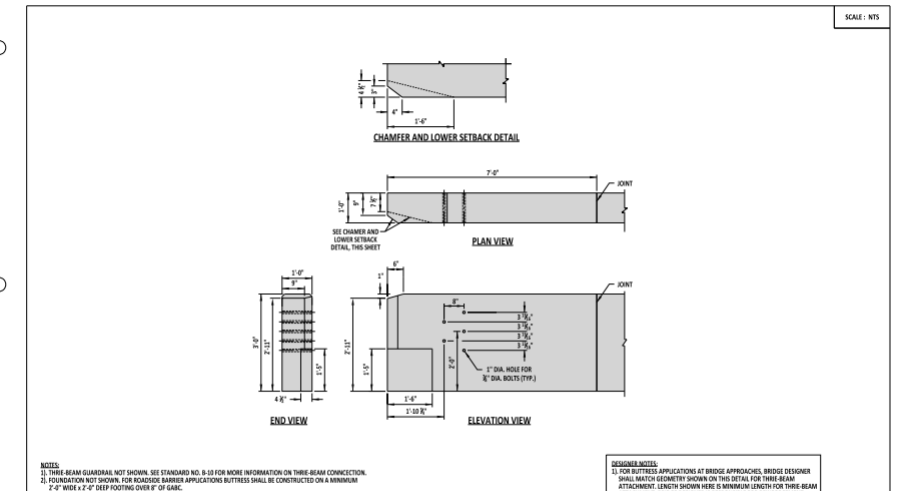
Design Considerations

- Use Type 1-31 AGT for retrofit applications at existing F-shape barrier wall attachments
- Use Type 3-31 AGT for new construction or where it is desirable to construct the concrete buttress
- Consult MASH Committee and/or Bridge Design for retrofit situations where the Type 3-31 AGT may be beneficial



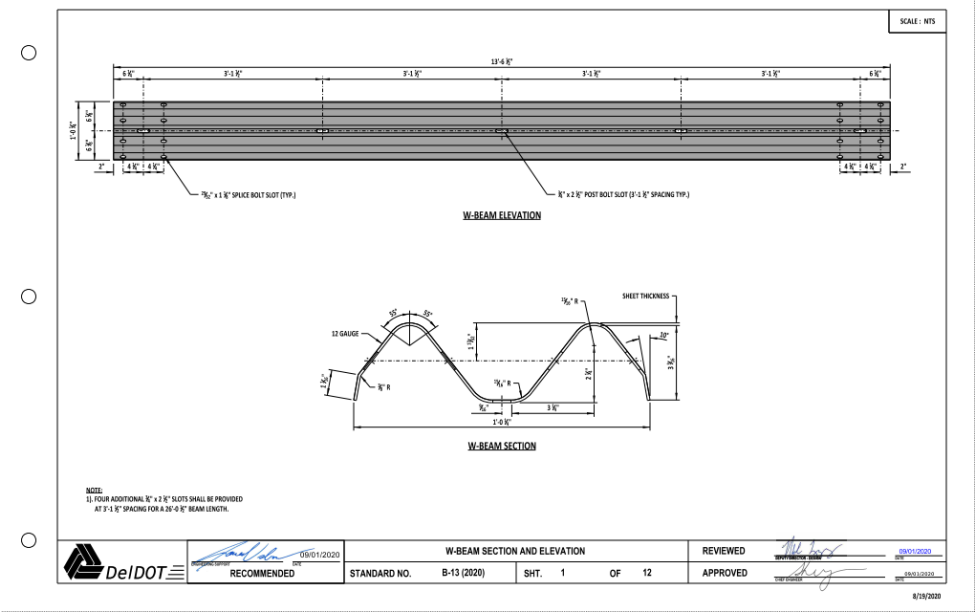
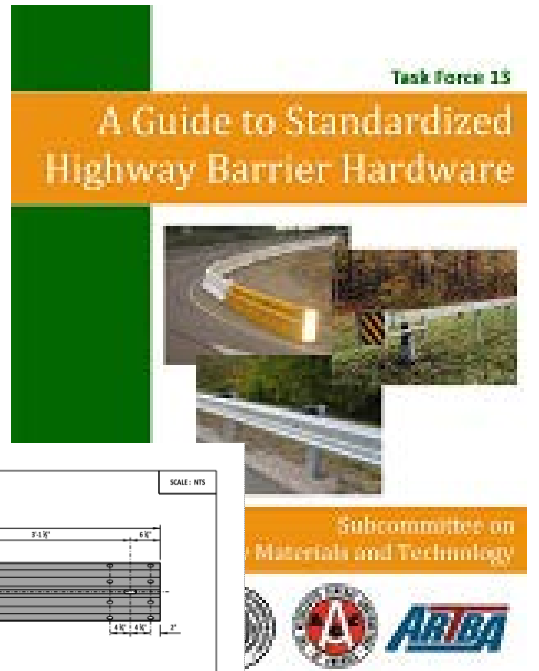
Concrete Buttress

- Detail B-11: Thrie-Beam Approach Guardrail Transition (AGT) to Concrete Buttress
 - Concrete buttress to be used with Type 3-31 Guardrail to Barrier Connection
 - Four options provided in details:
 - Vertical face (sheets 1-2)
 - Transition from vertical face to 36" F-Shape (sheets 3-4)
 - Transition from vertical face to 42" F-Shape (sheets 5-6)
 - Transition from vertical face to 42" Single Slope (sheets 7-8)
 - No MASH compliant options available for transitions to median barrier
 - Use applicable NCHRP 350 guardrail transitions for the time being
 - National research to be monitored



Barrier Hardware

- Detail B-13: Barrier Hardware (12 sheets)
 - All Sheets
 - Removed metric dimensions
 - Updated dimensions where applicable to be consistent with AASHTO Task Force 13 standardized dimensions
 - Updated sheet titles where appropriate

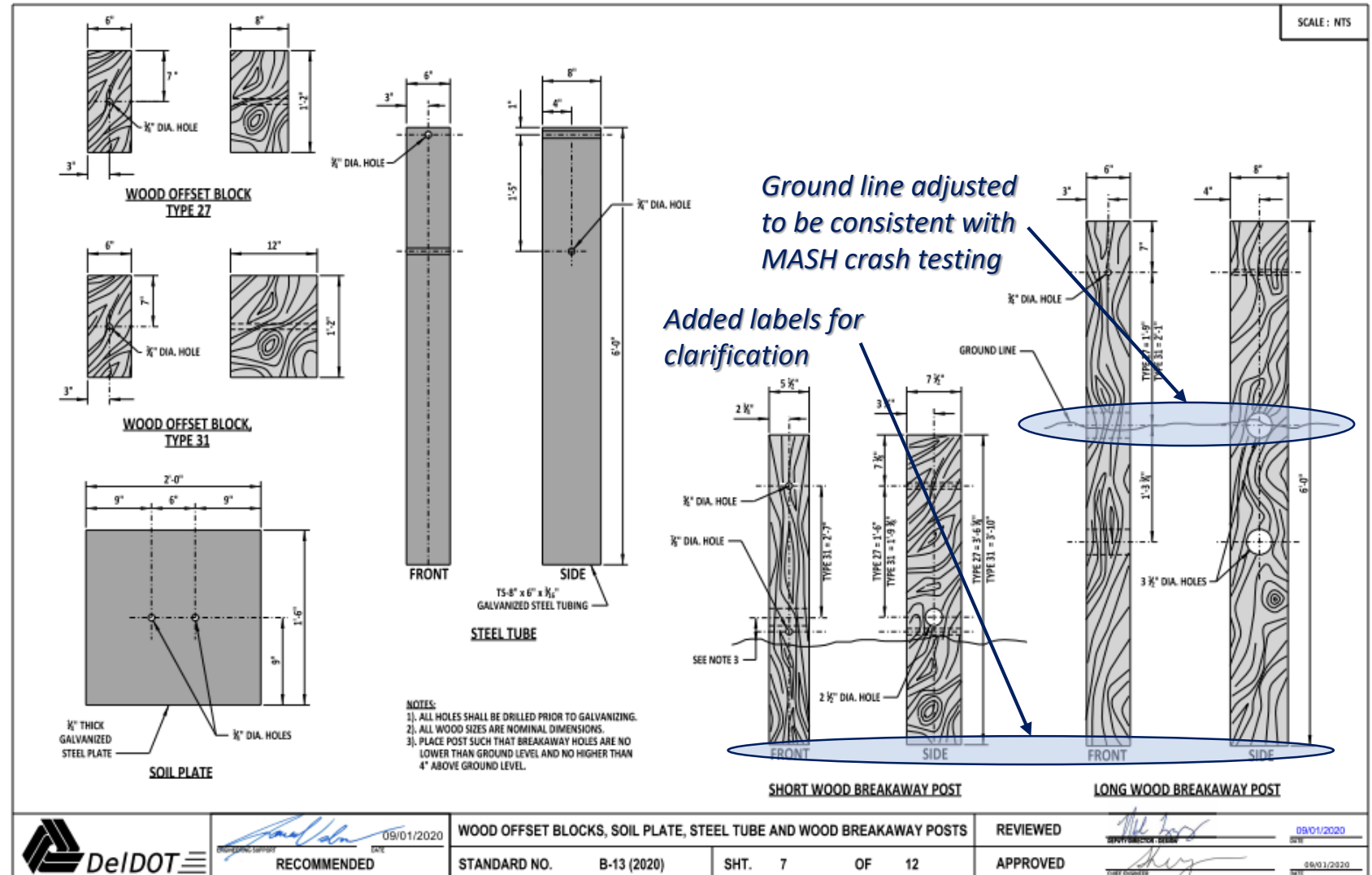


| | | | | | | |
|--------|--------------|-------------|------------------------------|---------|----------|------------|
| DeIDOT | RECOMMENDED | 09/01/2020 | W-BEAM SECTION AND ELEVATION | | REVIEWED | 09/01/2020 |
| | STANDARD NO. | B-13 (2020) | SHT. | 1 OF 12 | APPROVED | 09/01/2020 |

8/18/2020

Barrier Hardware

- Detail B-13, Sheet 7: Short & Long Wood Breakaway Posts



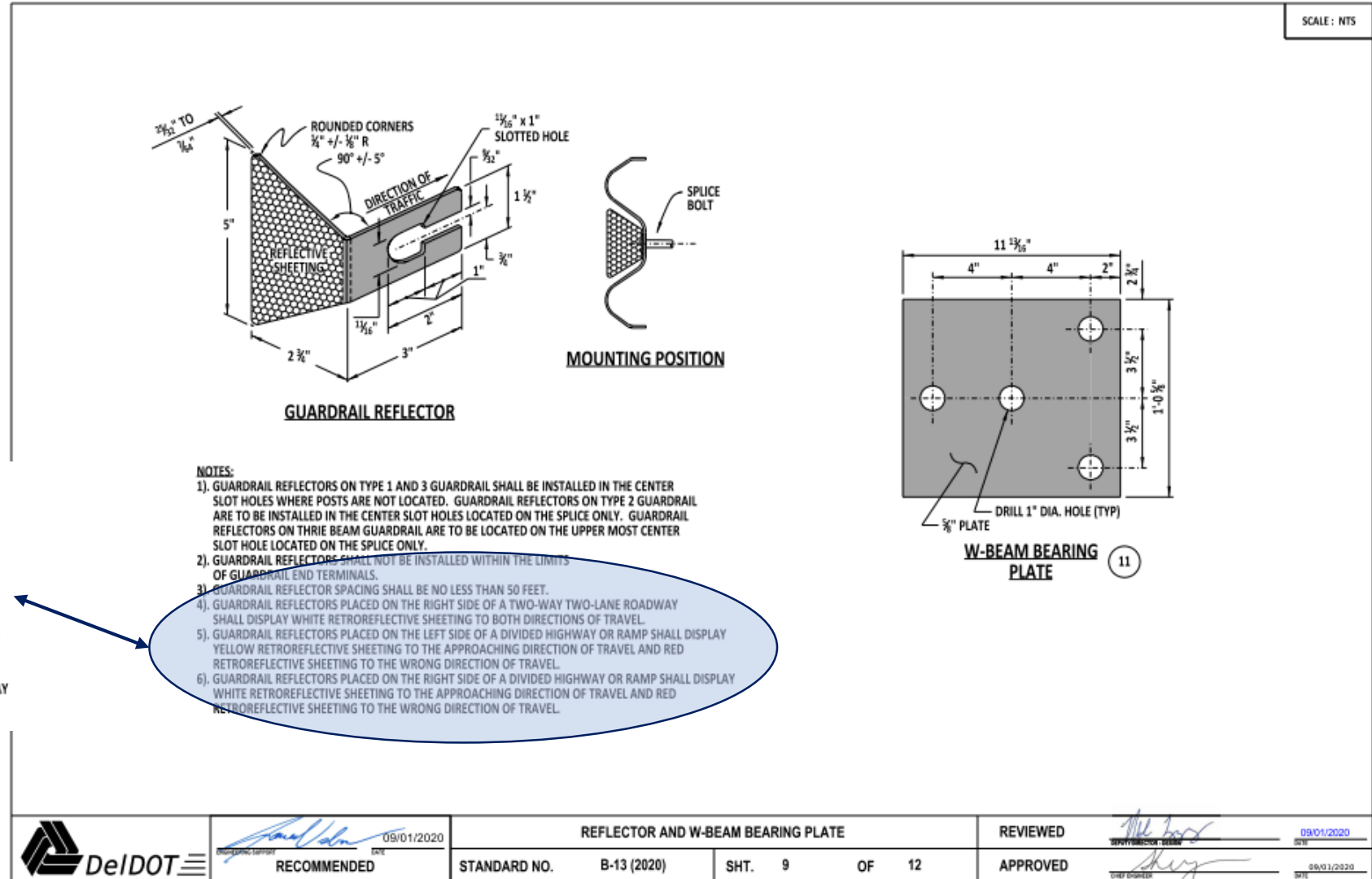
Barrier Hardware

- Detail B-13, Sheet 9: Guardrail Reflector

Added reflector color and placement requirements (based on DE MUTCD, Section 3F.04)

NOTES:

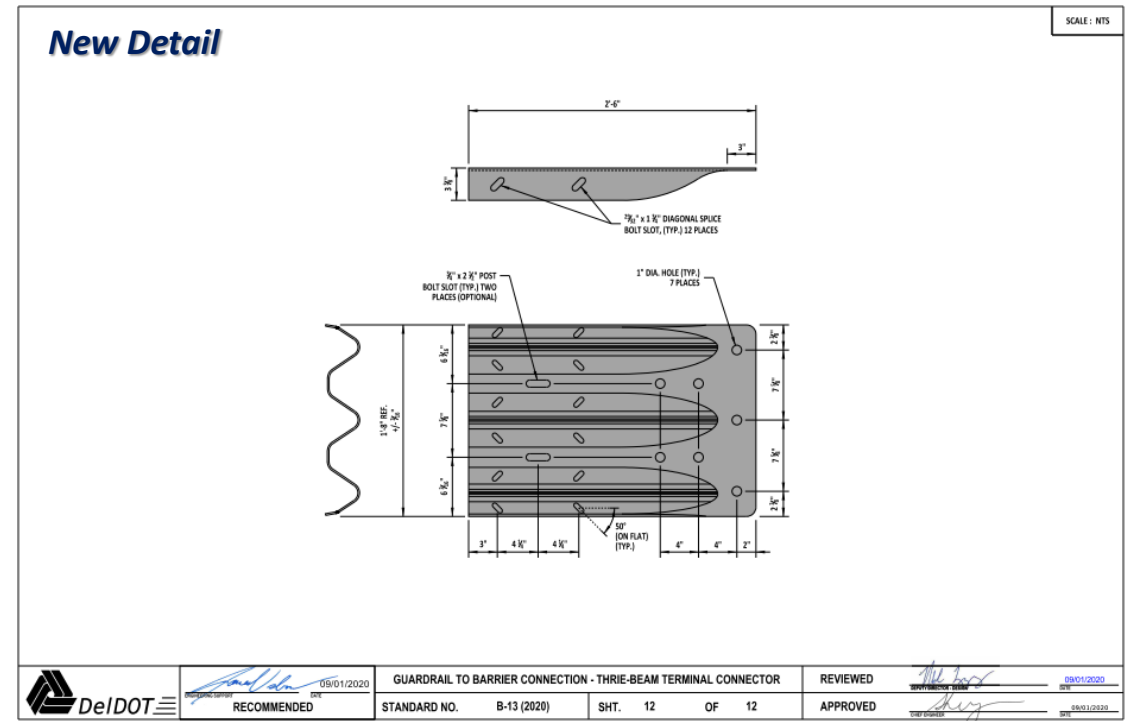
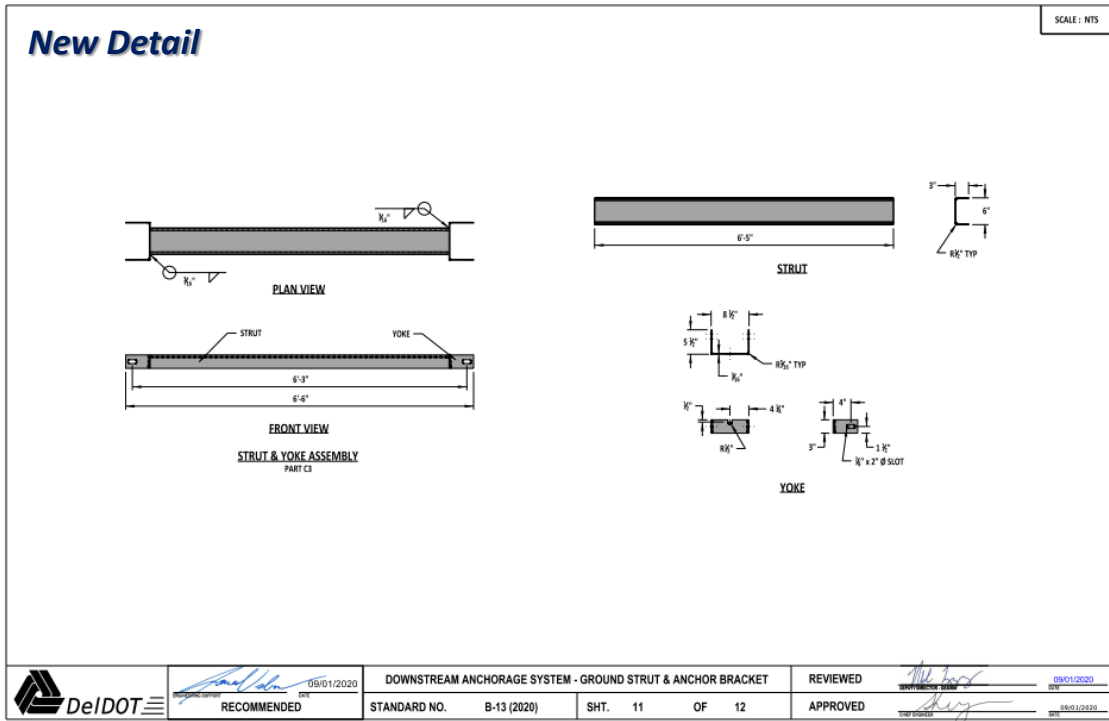
- 1). GUARDRAIL REFLECTORS ON TYPE 1 AND 3 GUARDRAIL SHALL BE INSTALLED IN THE CENTER SLOT HOLES WHERE POSTS ARE NOT LOCATED. GUARDRAIL REFLECTORS ON TYPE 2 GUARDRAIL ARE TO BE INSTALLED IN THE CENTER SLOT HOLES LOCATED ON THE SPLICE ONLY. GUARDRAIL REFLECTORS ON THRIE BEAM GUARDRAIL ARE TO BE LOCATED ON THE UPPER MOST CENTER SLOT HOLE LOCATED ON THE SPLICE ONLY.
- 2). GUARDRAIL REFLECTORS SHALL NOT BE INSTALLED WITHIN THE LIMITS OF GUARDRAIL END TERMINALS.
- 3). GUARDRAIL REFLECTOR SPACING SHALL BE NO LESS THAN 50 FEET.
- 4). GUARDRAIL REFLECTORS PLACED ON THE RIGHT SIDE OF A TWO-WAY TWO-LANE ROADWAY SHALL DISPLAY WHITE RETROREFLECTIVE SHEETING TO BOTH DIRECTIONS OF TRAVEL.
- 5). GUARDRAIL REFLECTORS PLACED ON THE LEFT SIDE OF A DIVIDED HIGHWAY OR RAMP SHALL DISPLAY YELLOW RETROREFLECTIVE SHEETING TO THE APPROACHING DIRECTION OF TRAVEL AND RED RETROREFLECTIVE SHEETING TO THE WRONG DIRECTION OF TRAVEL.
- 6). GUARDRAIL REFLECTORS PLACED ON THE RIGHT SIDE OF A DIVIDED HIGHWAY OR RAMP SHALL DISPLAY WHITE RETROREFLECTIVE SHEETING TO THE APPROACHING DIRECTION OF TRAVEL AND RED RETROREFLECTIVE SHEETING TO THE WRONG DIRECTION OF TRAVEL.



| | | | | |
|--|-------------------------------------|------------------------------------|----------------------------------|----------------------------------|
| | DATE: 09/01/2020 RECOMMENDED | REFLECTOR AND W-BEAM BEARING PLATE | | REVIEWED DATE: 09/01/2020 |
| | STANDARD NO. B-13 (2020) | SHT. 9 OF 12 | APPROVED DATE: 09/01/2020 | 8/19/2020 |

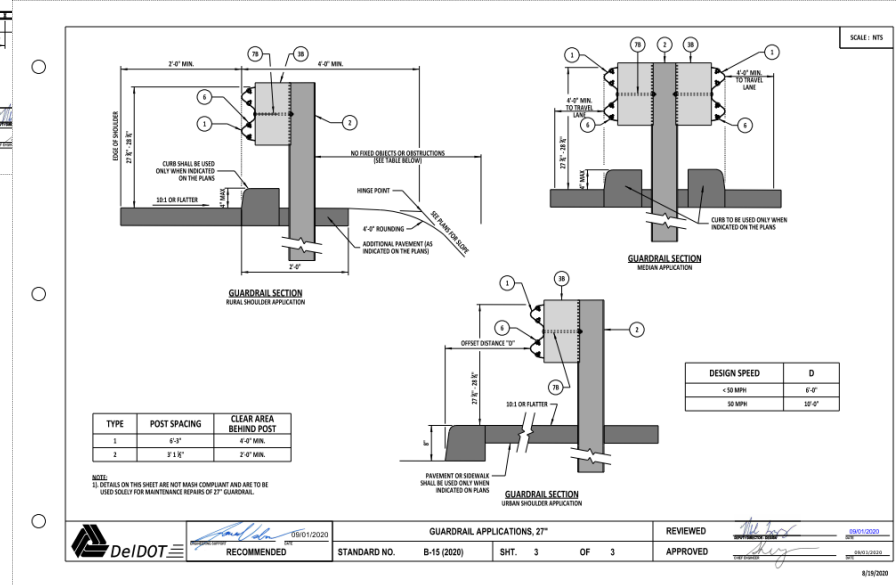
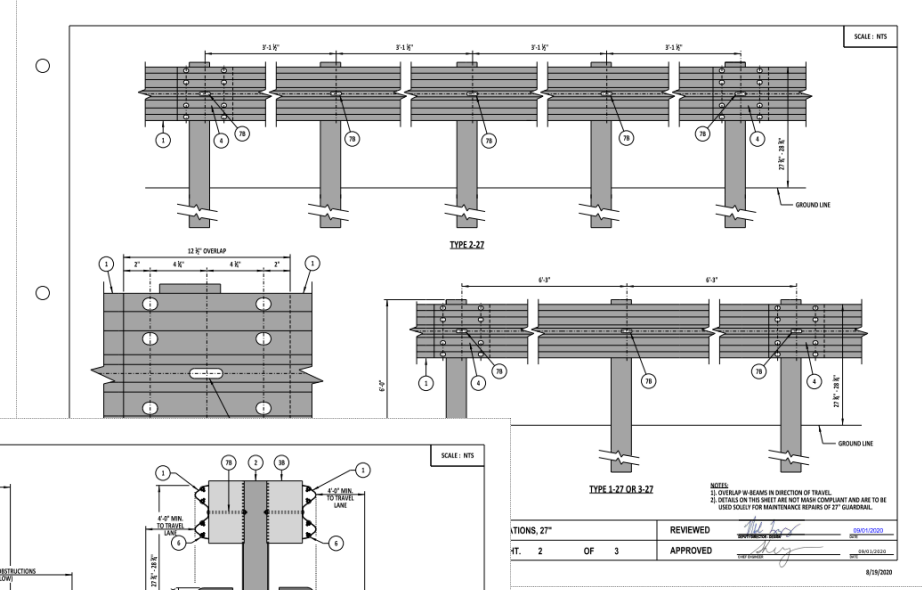
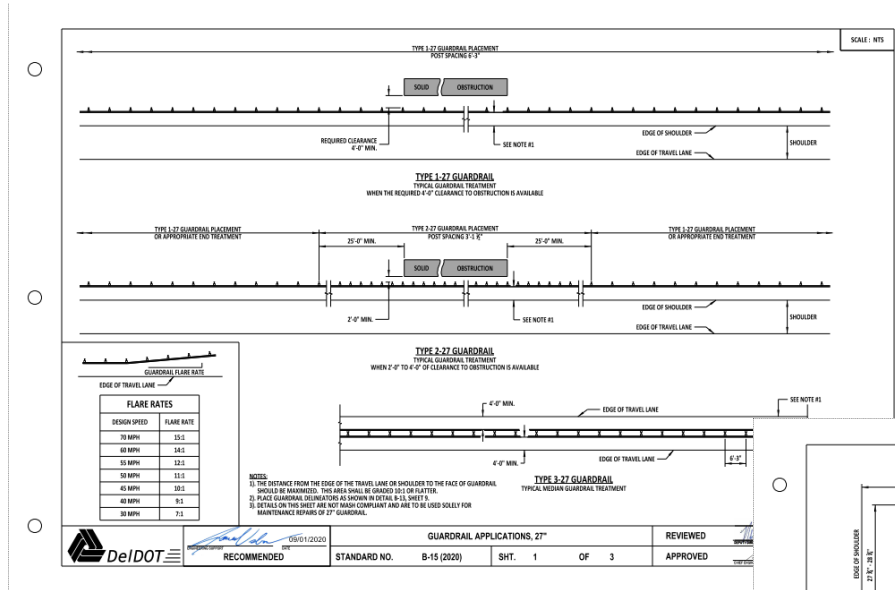
Barrier Hardware

- Detail B-13, NEW sheets 11 & 12



Guardrail Applications, 27"

- Detail B-15: Guardrail Applications, 27"



Only for use in maintenance of existing 27" high guardrail or minor retrofit applications
NCHRP 350 Compliant System



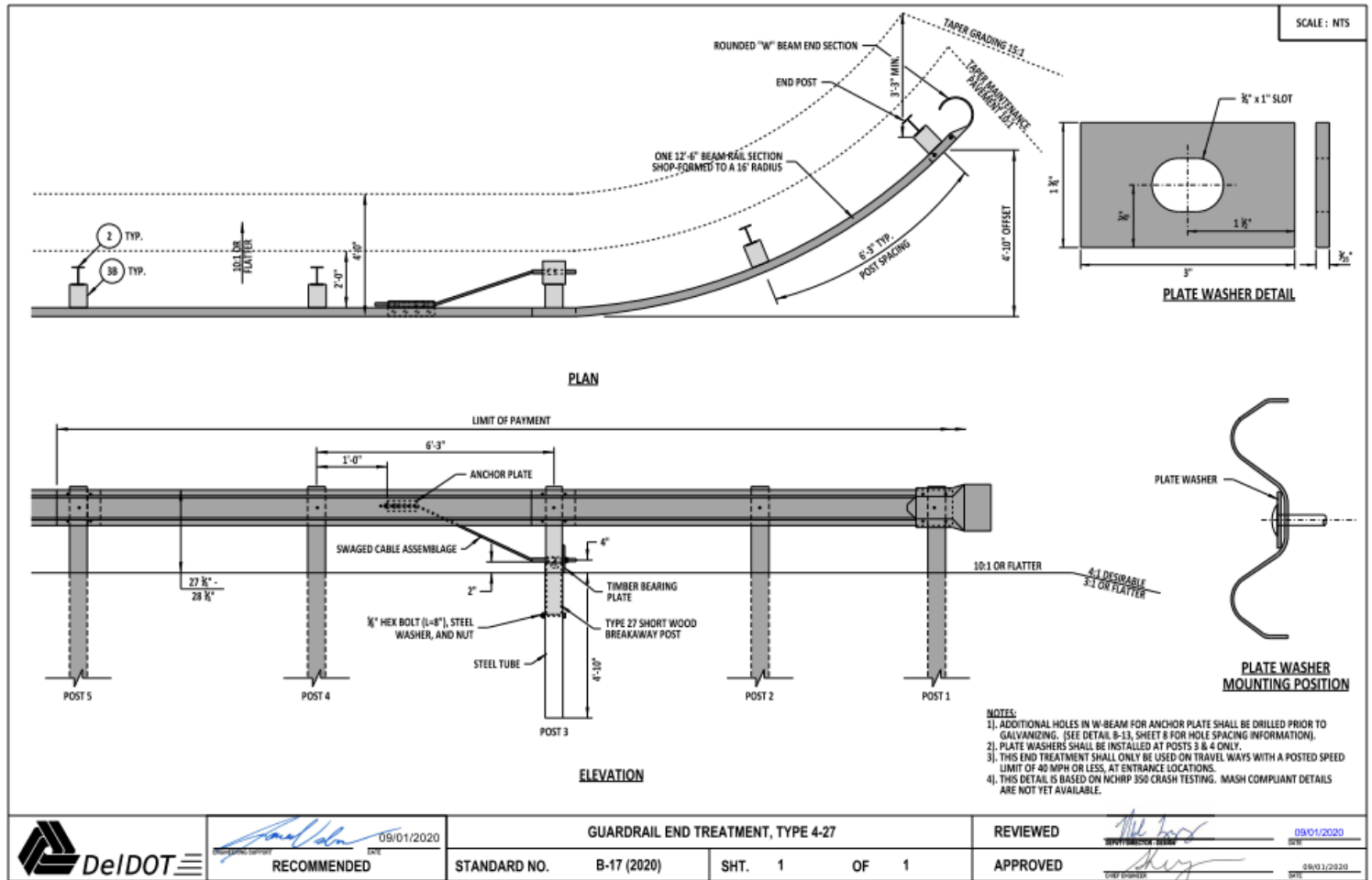
Guardrail Applications, 27"

- Detail B-17: Guardrail End Treatment, Type 4-27

Only for use at entrance locations on roadways with a posted speed limit ≤ 40 MPH

Use only where a standard end treatment will not fit

NCHRP 350 Compliant System



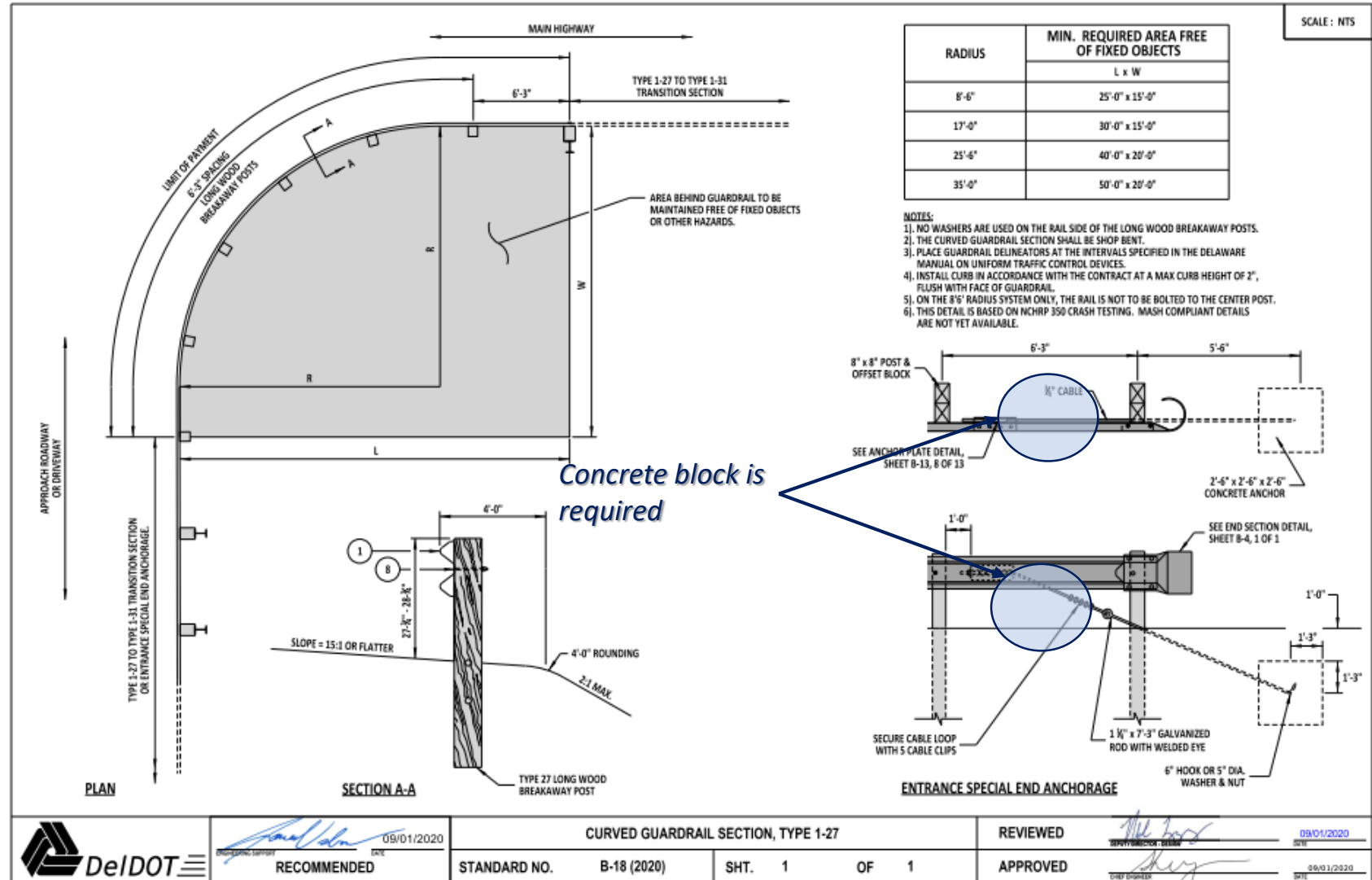
Guardrail Applications, 27"

- Detail B-18: Curved Guardrail Section

Use only where absolutely necessary

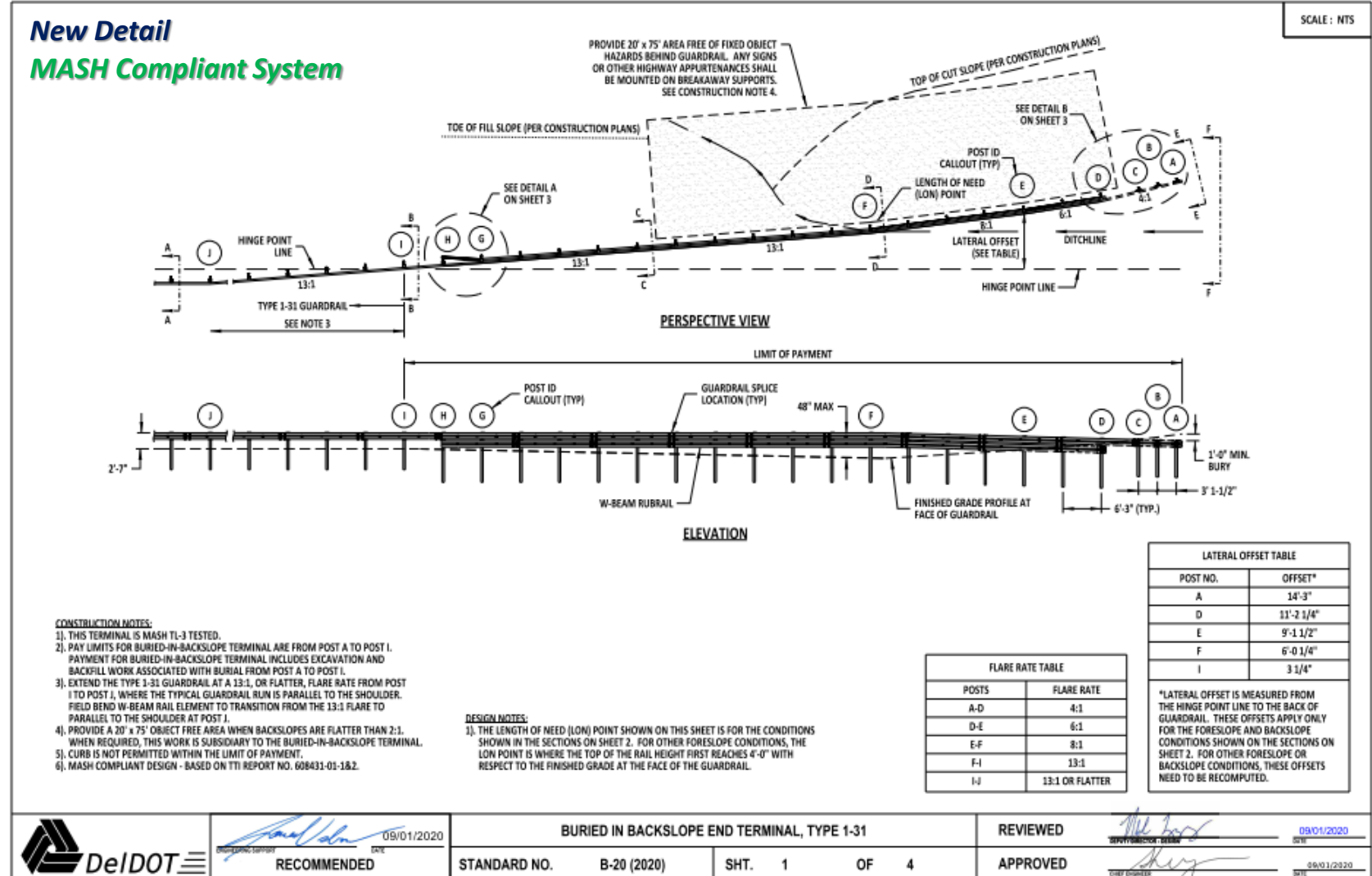
Detail B-7 required to transition from 27" to 31" approaching curved guardrail section

NCHRP 350 Compliant System



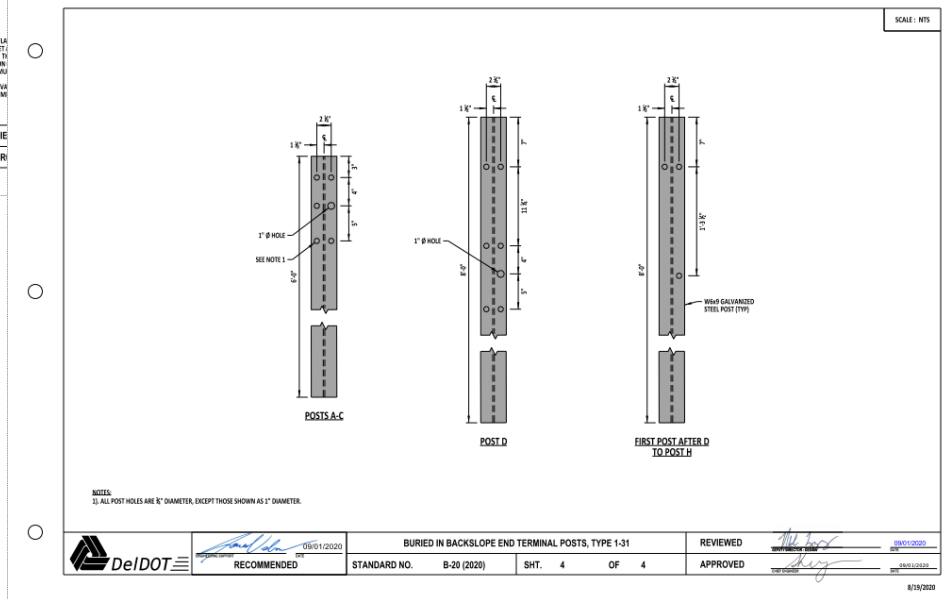
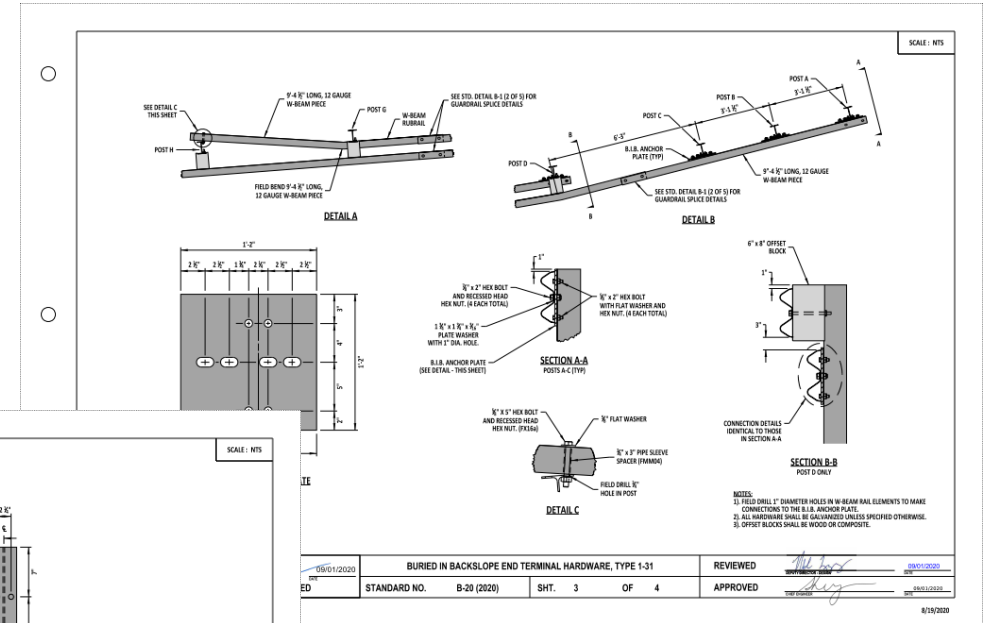
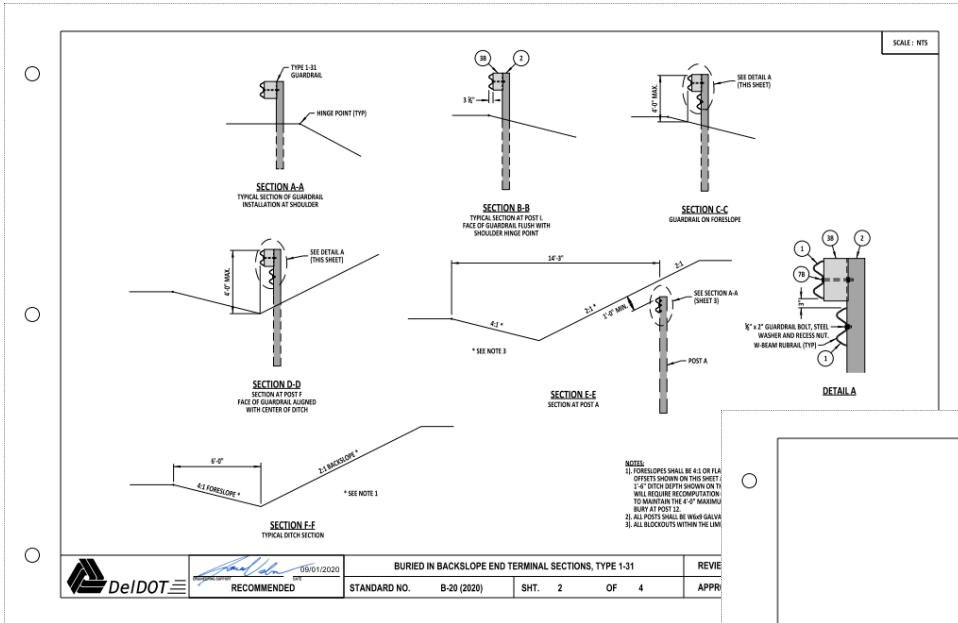
Buried End Section

- Detail B-20: Buried End Section



Buried End Section

Detail B-20: Buried End Section





Standard Construction Details: Concrete Barrier

Concrete Barrier Details

- Update Summary
 - Overall MASH compliance review
 - Resulted in elimination of existing concrete barrier details
 - Added new concrete barrier details
 - Address common Department uses
 - Minimizes need for project specific details
 - Roadside Concrete Barrier
 - 36" F-Shape, Single Face (Test Level 4)
 - 42" F-Shape, Single Face (Test Level 4)
 - Median Concrete Barrier
 - 32" F-Shape (Test Level 3)
 - 36" F-Shape (Test Level 4)
 - 42" F-Shape (Test Level 4)
 - 42" Single Slope (Test Level 5)
 - Designs based on available MASH crash testing and appropriate structural analyses



Whitman, Requardt & Associates, LLP
Engineers · Architects · Environmental Planners Est. 1915

MEMORANDUM

Date: July 21, 2020

To: James Osborne, DelDOT

From: David Nizamoff, P.E.
Adam Weiser, P.E., PTOE, RSP

Subject: DelDOT Concrete Barrier Standard Construction Details

CC: Jeff VanHorn, DelDOT Safety
Mark Buckalew, DelDOT Construction
Barry Benton, GPI

Work Order Number: 032197.001

Contract Number: N/A

Project: DelDOT MASH Standard Construction Details Update

In 2009, the American Association of State Highway Transportation Officials (AASHTO) published the *Manual for Assessing Safety Hardware (MASH)* which superseded NCHRP Report 350 *Recommended Procedure for Safety Performance Evaluation of Highway Features* as the guidelines for roadside safety hardware performance evaluation. In 2016, AASHTO published the second edition of MASH as well as agreed to a joint implementation agreement with the Federal Highway Administration (FHWA). The joint implementation agreement outlined the sunset dates for NCHRP 350 compliant roadside safety hardware and sunrise dates for MASH 2016 compliant roadside safety hardware for projects on the National Highway System (NHS). The agreement stated that "all w-beam and cast-in-place concrete barriers" would be MASH 2016 compliant for contracts let after December 31, 2017.

On May 26, 2017, the FHWA issued an open letter to the states which stated that "The FHWA's Federal-aid eligibility letters are provided as a service to the States and are not a requirement for roadside safety hardware to be eligible for federal-aid reimbursement." This letter also went on to state, "Since its official launch, questions about the AASHTO MASH criteria have been identified by a range of stakeholders. Until such time these questions are answered, and the transportation community has more experience with AASHTO MASH requirements, FHWA will require manufacturers and States to run all AASHTO MASH recommended crash tests in order to qualify for a FHWA Federal-aid eligibility letter." In addition, a letter from the FHWA to its Division Administrators issued on April 8, 2019 stated that "An eligibility letter is not a requirement for roadside safety hardware to be determined eligible for Federal funding. Roadside safety hardware is eligible for Federal funding if it has been determined to be crashworthy by the user agency (i.e., State DOT)." Both letters are attached to this memorandum.

DelDOT's Engineering Support section has been working to update all guardrail and barrier standard construction details to be MASH compliant. DelDOT historically has maintained standard construction details for cast-in-place and slip formed 32-inch tall F-shape concrete median barriers. The Department desires to add 36-inch and 42-inch F-shape median and roadside barriers and a 42-inch single slope barrier to its standard construction details. The purpose of this memorandum is to document the development of the new concrete barrier standard construction details and to provide a recommendation as to their crashworthiness in accordance with MASH standards.

Summary of testing on height determination by Test Levels: The Texas Transportation Institute (TTI) conducted research regarding bridge railing and barrier heights based on MASH crash testing procedures. Report TTI 9-1002.05¹ found that the minimum height for a Test Level 4 bridge railing or barrier is 36-inches. The research conducted a full-scale crash test on a 36-inch tall single slope bridge railing. The test, conducted using a single-unit truck, was passed successfully. The report indicates that while a single sloped barrier was used in the testing, the results are considered applicable to other safety shapes, e.g. the New Jersey shape and F-shape profiles. Based on this information, it was determined for the purposes of DelDOT's Standard Construction Details, the minimum height for a TL-4 barrier would be 36-inches for median and roadside applications. In addition, a 42-inch tall TL-4 barrier detail was developed for

¹ TTI Report 9-1002.05 <https://static.tti.tamu.edu/tti.tamu.edu/documents/9-1002-5.pdf>

1013 Centre Road, Suite 302

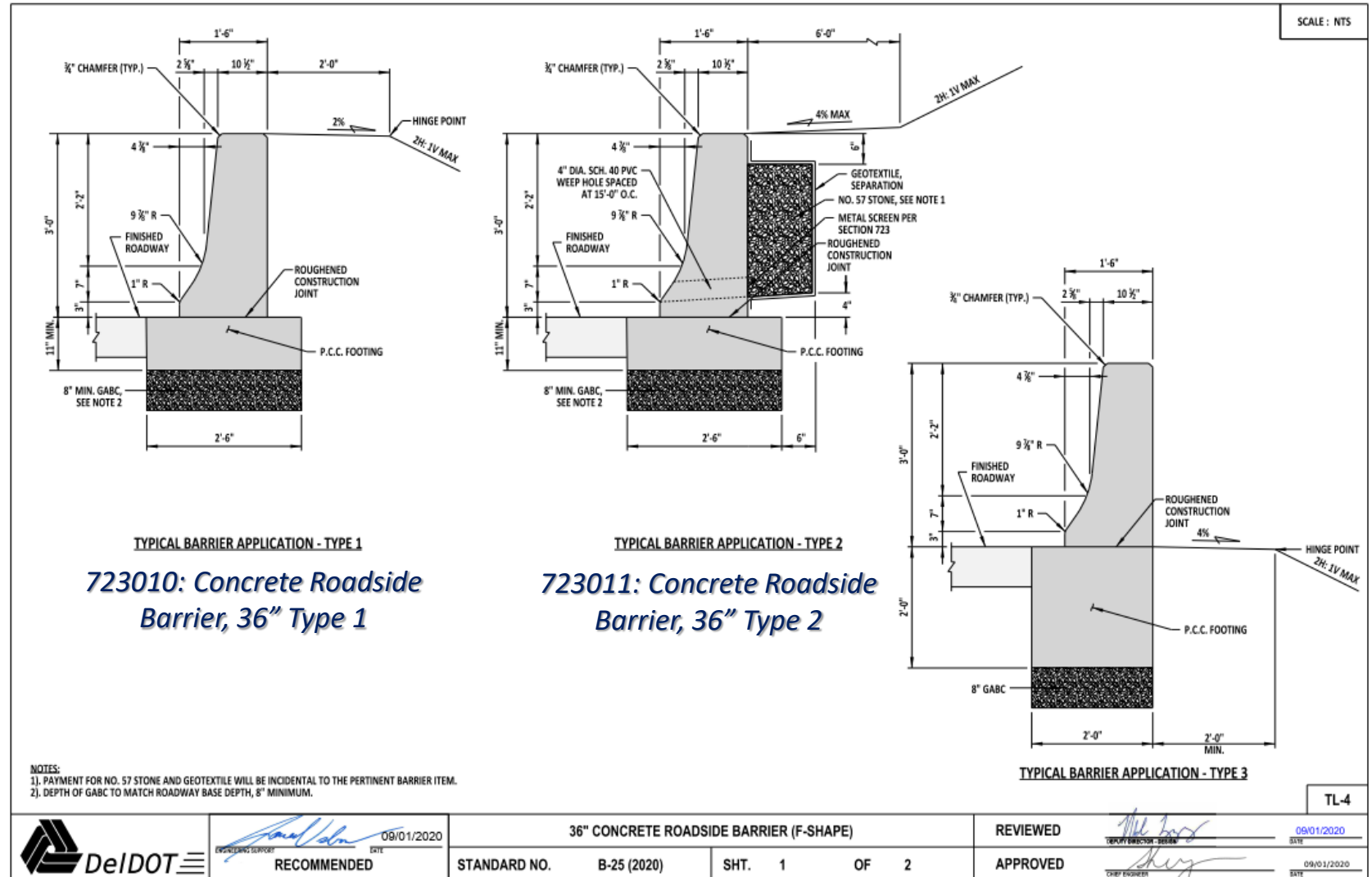
Wilmington, Delaware 19805

www.wraillp.com · Phone: 302.571.9001 · Fax: 302.571.9011

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Concrete Roadside Barriers

- Detail B-25: 36" Concrete Roadside Barrier (F-Shape)
 - Test Level 4
 - 3 application options
 - Cast-in-place or slip form
 - Reinforcement shown on Sheet 2



RECOMMENDED
 DATE: 09/01/2020

36" CONCRETE ROADSIDE BARRIER (F-SHAPE)
 STANDARD NO. B-25 (2020) SHT. 1 OF 2

REVIEWED [Signature] DATE: 09/01/2020
 APPROVED [Signature] DATE: 09/01/2020

Concrete Roadside Barriers

- Detail B-25: 36" Concrete Roadside Barrier (F-Shape)
 - Test Level 4
 - 3 application options
 - Cast-in-place or slip form
 - Reinforcement shown on Sheet 2

SCALE: NTS

ELEVATION

SECTION - REINFORCEMENT

NOTES:

- 1). CONCRETE CLEAR COVER FOR REINFORCEMENT BARS SHALL BE 2" MINIMUM, UNLESS NOTED OTHERWISE.
- 2). BARRIER CONTRACTION JOINTS OVER EXISTING PAVEMENT CONTRACTION JOINTS SHALL BE SEPARATED BY OPEN JOINTS HAVING THE SAME WIDTH AS THE PAVEMENT JOINTS FOR THE FULL EXPOSED SURFACE OF THE BARRIER.
- 3). BARRIER CONTRACTION JOINTS SHALL BE A GROOVE 1/4" WIDE AND 1/2" DEEP, SAWED OR FORMED ACROSS THE TOP AND ALONG THE SIDES FOR THE ENTIRE SURFACE OF THE BARRIER, OR A FULL DEPTH BUTT JOINT, AT APPROXIMATELY 10'-0" TO 20'-0" INTERVALS ALONG THE LENGTH OF THE BARRIER. IN ADDITION, THESE GROOVED OR BUTT JOINTS SHALL TRANSVERSELY ALIGN, WITH THE CONTRACTION JOINTS IN ABUTTING CONCRETE PAVEMENT.
- 4). EXPANSION JOINTS SHALL BE PLACED IN THE BARRIER AT STRUCTURES AND OTHER EXPANSION JOINTS IN ABUTTING CONCRETE PAVEMENT, OVER EXISTING EXPANSION JOINTS IN UNDERLYING CONCRETE PAVEMENT, AND LOCATIONS AS SHOWN ON THE PLANS OR AS DIRECTED BY THE ENGINEER. AT EXPANSION JOINTS, BARRIER SECTIONS SHALL BE 1/2" APART AND THE OPENING FILLED, FOR THE ENTIRE LENGTH AND DEPTH OF THE JOINT WITH 1/2" PREFORMED JOINT FILLER WHICH COMPLIES WITH THE REQUIREMENTS OF SECTION 1042 OF THE STANDARD SPECIFICATIONS. THE FILLER SHALL BE RECESSED 1/4" IN FROM THE SIDES AND TOP OF THE BARRIER.
- 5). AT EACH END OF THE BARRIER INSTALLATIONS, THE BARRIER SHALL BE ADEQUATELY TERMINATED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.
- 6). FOR SLIP-FORM CONSTRUCTION, THE SB2E BARS SHALL BE PLACED AS ONE CONTINUOUS PIECE. THE BARS SHALL LAP A MINIMUM OF 2'-10 1/2".
- 7). FOR SLIP-FORM CONSTRUCTION, A CONTROL JOINT SHALL BE CUT IN THE BARRIER EVERY 10'-0" AT A MAXIMUM DEPTH OF 1/2".
- 8). DIAGONAL NO. 4 BARS ONLY REQUIRED WHEN USING SLIP-FORM CONSTRUCTION. DIAGONAL NO. 4 BARS NOT SHOWN IN SECTION VIEW.

| BAR SCHEDULE | | | | | | | | | | |
|--------------|------|--------------------------|-----------|------|-------|--------|-----------|--------|-------|-----|
| MARK | SIZE | NUMBER PER 20' SECTION * | LENGTH * | TYPE | B | C | D | J | K | O |
| SB1E | 5 | 29 | 7'-5 1/2" | T15 | 3'-6" | 6 3/8" | 3'-6 3/8" | 4 3/8" | 3'-6" | 11" |
| SB2E | 5 | 8 | 19'-8" | STR. | - | - | - | - | - | - |

* NUMBER OF SB1E BARS AND LENGTH OF SB2E BARS GIVEN FOR 20'-0" SECTIONS. NUMBER AND LENGTH OF BARS SHALL BE ADJUSTED ACCORDINGLY FOR SECTION LENGTHS BETWEEN 10'-0" AND 20'-0".

TYPE T15 BAR

09/01/2020

RECOMMENDED

36" CONCRETE ROADSIDE BARRIER (F-SHAPE)

STANDARD NO. B-25 (2020) SHT. 2 OF 2

REVIEWED

APPROVED

09/01/2020

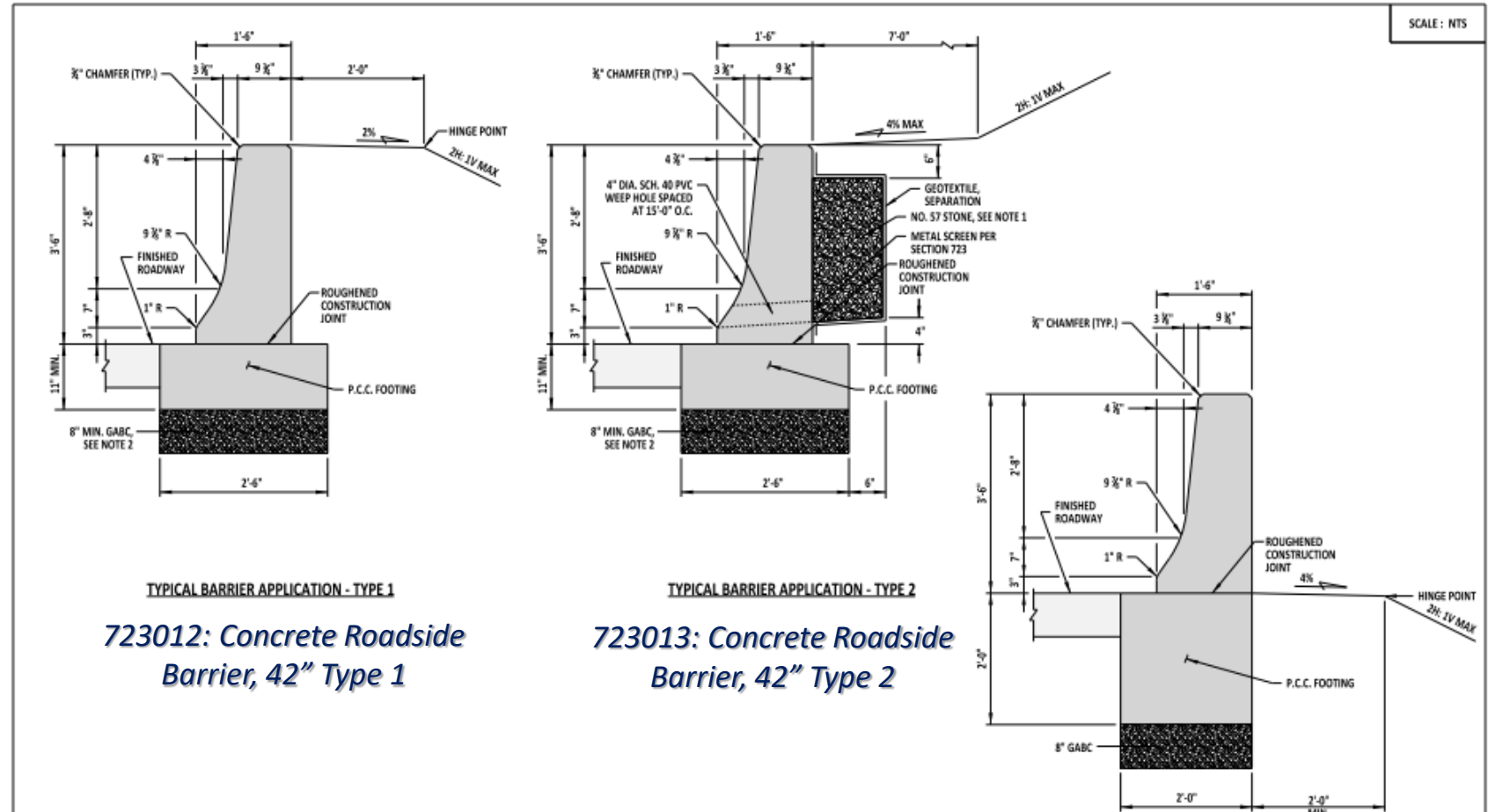
09/01/2020

TL-4



Concrete Roadside Barriers

- Detail B-26: 42" Concrete Roadside Barrier (F-Shape)
 - Test Level 4
 - 3 application options
 - Cast-in-place or slip form
 - Reinforcement shown on Sheet 2



NOTES:
 1). PAYMENT FOR NO. 57 STONE AND GEOTEXTILE WILL BE INCIDENTAL TO THE PERTINENT BARRIER ITEM.
 2). DEPTH OF GABC TO MATCH ROADWAY BASE DEPTH, 8" MINIMUM.

| | | | | |
|--|---------------------------|---|----------------------|----------------------|
| | 09/01/2020 RECOMMENDED | 42" CONCRETE ROADSIDE BARRIER (F-SHAPE) | | REVIEWED 09/01/2020 |
| | STANDARD NO. B-26 (2020) | SHT. 1 OF 2 | APPROVED 09/01/2020 | TL-4 |



Concrete Roadside Barriers

- Detail B-26: 42" Concrete Roadside Barrier (F-Shape)
 - Test Level 4
 - 3 application options
 - Cast-in-place or slip form
 - Reinforcement shown on Sheet 2

SCALE: NTS

ELEVATION

SECTION - REINFORCEMENT

NOTES:

- 1). CONCRETE CLEAR COVER FOR REINFORCEMENT BARS SHALL BE 2" MINIMUM, UNLESS NOTED OTHERWISE.
- 2). BARRIER CONTRACTION JOINTS OVER EXISTING PAVEMENT CONTRACTION JOINTS SHALL BE SEPARATED BY OPEN JOINTS HAVING THE SAME WIDTH AS THE PAVEMENT JOINTS FOR THE FULL EXPOSED SURFACE OF THE BARRIER.
- 3). BARRIER CONTRACTION JOINTS SHALL BE A GROOVE 3/8" WIDE AND 1/2" DEEP, SAWED OR FORMED ACROSS THE TOP AND ALONG THE SIDES FOR THE ENTIRE SURFACE OF THE BARRIER, OR A FULL DEPTH BUTT JOINT, AT APPROXIMATELY 10'-0" TO 20'-0" INTERVALS ALONG THE LENGTH OF THE BARRIER. IN ADDITION, THESE GROOVED OR BUTT JOINTS SHALL TRANSVERSELY ALIGN, WITH THE CONTRACTION JOINTS IN ABUTTING CONCRETE PAVEMENT.
- 4). EXPANSION JOINTS SHALL BE PLACED IN THE BARRIER AT STRUCTURES AND OTHER EXPANSION JOINTS IN ABUTTING CONCRETE PAVEMENT, OVER EXISTING EXPANSION JOINTS IN UNDERLYING CONCRETE PAVEMENT, AND LOCATIONS AS SHOWN ON THE PLANS OR AS DIRECTED BY THE ENGINEER. AT EXPANSION JOINTS, BARRIER SECTIONS SHALL BE 3/8" APART AND THE OPENING FILLED, FOR THE ENTIRE LENGTH AND DEPTH OF THE JOINT WITH 3/8" PREFORMED JOINT FILLER WHICH COMPLIES WITH THE REQUIREMENTS OF SECTION 1042 OF THE STANDARD SPECIFICATIONS. THE FILLER SHALL BE RECESSED 3/8" IN FROM THE SIDES AND TOP OF THE BARRIER.
- 5). AT EACH END OF THE BARRIER INSTALLATIONS, THE BARRIER SHALL BE ADEQUATELY TERMINATED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.
- 6). FOR SLIP-FORM CONSTRUCTION, THE 5B2E BARS SHALL BE PLACED AS ONE CONTINUOUS PIECE. THE BARS SHALL LAP A MINIMUM OF 2'-10 1/2".
- 7). FOR SLIP-FORM CONSTRUCTION, A CONTROL JOINT SHALL BE CUT IN THE BARRIER EVERY 10'-0" AT A MAXIMUM DEPTH OF 1/2".
- 8). DIAGONAL NO. 4 BARS ONLY REQUIRED WHEN USING SLIP-FORM CONSTRUCTION. DIAGONAL NO. 4 BARS NOT SHOWN IN SECTION VIEW.

TYPE T15 BAR

| BAR SCHEDULE | | | | | | | | | | |
|--------------|------|--------------------------|-----------|------|-------|----|-----------|----|-------|-----|
| MARK | SIZE | NUMBER PER 20' SECTION * | LENGTH * | TYPE | B | C | D | J | K | O |
| 5B1E | 5 | 29 | 8'-4 3/8" | T15 | 4'-0" | 6" | 4'-0 3/8" | 5" | 4'-0" | 11" |
| 5B2E | 5 | 10 | 19'-8" | STR. | - | - | - | - | - | - |

* NUMBER OF 5B1E BARS AND LENGTH OF 5B2E BARS GIVEN FOR 20'-0" SECTIONS. NUMBER AND LENGTH OF BARS SHALL BE ADJUSTED ACCORDINGLY FOR SECTION LENGTHS BETWEEN 10'-0" AND 20'-0".

TL-4



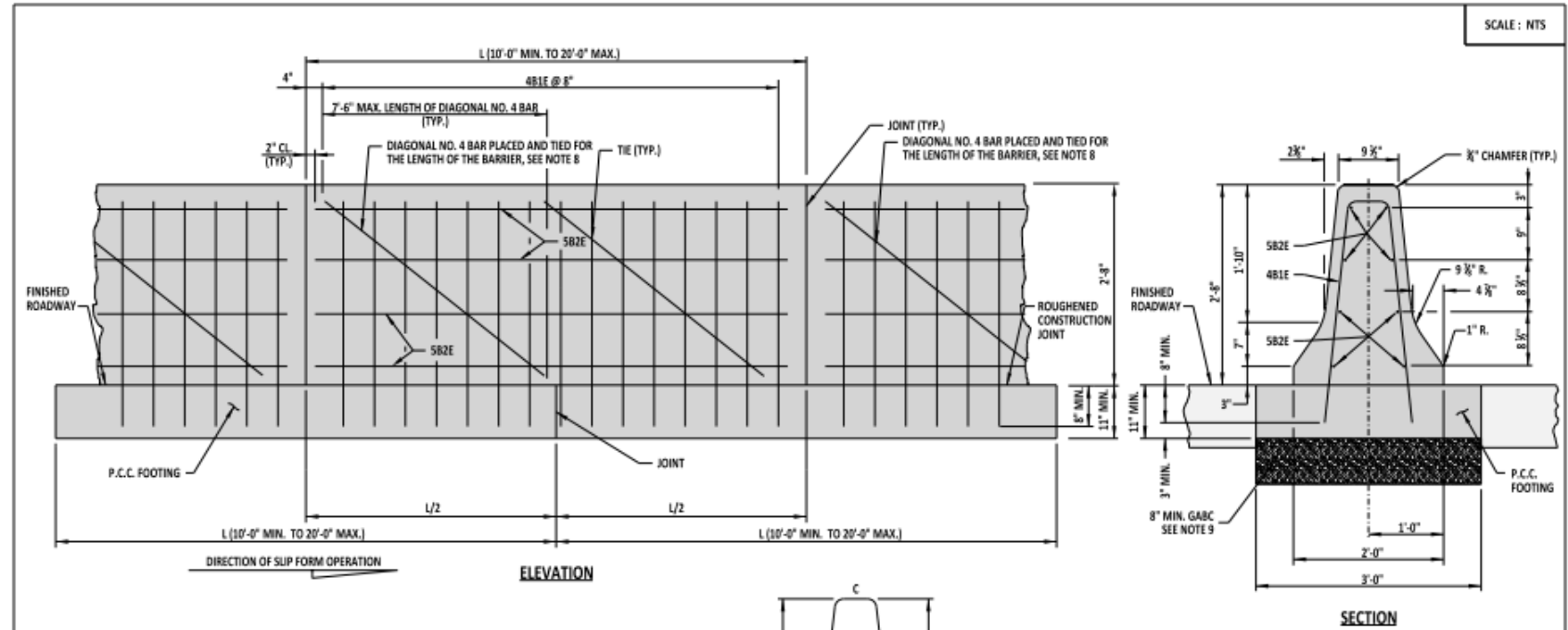
RECOMMENDED
DATE: 09/01/2020

STANDARD NO. B-26 (2020) SHT. 2 OF 2

REVIEWED
APPROVED
DATE: 09/01/2020

Concrete Median Barriers

- Detail B-27: 32" Concrete Median Barrier (F-Shape)
 - Test Level 3
 - Cast-in-place or slip form



- NOTES:**
- 1). CONCRETE CLEAR COVER FOR REINFORCEMENT BARS SHALL BE 2" MINIMUM, UNLESS OTHERWISE NOTED.
 - 2). BARRIER CONTRACTION JOINTS OVER EXISTING PAVEMENT CONTRACTION JOINTS SHALL BE SEPARATED BY OPEN JOINTS HAVING THE SAME WIDTH AS THE PAVEMENT JOINTS FOR THE FULL EXPOSED SURFACE OF THE BARRIER.
 - 3). BARRIER CONTRACTION JOINTS SHALL BE A GROOVE 1/2" WIDE AND 1/2" DEEP, SAWED OR FORMED ACROSS THE TOP AND ALONG THE SIDES FOR THE ENTIRE SURFACE OF THE BARRIER, OR A FULL DEPTH BUTT JOINT, AT APPROXIMATELY 10'-0" TO 20'-0" INTERVALS ALONG THE LENGTH OF THE BARRIER. IN ADDITION, THESE GROOVED OR BUTT JOINTS SHALL TRANSVERSELY ALIGN, WITH THE CONTRACTION JOINTS IN ABUTTING CONCRETE PAVEMENT.
 - 4). EXPANSION JOINTS SHALL BE PLACED IN THE BARRIER AT STRUCTURES AND OTHER EXPANSION JOINTS IN ABUTTING CONCRETE PAVEMENT, OVER EXISTING EXPANSION JOINTS IN UNDERLYING CONCRETE PAVEMENT, AND LOCATIONS AS SHOWN ON THE PLANS OR AS DIRECTED BY THE ENGINEER. AT EXPANSION JOINTS, BARRIER SECTIONS SHALL BE 3/4" APART AND THE OPENING FILLED, FOR THE ENTIRE LENGTH AND DEPTH OF THE JOINT WITH 1/2" PREFORMED JOINT FILLER WHICH COMPLIES WITH THE REQUIREMENTS OF SECTION 1042 OF THE STANDARD SPECIFICATIONS. THE FILLER SHALL BE RECESSED 1/4" IN FROM THE SIDES AND TOP OF THE BARRIER.
 - 5). AT EACH END OF THE BARRIER INSTALLATIONS, THE BARRIER SHALL BE ADEQUATELY TERMINATED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.
 - 6). FOR SLIP-FORM CONSTRUCTION, THE 5B2E BARS SHALL BE PLACED AS ONE CONTINUOUS PIECE. THE BARS SHALL LAP A MINIMUM OF 2'-10 3/4".
 - 7). FOR SLIP-FORM CONSTRUCTION, A CONTROL JOINT SHALL BE CUT IN THE BARRIER EVERY 10'-0" AT A MAXIMUM DEPTH OF 3/4".
 - 8). DIAGONAL NO. 4 BARS ONLY REQUIRED WHEN USING SLIP-FORM CONSTRUCTION. DIAGONAL NO. 4 BARS NOT SHOWN IN SECTION VIEW.
 - 9). DEPTH OF GABC TO MATCH ROADWAY BASE, 8" MINIMUM.

723002: Concrete Median Barrier, 32" F-Shape

| BAR SCHEDULE | | | | | | | | | | | |
|--------------|------|-------------------------|-----------|------|-----------|----|-----------|-------|----|-------|-------|
| MARK | SIZE | NUMBER PER 20' SECTION* | LENGTH* | TYPE | B | C | D | H | K | J | O |
| 4B1E | 4 | 29 | 6'-9 3/4" | DE10 | 3'-2 1/2" | 6" | 3'-2 1/2" | 3'-2" | 4" | 3'-2" | 1'-2" |
| 5B2E | 5 | 8 | 19'-6" | STR. | | | | | | | |

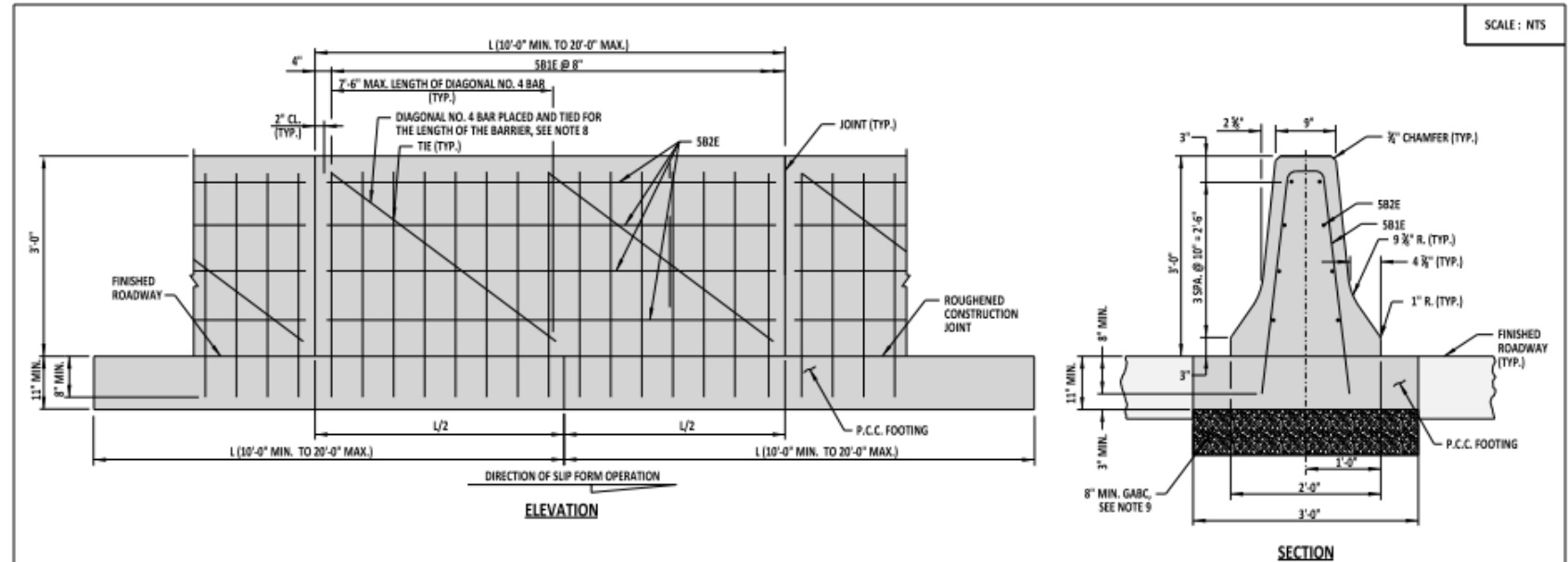
* NUMBER OF 4B1E BARS AND LENGTH OF 5B2E BARS GIVEN FOR 20'-0" SECTIONS. NUMBER AND LENGTH OF BARS SHALL BE ADJUSTED ACCORDINGLY FOR SECTION LENGTHS BETWEEN 10'-0" AND 20'-0".



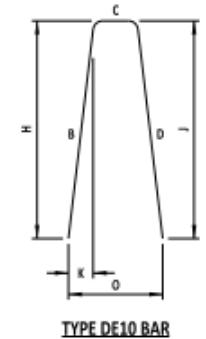
| | | | |
|--|-------------------------------------|---------------------------------------|----------------------------------|
| | DATE: 09/01/2020 RECOMMENDED | 32" CONCRETE MEDIAN BARRIER (F-SHAPE) | REVIEWED DATE: 09/01/2020 |
| | STANDARD NO. B-27 (2020) | SHT. 1 OF 1 | APPROVED DATE: 09/01/2020 |

Concrete Median Barriers

- Detail B-28: 36" Concrete Median Barrier (F-Shape)
 - Test Level 4
 - Cast-in-place or slip form



- NOTES:**
- 1). CONCRETE CLEAR COVER FOR REINFORCEMENT BARS SHALL BE 2" MINIMUM, UNLESS OTHERWISE NOTED.
 - 2). BARRIER CONTRACTION JOINTS OVER EXISTING PAVEMENT CONTRACTION JOINTS SHALL BE SEPARATED BY OPEN JOINTS HAVING THE SAME WIDTH AS THE PAVEMENT JOINTS FOR THE FULL EXPOSED SURFACE OF THE BARRIER.
 - 3). BARRIER CONTRACTION JOINTS SHALL BE A GROOVE 1/8" WIDE AND 1/8" DEEP, SAWED OR FORMED ACROSS THE TOP AND ALONG THE SIDES FOR THE ENTIRE SURFACE OF THE BARRIER, OR A FULL DEPTH BUTT JOINT, AT APPROXIMATELY 10'-0" TO 20'-0" INTERVALS ALONG THE LENGTH OF THE BARRIER. IN ADDITION, THESE GROOVED OR BUTT JOINTS SHALL TRANSVERSELY ALIGN, WITH THE CONTRACTION JOINTS IN ABUTTING CONCRETE PAVEMENT.
 - 4). EXPANSION JOINTS SHALL BE PLACED IN THE BARRIER AT STRUCTURES AND OTHER EXPANSION JOINTS IN ABUTTING CONCRETE PAVEMENT, OVER EXISTING EXPANSION JOINTS IN UNDERLYING CONCRETE PAVEMENT, AND LOCATIONS AS SHOWN ON THE PLANS OR AS DIRECTED BY THE ENGINEER. AT EXPANSION JOINTS, BARRIER SECTIONS SHALL BE 3/8" APART AND THE OPENING FILLED, FOR THE ENTIRE LENGTH AND DEPTH OF THE JOINT WITH 3/8" PREFORMED JOINT FILLER WHICH COMPLIES WITH THE REQUIREMENTS OF SECTION 1042 OF THE STANDARD SPECIFICATIONS. THE FILLER SHALL BE RECESSED 1/8" IN FROM THE SIDES AND TOP OF THE BARRIER.
 - 5). AT EACH END OF THE BARRIER INSTALLATIONS, THE BARRIER SHALL BE ADEQUATELY TERMINATED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.
 - 6). FOR SLIP-FORM CONSTRUCTION, THE SB2E BARS SHALL BE PLACED AS ONE CONTINUOUS PIECE. THE BARS SHALL LAP A MINIMUM OF 2'-10 1/2".
 - 7). FOR SLIP-FORM CONSTRUCTION, A CONTROL JOINT SHALL BE CUT IN THE BARRIER EVERY 10'-0" AT A MAXIMUM DEPTH OF 1/2".
 - 8). DIAGONAL NO. 4 BARS ONLY REQUIRED WHEN USING SLIP-FORM CONSTRUCTION. DIAGONAL NO. 4 BARS NOT SHOWN IN SECTION VIEW.
 - 9). DEPTH OF GABC TO MATCH ROADWAY BASE, 8" MINIMUM.



723014: Concrete Median Barrier, 36" F-Shape

| BAR SCHEDULE | | | | | | | | | | | |
|--------------|------|--------------------------|-----------|------|-----------|--------|-----------|-------|-------|--------|-----------|
| MARK | SIZE | NUMBER PER 20' SECTION * | LENGTH * | TYPE | B | C | D | H | J | K | O |
| SB1E | 5 | 29 | 7'-4 1/2" | DE10 | 3'-6 1/2" | 5 1/2" | 3'-6 1/2" | 3'-6" | 3'-6" | 4 1/2" | 1'-1 1/2" |
| SB2E | 5 | 8 | 19'-8" | STR. | - | - | - | - | - | - | - |

* NUMBER OF SB1E BARS AND LENGTH OF SB2E BARS GIVEN FOR 20'-0" SECTIONS. NUMBER AND LENGTH OF BARS SHALL BE ADJUSTED ACCORDINGLY FOR SECTION LENGTHS BETWEEN 10'-0" AND 20'-0".



RECOMMENDED
DATE: 09/01/2020

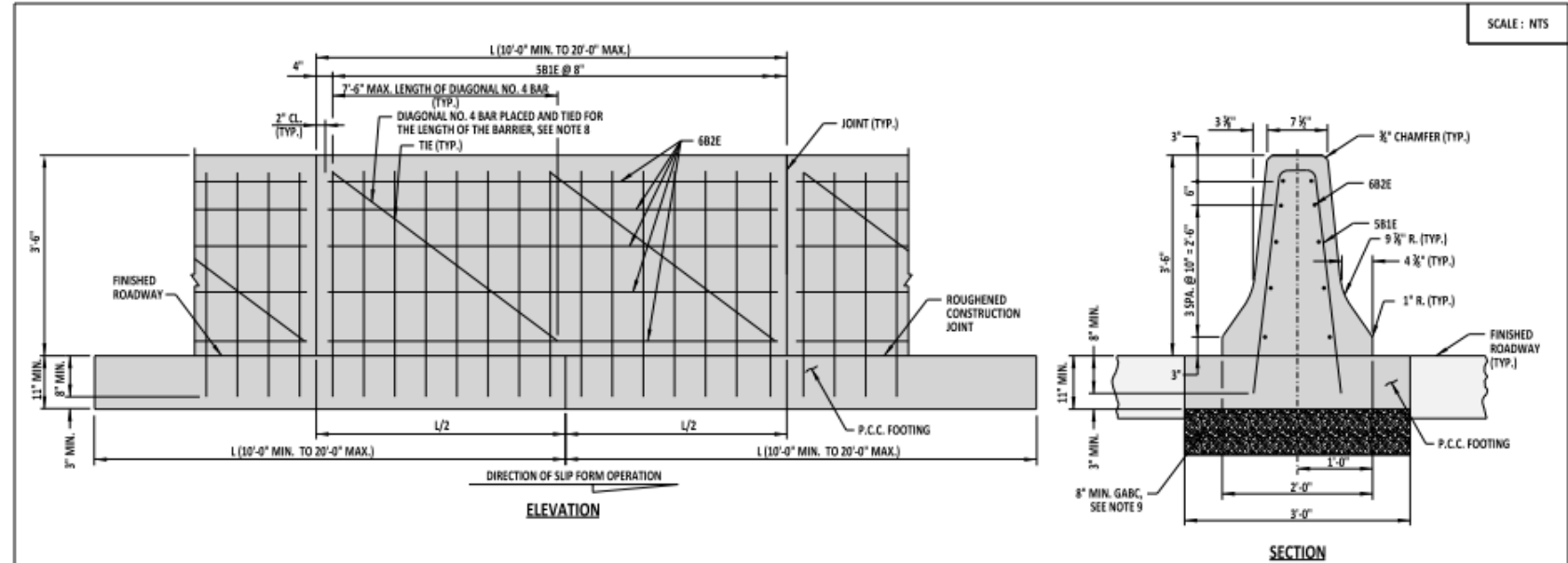
STANDARD NO. B-28 (2020) SHT. 1 OF 1
36" CONCRETE MEDIAN BARRIER (F - SHAPE)

REVIEWED
APPROVED
DATE: 09/01/2020

TL-4

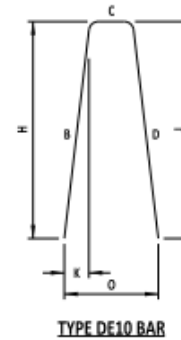
Concrete Median Barriers

- Detail B-28: 42" Concrete Median Barrier (F-Shape)
 - Test Level 4
 - Cast-in-place or slip form



NOTES:

1. CONCRETE CLEAR COVER FOR REINFORCEMENT BARS SHALL BE 2" MINIMUM, UNLESS OTHERWISE NOTED.
2. BARRIER CONTRACTION JOINTS OVER EXISTING PAVEMENT CONTRACTION JOINTS SHALL BE SEPARATED BY OPEN JOINTS HAVING THE SAME WIDTH AS THE PAVEMENT JOINTS FOR THE FULL EXPOSED SURFACE OF THE BARRIER.
3. BARRIER CONTRACTION JOINTS SHALL BE A GROOVE 1/4" WIDE AND 1/2" DEEP, SAWED OR FORMED ACROSS THE TOP AND ALONG THE SIDES FOR THE ENTIRE SURFACE OF THE BARRIER, OR A FULL DEPTH BUTT JOINT, AT APPROXIMATELY 10'-0" TO 20'-0" INTERVALS ALONG THE LENGTH OF THE BARRIER. IN ADDITION, THESE GROOVED OR BUTT JOINTS SHALL TRANSVERSELY ALIGN, WITH THE CONTRACTION JOINTS IN ABUTTING CONCRETE PAVEMENT.
4. EXPANSION JOINTS SHALL BE PLACED IN THE BARRIER AT STRUCTURES AND OTHER EXPANSION JOINTS IN ABUTTING CONCRETE PAVEMENT, OVER EXISTING EXPANSION JOINTS IN UNDERLYING CONCRETE PAVEMENT, AND LOCATIONS AS SHOWN ON THE PLANS OR AS DIRECTED BY THE ENGINEER. AT EXPANSION JOINTS, BARRIER SECTIONS SHALL BE 1/2" APART AND THE OPENING FILLED, FOR THE ENTIRE LENGTH AND DEPTH OF THE JOINT WITH 1/2" PREFORMED JOINT FILLER WHICH COMPLIES WITH THE REQUIREMENTS OF SECTION 1042 OF THE STANDARD SPECIFICATIONS. THE FILLER SHALL BE RECESSED 1/2" IN FROM THE SIDES AND TOP OF THE BARRIER.
5. AT EACH END OF THE BARRIER INSTALLATIONS, THE BARRIER SHALL BE ADEQUATELY TERMINATED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.
6. FOR SLIP-FORM CONSTRUCTION, THE 6B2E BARS SHALL BE PLACED AS ONE CONTINUOUS PIECE. THE BARS SHALL LAP A MINIMUM OF 3'-9".
7. FOR SLIP-FORM CONSTRUCTION, A CONTROL JOINT SHALL BE CUT IN THE BARRIER EVERY 10'-0" AT A MAXIMUM DEPTH OF 1/2".
8. DIAGONAL NO. 4 BARS ONLY REQUIRED WHEN USING SLIP-FORM CONSTRUCTION. DIAGONAL NO. 4 BARS NOT SHOWN IN SECTION VIEW.
9. DEPTH OF GABC TO MATCH ROADWAY BASE, 8" MINIMUM.



723015: Concrete Median Barrier, 42" F-Shape

| BAR SCHEDULE | | | | | | | | | | | |
|--------------|------|--------------------------|----------|------|-----------|----|-----------|-------|-------|----|-------|
| MARK | SIZE | NUMBER PER 20' SECTION * | LENGTH * | TYPE | B | C | D | H | J | K | O |
| 5B1E | 5 | 29 | 8'-3" | DE10 | 4'-0 1/2" | 4" | 4'-0 1/2" | 4'-0" | 4'-0" | 5" | 1'-2" |
| 6B2E | 6 | 10 | 19'-8" | STR. | - | - | - | - | - | - | - |

* NUMBER OF 5B1E BARS AND LENGTH OF 6B2E BARS GIVEN FOR 20'-0" SECTIONS. NUMBER AND LENGTH OF BARS SHALL BE ADJUSTED ACCORDINGLY FOR SECTION LENGTHS BETWEEN 10'-0" AND 20'-0".



RECOMMENDED
DATE: 09/01/2020

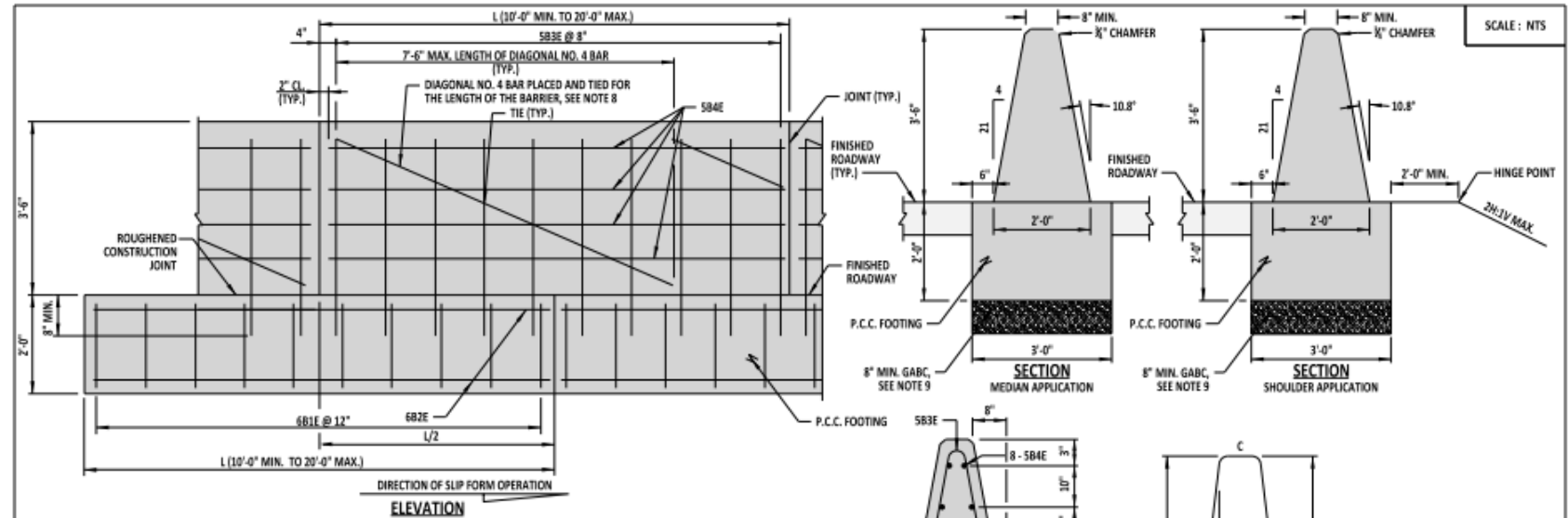
STANDARD NO. B-29 (2020) SHT. 1 OF 1

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APPROVED [Signature] 09/01/2020

TL-4

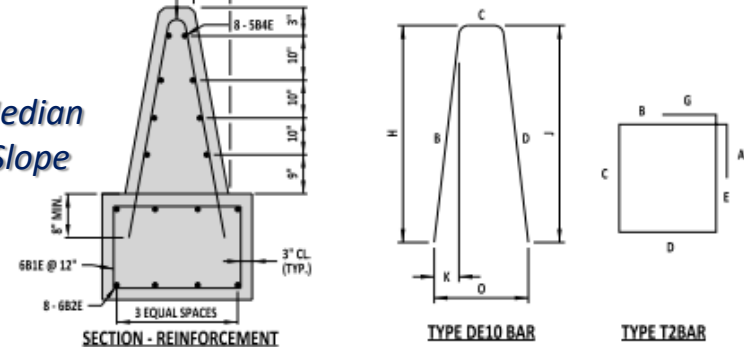
Concrete Median Barriers

- Detail B-28: 42" Concrete Median Barrier (Single Slope)
 - Test Level 5
 - Cast-in-place or slip form
 - Footing requires reinforcement
 - Only for Interstates, freeways and expressways



723016: Concrete Median Barrier, 42" Single Slope

- NOTES:**
1. CONCRETE CLEAR COVER FOR REINFORCEMENT BARS SHALL BE 2" MINIMUM, UNLESS NOTED OTHERWISE.
 2. BARRIER CONTRACTION JOINTS OVER EXISTING PAVEMENT CONTRACTION JOINTS SHALL BE SEPARATED BY OPEN JOINTS HAVING THE SAME WIDTH AS THE PAVEMENT JOINTS FOR THE FULL EXPOSED SURFACE OF THE BARRIER.
 3. BARRIER CONTRACTION JOINTS SHALL BE A GROOVE 1/2" WIDE AND 1/2" DEEP, SAWS OR FORMED ACROSS THE TOP AND ALONG THE SIDES FOR THE ENTIRE SURFACE OF THE BARRIER, OR A FULL DEPTH BUTT JOINT, AT APPROXIMATELY 10'-0" TO 20'-0" INTERVALS ALONG THE LENGTH OF THE BARRIER. IN ADDITION, THESE GROOVED OR BUTT JOINTS SHALL TRANSVERSELY ALIGN, WITH THE CONTRACTION JOINTS IN ABUTTING CONCRETE PAVEMENT.
 4. EXPANSION JOINTS SHALL BE PLACED IN THE BARRIER AT STRUCTURES AND OTHER EXPANSION JOINTS IN ABUTTING CONCRETE PAVEMENT, OVER EXISTING EXPANSION JOINTS IN UNDERLYING CONCRETE PAVEMENT, AND LOCATIONS AS SHOWN ON THE PLANS OR AS DIRECTED BY THE ENGINEER. AT EXPANSION JOINTS, BARRIER SECTIONS SHALL BE 1/2" APART AND THE OPENING FILLED, FOR THE ENTIRE LENGTH AND DEPTH OF THE JOINT WITH 3/8" PREFORMED JOINT FILLER WHICH COMPLIES WITH THE REQUIREMENTS OF SECTION 1042 OF THE STANDARD SPECIFICATIONS. THE FILLER SHALL BE RECESSED 1/2" IN FROM THE SIDES AND TOP OF THE BARRIER.
 5. AT EACH END OF THE BARRIER INSTALLATIONS, THE BARRIER SHALL BE ADEQUATELY TERMINATED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.
 6. FOR SLIP-FORM CONSTRUCTION, THE 6B2E AND 5B4E BARS SHALL BE PLACED AS ONE CONTINUOUS PIECE. THE BARS SHALL LAP A MINIMUM OF 3'-5 1/2" AND 2'-10 1/2" RESPECTIVELY.
 7. FOR SLIP-FORM CONSTRUCTION, A CONTROL JOINT SHALL BE CUT IN THE BARRIER EVERY 10'-0" AT A MAXIMUM DEPTH OF 3/8".
 8. DIAGONAL NO. 4 BARS ONLY REQUIRED WHEN USING SLIP-FORM CONSTRUCTION. DIAGONAL NO. 4 BARS NOT SHOWN IN SECTION VIEW.
 9. DEPTH OF GABC TO MATCH ROADWAY BASE, 8" MINIMUM.
 10. THIS BARRIER TO BE ONLY BE USED ON INTERSTATES, FREEWAYS AND EXPRESSWAYS.



| | | BAR SCHEDULE | | | | | | | | | | | | |
|------|------|--------------------------|----------|------|-------|-------|--------|-------|-------|-------|-------|-------|----|--------|
| MARK | SIZE | NUMBER PER 20' SECTION * | LENGTH * | TYPE | A | B | C | D | E | G | H | J | K | O |
| 6B1E | 6 | 20 | 10'-0" | T2 | 1'-0" | 2'-6" | 1'-6" | 2'-6" | 1'-6" | 1'-0" | - | - | - | - |
| 6B2E | 6 | 8 | 19'-6" | STR. | - | - | - | - | - | - | - | - | - | - |
| 5B3E | 5 | 29 | 8'-5" | DE10 | - | 4'-1" | 4 1/2" | 4'-1" | - | - | 4'-0" | 4'-0" | 9" | 1'-11" |
| 5B4E | 5 | 8 | 19'-8" | STR. | - | - | - | - | - | - | - | - | - | - |

* NUMBER OF 6B1E AND 6B2E BARS AND LENGTH OF 6B2E AND 5B4E BARS GIVEN FOR 20'-0" SECTIONS. NUMBER AND LENGTH OF BARS SHALL BE ADJUSTED ACCORDINGLY FOR SECTION LENGTHS BETWEEN 10'-0" AND 20'-0".



| | | | |
|--|---------------------------|-------------------------------------|----------------------|
| | 09/01/2020 RECOMMENDED | 42" CONCRETE BARRIER (SINGLE SLOPE) | REVIEWED 09/01/2020 |
| | STANDARD NO. B-30 (2020) | SHT. 1 OF 1 | APPROVED 09/01/2020 |

Topics Covered

- Morning Session
 - Standard Specifications Update – Guardrail and Barrier
- Afternoon Session
 - Crash Testing and MASH
 - DeIDOT's MASH Compliance
 - Roadside Design Considerations
 - Standard Construction Details – Guardrail
 - Standard Construction Details – Concrete Barrier



Thank you!

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