NORTH CAROLINA
Department of Transportation









NCDOT/ AGC Workshop
Roadway Breakout

Vickie Davis, PE

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

ROY COOPER
GOVERNOR

JAMES H. TROGDON, III
SECRETARY

May 12, 2017

TO: Division Engineers

FROM: M. L. Sylvester, PE
State Construction Engineer

SUBJECT: Snowplowable Pavement Markers

This is to request your assistance in evaluating current and future work zones for the presence of snowplowable markers that may have traffic loading impacts when lane shifts and other temporary traffic control phases are implemented. Our typical practice has been to remove the lenses from the snowplowable markers so as not to create any conflicting guidance to the traveling public, while the castings have been allowed to remain in place.

All active work zones should be reviewed to determine if lane shifts, etc. have created instances where the castings that have been allowed to remain in place will have continual traffic loading impacts. In those cases, the contractor should be directed to remove the castings and repair any pavement damage. The resulting pavement damage from removal of the castings should be repaired prior to the end of the work day and in

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MLS:rmf

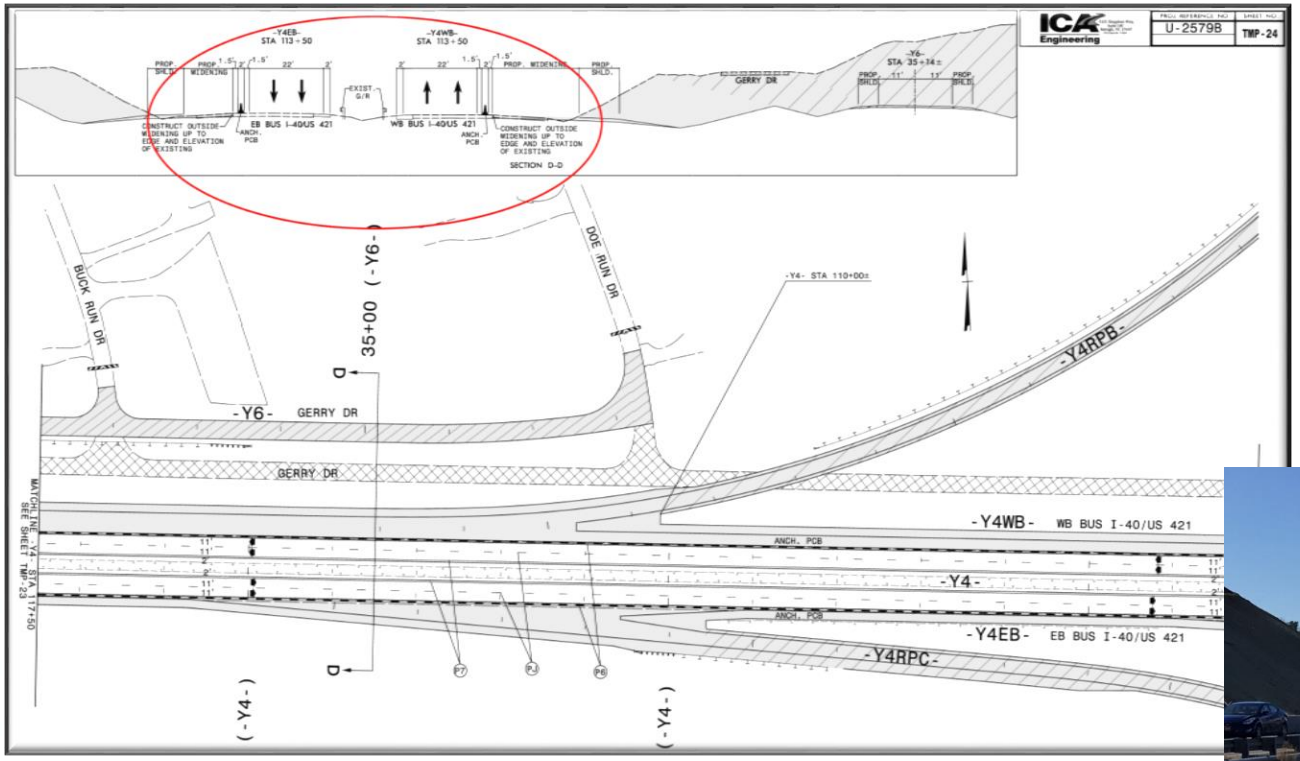
CC: M. L. Holder, PE, Chief Engineer
R. A. Hancock, PE, Deputy Chief Engineer
J. K. Lacy, PE, State Traffic Engineer

Mailing Address:
NC DEPARTMENT OF TRANSPORTATION
CONSTRUCTION UNIT
1543 MAIL SERVICE CENTER
RALEIGH, NC 27699-1543

Telephone: (919) 707-2400
Customer Service: 1-877-368-4968

Website: www.ncdot.gov

Location:
1 S. WILMINGTON STREET
RALEIGH, NC 27601



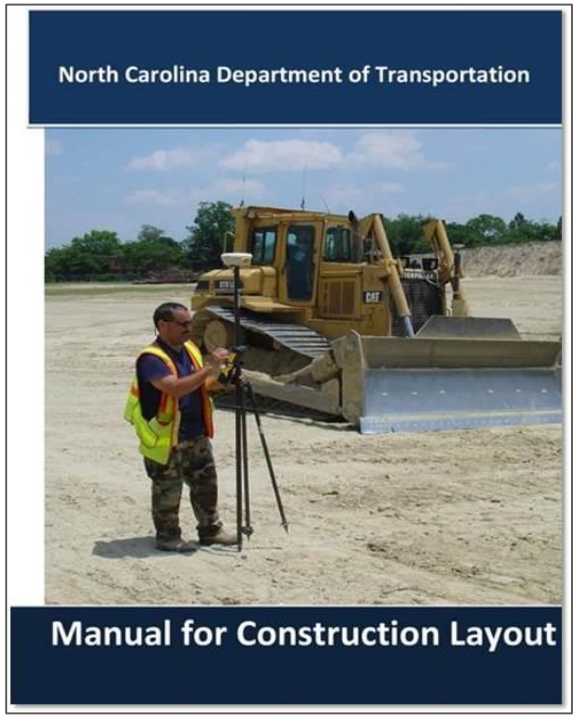
U-2579B Winston-Salem Northern Beltway

Existing Snowplowable Markers

Construction Surveying

- Conduct survey preconstruction meeting to discuss control and required submittals
- Will Contractor use Automated Machine Guidance? Submit AMG plan
- NCDOT Standard Specifications Section 801
- Manual for Construction Layout

TO BE REVISED 2018



Manual for Construction Layout

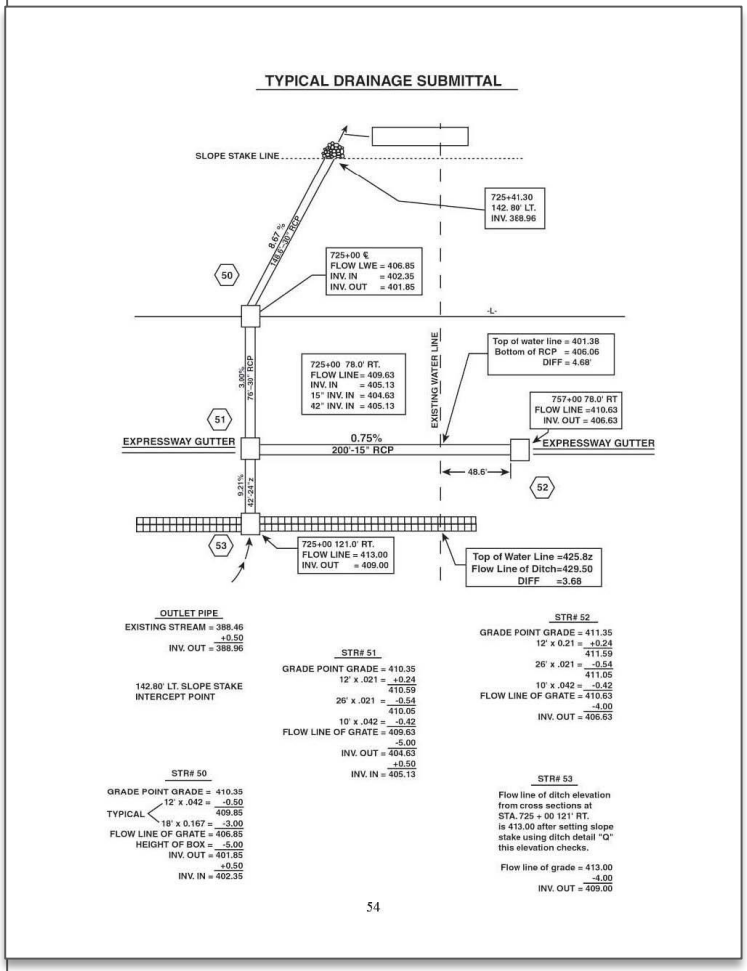
intended area of operation and the expected time period of occupancy. Crew members should be alert for backing equipment. When one is setting stakes, it is recommended to have a standing person close by to make the operation more visible and act as the eyes of the stake driver. If working beneath a construction operation, each crew member should wear an approved safety helmet. In some cases, the Prime Contractor may require the use of safety helmets while performing work within the project limits.

When stakeout is required adjacent to active travel lanes, extreme caution should be taken to protect the crew from oncoming traffic. Each member of the crew should stay alert and watch for potential hazardous situations. In addition, the appropriate traffic control measures should be installed. The stakeout crew will be exposed to the elements, insects and some poisonous plants. Therefore, the appropriate clothing should always be worn.

1.3 Required Submittals

Submit the following information to the Engineer for review and approval.

- A printout of horizontal verification, as well as coordinates, differences and error of closure.
- A printout of vertical control verification, with benchmark location elevations, and differences from plan elevations.
- Sketch of location of newly referenced horizontal control, with text printout of coordinates, method of reference and field notes associated with referencing control.
- Description of newly established benchmarks with location, elevation and closed loop survey field notes.
- The proposed method for recording information in field books to ensure clarity and adequacy.
- All updated electronic and manuscript survey records on a monthly basis.
- Two (2) copies of layout drawings for all utility construction systems.
- Two (2) copies of layout drawings for all drainage systems.
- Layout drawing for each structure and culvert.
- Computations for buildups over beams, screed grades and overhang form elevations.
- Sign S-Dimension information on an 11 ½ inch x 17 inch drawing depicting the theoretical finished section at each proposed overhead sign assembly location.
- Coordinate data showing differences between supplied baseline coordinates and field obtained GPS coordinates, including report detailing preliminary input data.
- Any proposed plan alteration to rectify a construction stakeout error, including design calculations, narrative and sealed drawings.
- Validation of right-of-way marker locations.
- Alignment of baseline for each borrow pit location.
- Detailed sketch of proposed overhead and Type A and B ground mounted sign locations along with any obstructions that may interfere with installation.
- Digital Terrain Model
- AMG Work Plan



Digital Terrain Models

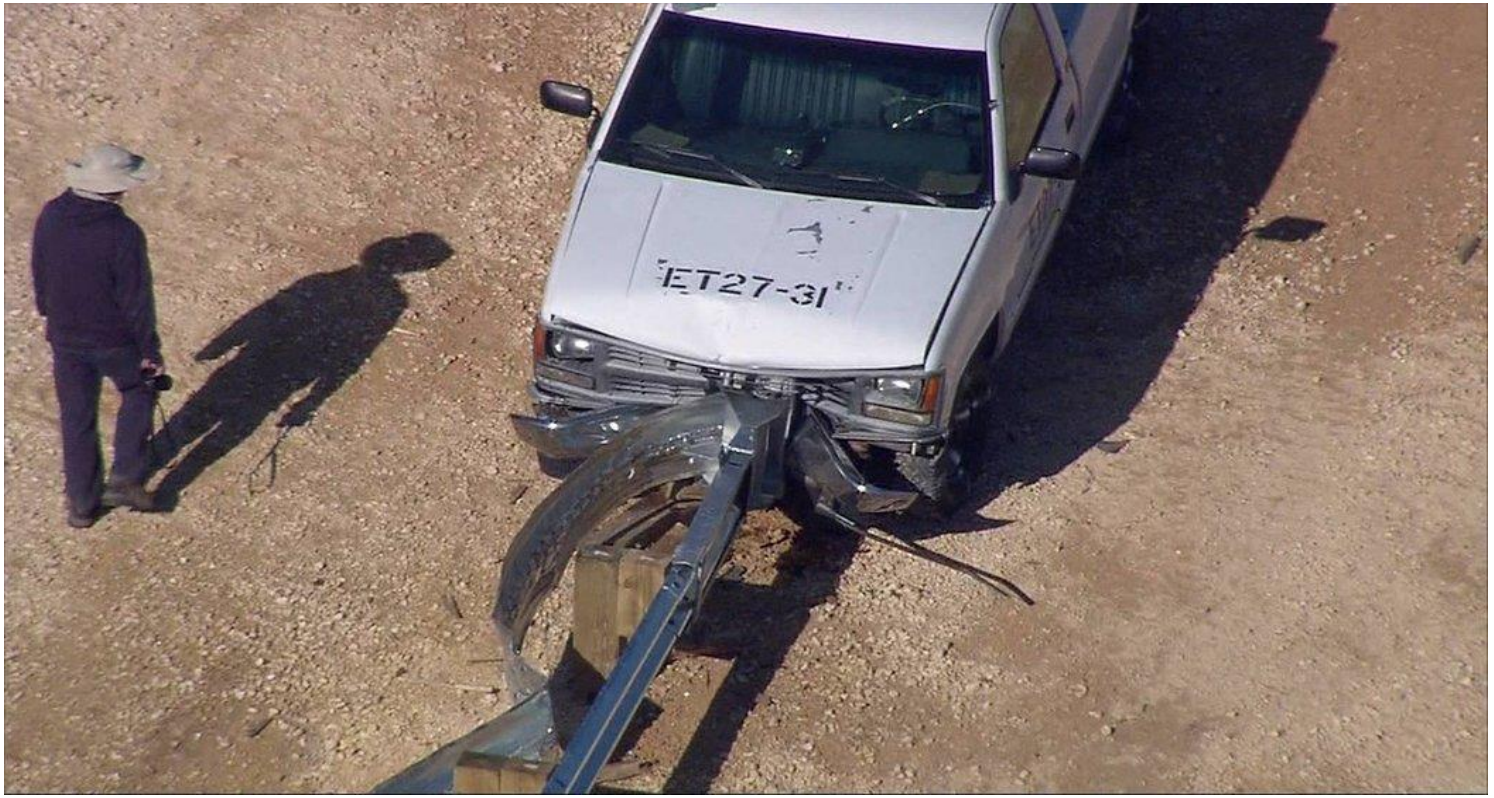
- If the Contractor elects to use Automated Machine Guidance, a Digital Terrain Model (DTM) shall be developed and submitted to the Engineer for review

- RE should consult with Division Locating Engineer who can assist with review of DTM

- RE offices will receive Trimble Business Center software; Location & Surveys Unit providing training

GUARDRAIL INSTALLATION- MASH 2016

HOW IS GUARDRAIL APPROVED??



- *Guardrail and terminals are crash tested in laboratory settings*
- *FHWA and AASHTO joint task force evaluated how terminals performed in real-world conditions using actual crash data*

Based on their findings…

- ✓ AASHTO's Manual for Assessing Safety Hardware was published in 2009
- ✓ Updated guidelines for crash testing permanent and temporary highway safety features including guardrail terminals

http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/ctrmeasures/mash/

History of Testing Procedures

- Procedures for crash testing have evolved

Highway Research Correlation Services Circular 482	1962
NCHRP Report 153	1974
NCHRP Report 230	1980
NCHRP Report 350	1993
AASHTO MASH is the newest and safest generation of roadside hardware.... Approved by FHWA in 2015	

The AASHTO Manual for Assessing Safety Hardware (MASH) is the new state of the practice for the crash testing of safety hardware devices for use on the National Highway System (NHS). It updates and replaces NCHRP Report 350.

Testing criteria for highway roadside hardware have been in place since 1962. NCHRP Report 350, *Recommended Procedures for the Safety Performance Evaluation of Highway Features*, has been the accepted method for safety hardware device testing and acceptance since 1993.

Key Points

1. *All new testing will be done following MASH evaluation techniques.*
2. *Hardware accepted under NCHRP Report 350 is appropriate for*

Topic	NCHRP 350	MASH
Small car test vehicle	820C vehicle (1,800 lbs.)	1100C vehicle (2,420 lbs.)
Small car impact angle	20 degrees	25 degrees
Light truck test vehicle	2000P vehicle (4,400 lbs.)	2270P vehicle (5,000 lbs.)
Gating terminals and crash cushion impact angle	15 degrees	5 degrees
Variable message signs and arrow board trailers	No mention	Added to TMA crash test matrix
Support structure and work zone traffic control device testing	Only small car tested	Small car and light truck tested
Windshield damage criteria	Subjective/Qualitative	Objective/Quantitative
Vehicle rebound in crash cushion tests	None	Required

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

ROY COOPER
GOVERNOR

JAMES H. TROGDON, III
SECRETARY

MEMO TO: John Sullivan, PE FHWA

FROM: T. M. Little, PE
Chief Engineer

DATE: September 11, 2017

SUBJECT: Roadside Safety Hardware – MASH-16 Implementation Plan

This memo outlines the Department's implementation plan for roadside safety hardware compliance with the 2016 edition of the AASHTO Manual for Assessing Safety Hardware (MASH-16). The plan includes the full integration of roadside safety hardware that are considered proprietary and are listed on the NCDOT's Approved Products List (APL) and non-proprietary items shown in the Roadway and Structures Standard

oadside safety hardware on

uly 1, 2017. MASH app
outlined:

1. All projects, centrally let or Division let with guardrail items, will be required et with GRAU-350 or contract and replaced

s will be amended to ment installations. t the new 2'-1" height equirement. When installing the GREU devices connecting to existing 1'-11" w-beam guardrail, an additional 25' of guardrail will be required to transition from the 2'-1" height down to the existing 1'-11" height. If the existing guardrail height is 1'-9", an additional 25' of guardrail will be required to transition from 2'-1" down to 1'-9" for a total of 50' of additional guardrail.

Mailing Address:
NC DEPARTMENT OF TRANSPORTATION
OFFICE OF THE CHIEF ENGINEER
MAIL SERVICE CENTER 1536
RALEIGH, NC 27699-1536

Telephone 919-707-2500
Fax: 919-733-9428
Customer Service: 1-877-368-4968

Website: www.ncdot.gov

Location:
1 SOUTH WILMINGTON STREET
RALEIGH, NC 27601

All projects, centrally let or Division let with guardrail items, will be required to install GREU devices. For projects that have been let with GRAU-350 or M-350 end units, those items will be removed from the c with MASH GREU devices

All MASH approved GREU devices will be installed at the new 2'-1" height requirement. When installing the GREU devices connecting to existing 1'-11" w-beam guardrail, an additional 25' of guardrail will be required to transition from the 2'-1" height down to the existing 1'-11" height.

If the existing guardrail height is 1'-9", an additional 25' of guardrail will be required to transition from 2'-1" down to 1'-9" for a total of 50' of additional guardrail.

4. When replacing the current M-350 end units, a new GREU device will be installed. The GREU will not have the same flare rate as the M-350. Additional guardrail will need to be installed along with the GREU device to provide the needed protection.

When replacing the current M-350 end units, a new GREU device will be installed. The GREU will not have the same flare rate as the M-350. Additional guardrail will need to be installed along with the GREU device to provide the needed protection.

...il, will be
...way Standard

...Beam guardrail

... of 1'-11" or

All projects, centrally let or Division let with W-Beam guardrail, will be required to install 2'-1" height W-Beam guardrail. See Roadway Standard Details 862d01, 862d02, and 862d03.

December 31, 2018 deadline

Bridge Rails, Temporary Work Zone Devices, Sign Supports and all Other Breakaway Devices - We will incorporate the new MASH compliant devices when they become available prior to the December 31, 2019 deadline

The development of this implementation plan is in response to the AASHTO/FHWA Joint Implementation Agreement for the Manual for Assessing Safety Hardware. For more information, follow the link below:

https://safety.fhwa.dot.gov/roadway_dept/countermeasures/reduce_crash_severity/

For questions about the new requirements, please contact Joel S. Howerton, PE, at 919-707-6950 or jhowerton@ncdot.gov .

TML/jsh

Cc:
Brenda Moore, PE
Kevin Lacy, PE
Lamar Sylvester, PE
Division Engineers
Resident Engineers
Ron E. Davenport, Jr., PE
Teresa Bruton, PE
Virginia Mabry
Scott Capps, PE
Emily McGraw, PE
Chris Peoples, PE
District Engineers
Maintenance Engineers
Brenda Moore, PE
Roadway Project Engineers
Dennis Jernigan, PE

Supplemental Agreements
(Projects Let prior to January 2018)

North Carolina Department of Transportation

Supplemental Agreement Documentation

Contract: C203652 **Supplemental Agreement Number:** 7.0

County/Counties: Rowan **Federal Aid Number:**

Contractor: SMITH-ROWE, LLC

1. Description, location, and justification for change:

GUARDRAIL MASH: This supplemental agreement is written in accordance with article 104-3 of the 2012 Standard Specifications and establishes a unit price for guardrail upgrade. This is required to replace original guardrail sections to the updated AASHTO MASH compliance (GREU, TL-3). This work shall be performed in accordance with Section 862 of the 2012 Standard Specifications and the attached special provision and shall include compensation for all labor, materials, equipment, and incidentals necessary to complete the work.

2. Estimate of quantities of work resulting from change and the basis for payment:

Line Item	Description	Unit of Measure	Price	Contract Quantity	Negotiated Quantity	Net Change Quantity	Net Change Amount
68	STL BM GUARDRAIL	Linear Feet	$14.5000	0.000	-350.000	-350.000	$-5,075.00
73	GR ANCHOR TYPE 350	Each	$1,850.0000	0.000	-14.000	-14.000	$-25,900.00
184	GUARDRAIL END UNITS, TYPE TL-3	Each	$	0.000	14.000	14.000	$52,060.40
185	STL BM GUARDRAIL- MASH UPGRADE	Each	$	0.000	350.000	350.000	$6,398.00

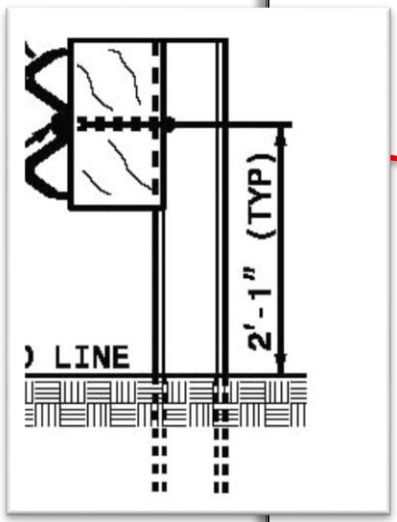
Supplemental Agreement Net Overrun: **$27,483.40**

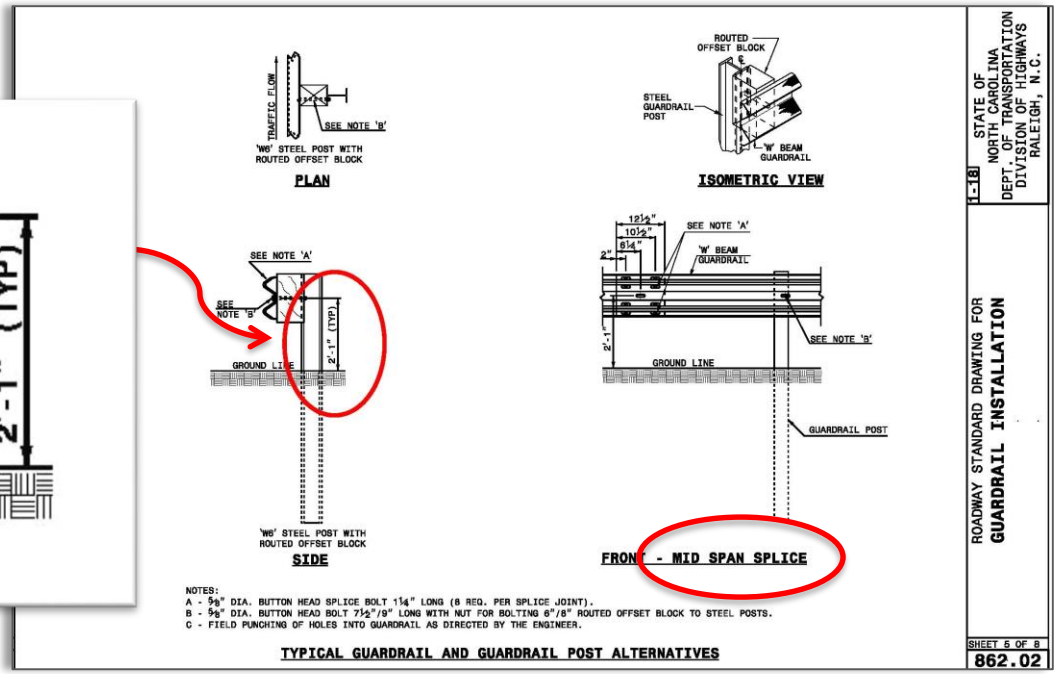
3. Extension of contract time (if applicable):

The intermediate completion date for Intermediate Contract Time Number 1 is extended only as allowed for overruns in accordance with Article 108-10(B)1 of the Standard Specifications in consideration of performance of the extra and/or additional work.

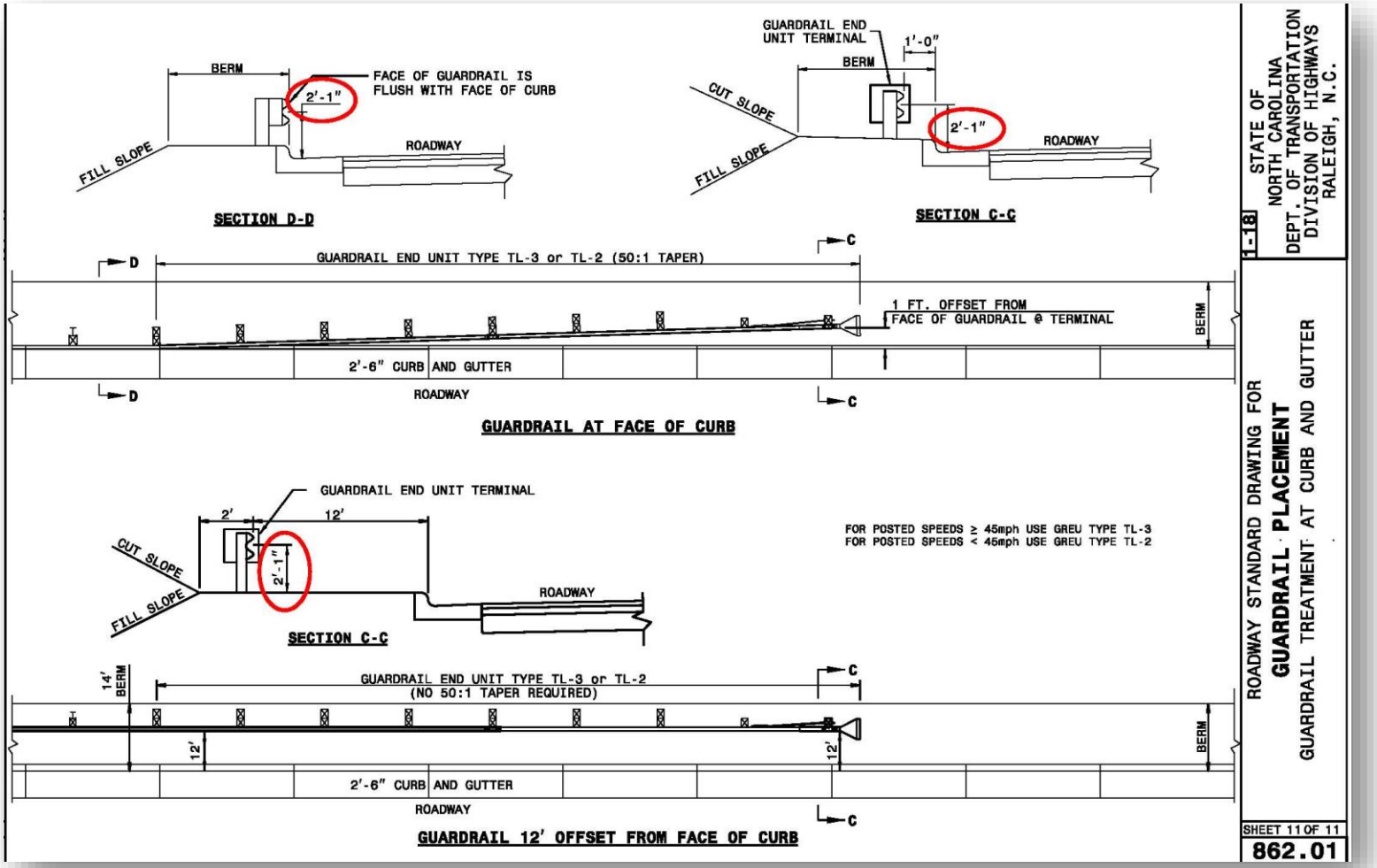
The contract completion date is extended only as allowed for overruns in accordance with Article 108-10(B)1 of the Standard Specifications in consideration of performance of the extra and/or additional work.

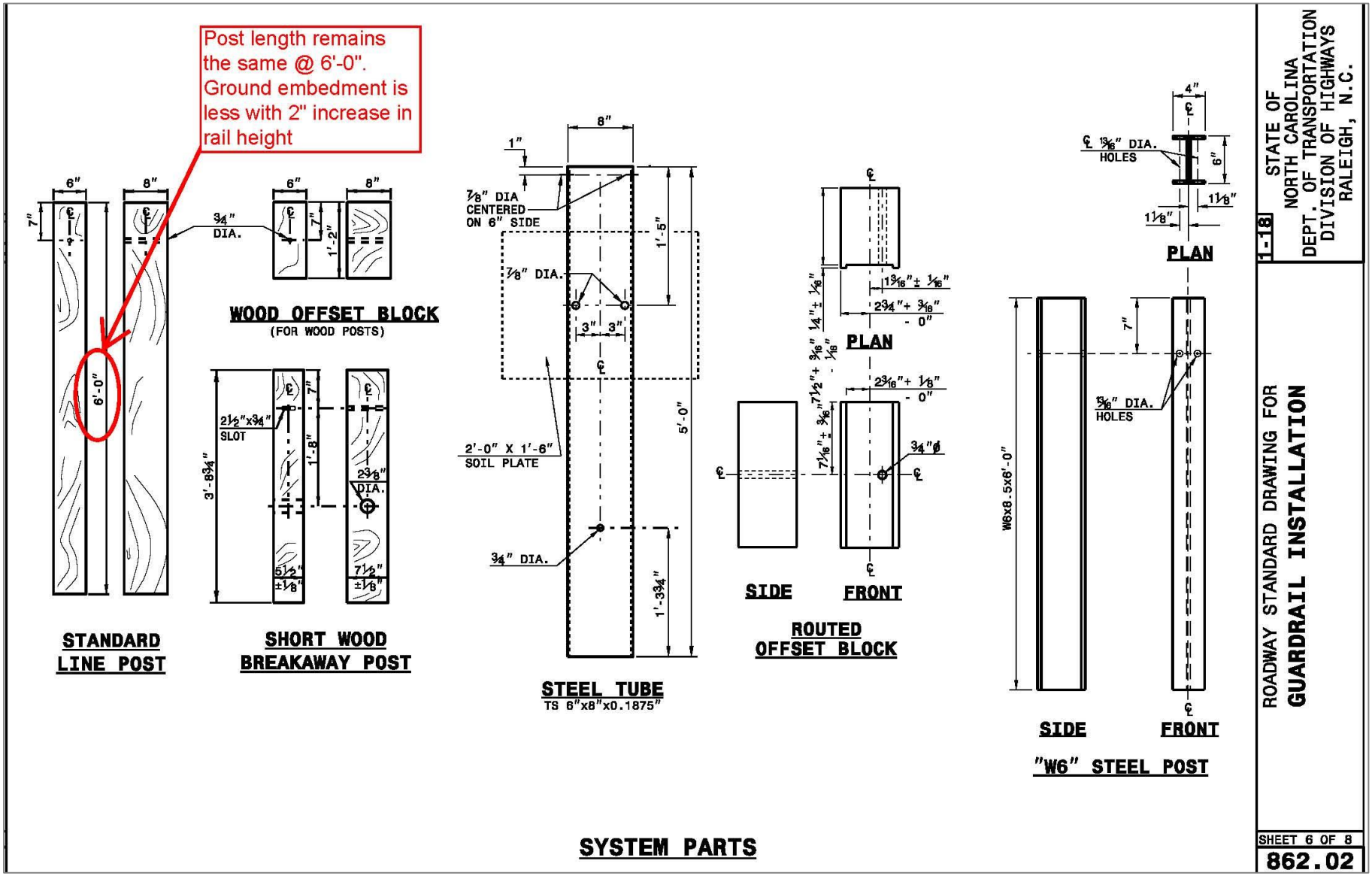

NCDOT
JANUARY 2018
TO BE USED IN
CONJUNCTION WITH JANUARY 2018
STANDARD SPECIFICATIONS
ROADWAY
STANDARD
DRAWINGS
STATE OF NORTH CAROLINA · DEPARTMENT OF TRANSPORTATION


) LINE
2'-1" (TYP)


TRAFFIC FLOW
SEE NOTE 'B'
'W6' STEEL POST WITH
ROUTED OFFSET BLOCK
PLAN
ROUTED
OFFSET BLOCK
STEEL
GUARDRAIL
POST
'W' BEAM
GUARDRAIL
ISOMETRIC VIEW
SEE NOTE 'A'
SEE
NOTE 'B'
GROUND LINE
2'-1" (TYP)
'W6' STEEL POST WITH
ROUTED OFFSET BLOCK
SIDE
12½"
10½"
6¼"
2"
SEE NOTE 'A'
'W' BEAM
GUARDRAIL
SEE NOTE 'B'
GROUND LINE
GUARDRAIL POST
FRONT - MID SPAN SPLICE
NOTES:
A - ⅝" DIA. BUTTON HEAD SPLICE BOLT 1¼" LONG (8 REQ. PER SPLICE JOINT).
B - ⅝" DIA. BUTTON HEAD BOLT 7½"/8" LONG WITH NUT FOR BOLTING 6"/8" ROUTED OFFSET BLOCK TO STEEL POSTS.
C - FIELD PUNCHING OF HOLES INTO GUARDRAIL AS DIRECTED BY THE ENGINEER.
TYPICAL GUARDRAIL AND GUARDRAIL POST ALTERNATIVES
STATE OF
NORTH CAROLINA
DEPT. OF TRANSPORTATION
DIVISION OF HIGHWAYS
RALEIGH, N.C.
1-18
ROADWAY STANDARD DRAWING FOR
GUARDRAIL INSTALLATION
SHEET 5 OF 8
862.02

Rdwy Standard Drawing 862.01





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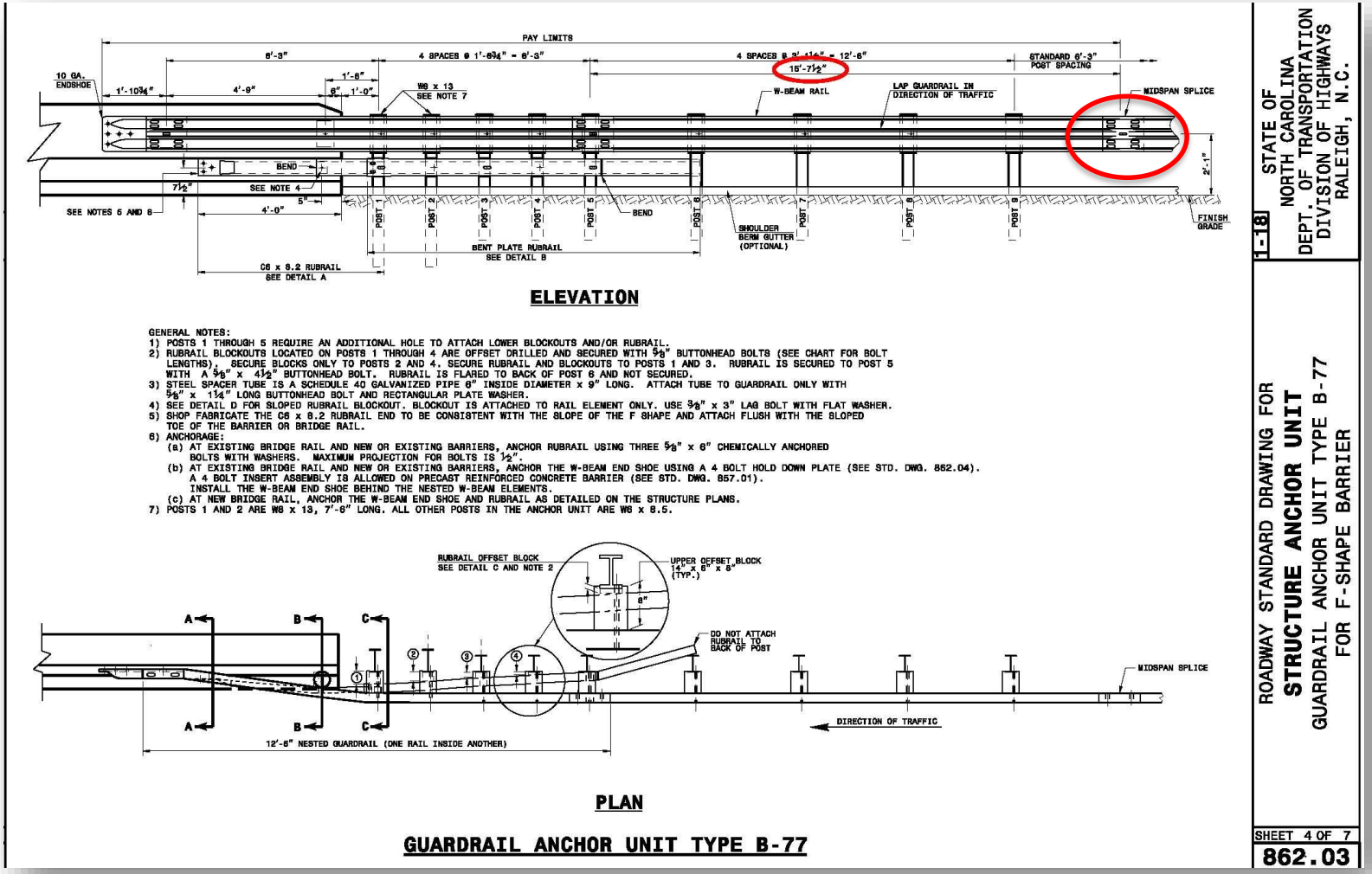
DEPT. OF TRANSPORTATION
DIVISION OF HIGHWAYS
RALEIGH, N.C.

1-18

ROADWAY STANDARD DRAWING FOR
GUARDRAIL INSTALLATION

SHEET 6 OF 8
862.02

B-77 STRUCTURE ANCHOR UNIT



ELEVATION

GENERAL NOTES:
1) POSTS 1 THROUGH 5 REQUIRE AN ADDITIONAL HOLE TO ATTACH LOWER BLOCKOUTS AND/OR RUBRAIL.
2) RUBRAIL BLOCKOUTS LOCATED ON POSTS 1 THROUGH 4 ARE OFFSET DRILLED AND SECURED WITH $\frac{5}{8}$" BUTTONHEAD BOLTS (SEE CHART FOR BOLT LENGTHS). SECURE BLOCKS ONLY TO POSTS 2 AND 4. SECURE RUBRAIL AND BLOCKOUTS TO POSTS 1 AND 3. RUBRAIL IS SECURED TO POST 5 WITH A $\frac{5}{8}$" x 4½" BUTTONHEAD BOLT. RUBRAIL IS FLARED TO BACK OF POST 6 AND NOT SECURED.
3) STEEL SPACER TUBE IS A SCHEDULE 40 GALVANIZED PIPE 8" INSIDE DIAMETER x 9" LONG. ATTACH TUBE TO GUARDRAIL ONLY WITH $\frac{5}{8}$" x 1¼" LONG BUTTONHEAD BOLT AND RECTANGULAR PLATE WASHER.
4) SEE DETAIL D FOR SLOPED RUBRAIL BLOCKOUT. BLOCKOUT IS ATTACHED TO RAIL ELEMENT ONLY. USE $\frac{3}{8}$" x 3" LAG BOLT WITH FLAT WASHER.
5) SHOP FABRICATE THE C6 x 8.2 RUBRAIL END TO BE CONSISTENT WITH THE SLOPE OF THE F SHAPE AND ATTACH FLUSH WITH THE SLOPED TOE OF THE BARRIER OR BRIDGE RAIL.
6) ANCHORAGE:
   (a) AT EXISTING BRIDGE RAIL AND NEW OR EXISTING BARRIERS, ANCHOR RUBRAIL USING THREE $\frac{5}{8}$" x 6" CHEMICALLY ANCHORED BOLTS WITH WASHERS. MAXIMUM PROJECTION FOR BOLTS IS 1½".
   (b) AT EXISTING BRIDGE RAIL AND NEW OR EXISTING BARRIERS, ANCHOR THE W-BEAM END SHOE USING A 4 BOLT HOLD DOWN PLATE (SEE STD. DWG. 862.04). A 4 BOLT INSERT ASSEMBLY IS ALLOWED ON PRECAST REINFORCED CONCRETE BARRIER (SEE STD. DWG. 857.01). INSTALL THE W-BEAM END SHOE BEHIND THE NESTED W-BEAM ELEMENTS.
   (c) AT NEW BRIDGE RAIL, ANCHOR THE W-BEAM END SHOE AND RUBRAIL AS DETAILED ON THE STRUCTURE PLANS.
7) POSTS 1 AND 2 ARE W8 x 13, 7'-6" LONG. ALL OTHER POSTS IN THE ANCHOR UNIT ARE W8 x 8.5.

PLAN

GUARDRAIL ANCHOR UNIT TYPE B-77

STATE OF NORTH CAROLINA
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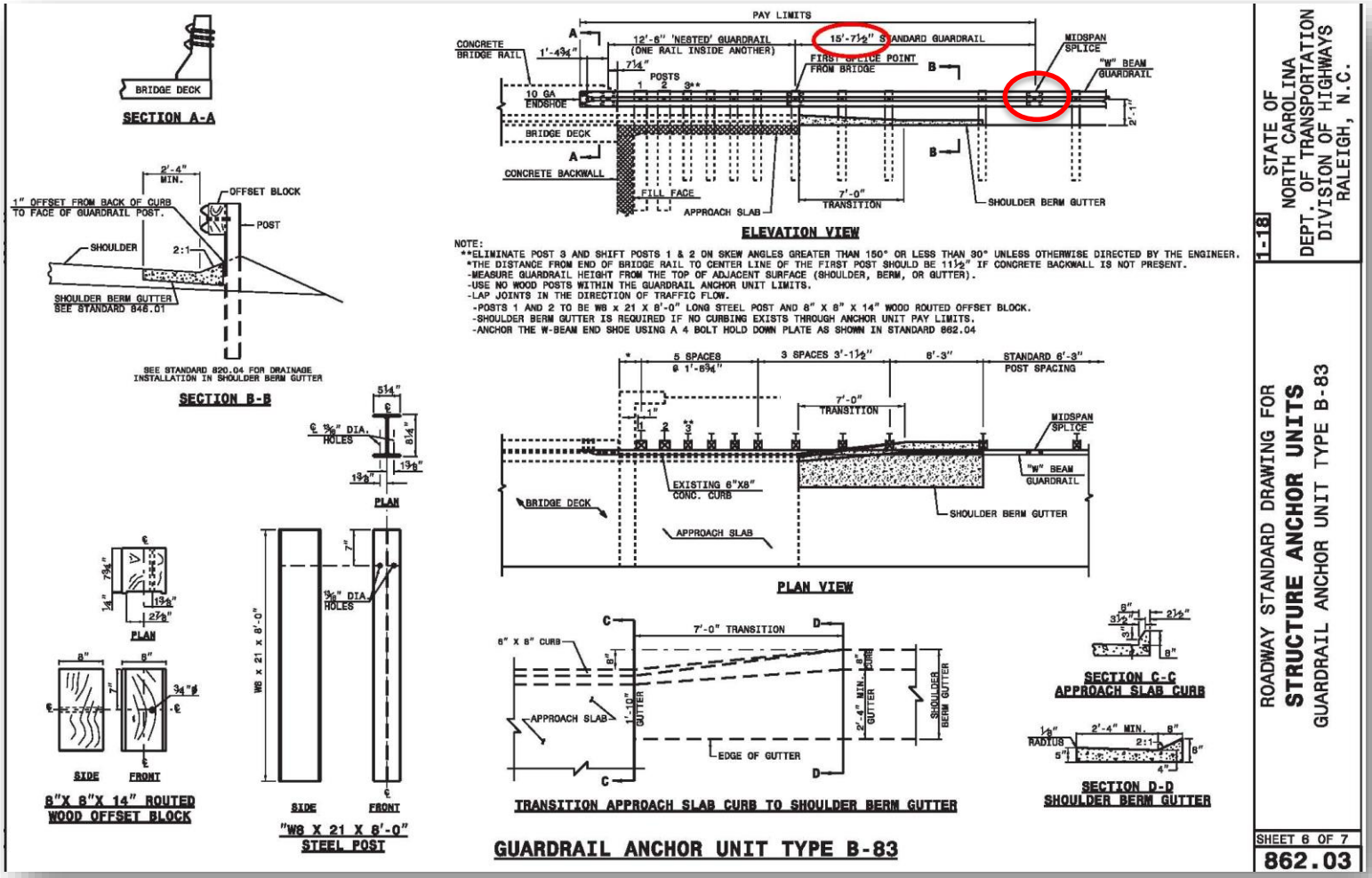
DIVISION OF HIGHWAYS
RALEIGH, N.C.

1-18

ROADWAY STANDARD DRAWING FOR
STRUCTURE ANCHOR UNIT
GUARDRAIL ANCHOR UNIT TYPE B-77
FOR F-SHAPE BARRIER

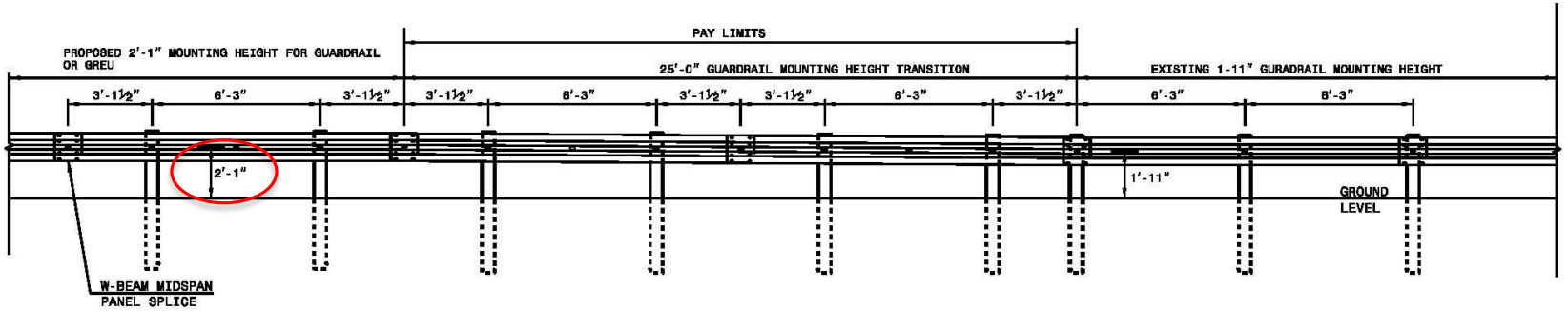
SHEET 4 OF 7
862.03

B-83 STRUCTURE ANCHOR UNIT



Transition in Guardrail Height …

NOTE: IF EXISTING GUARDRAIL IS LOWER THAN 1′-11″, USE AN ADDITIONAL 12′-6″ LONG SECTION OF GUARDRAIL, FOR EVERY 1″ OF HEIGHT DIFFERENCE, TO TRANSITION FROM EXISTING GUARDRAIL TO PROPOSED 2′-1″ GUARDRAIL.



ELEVATION VIEW

TRANSITION FROM OR 1′-11″ TO 2′-1″ W-BEAM GUARDRAIL MOUNTING HEIGHT

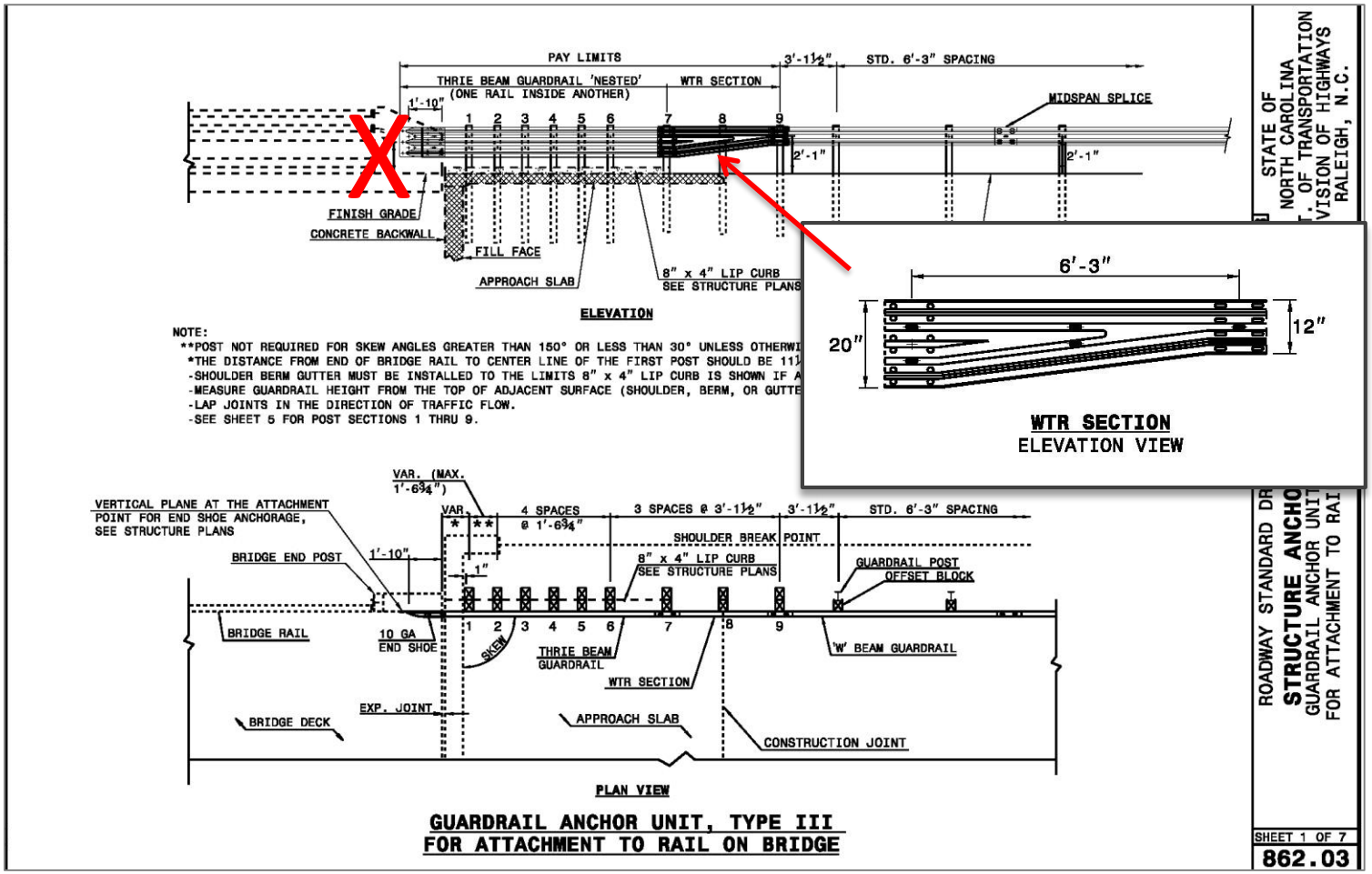
1-18
STATE OF NORTH CAROLINA
DEPT. OF TRANSPORTATION
DIVISION OF HIGHWAYS
RALEIGH, N.C.

ROADWAY STANDARD DRAWING FOR
GUARDRAIL INSTALLATION

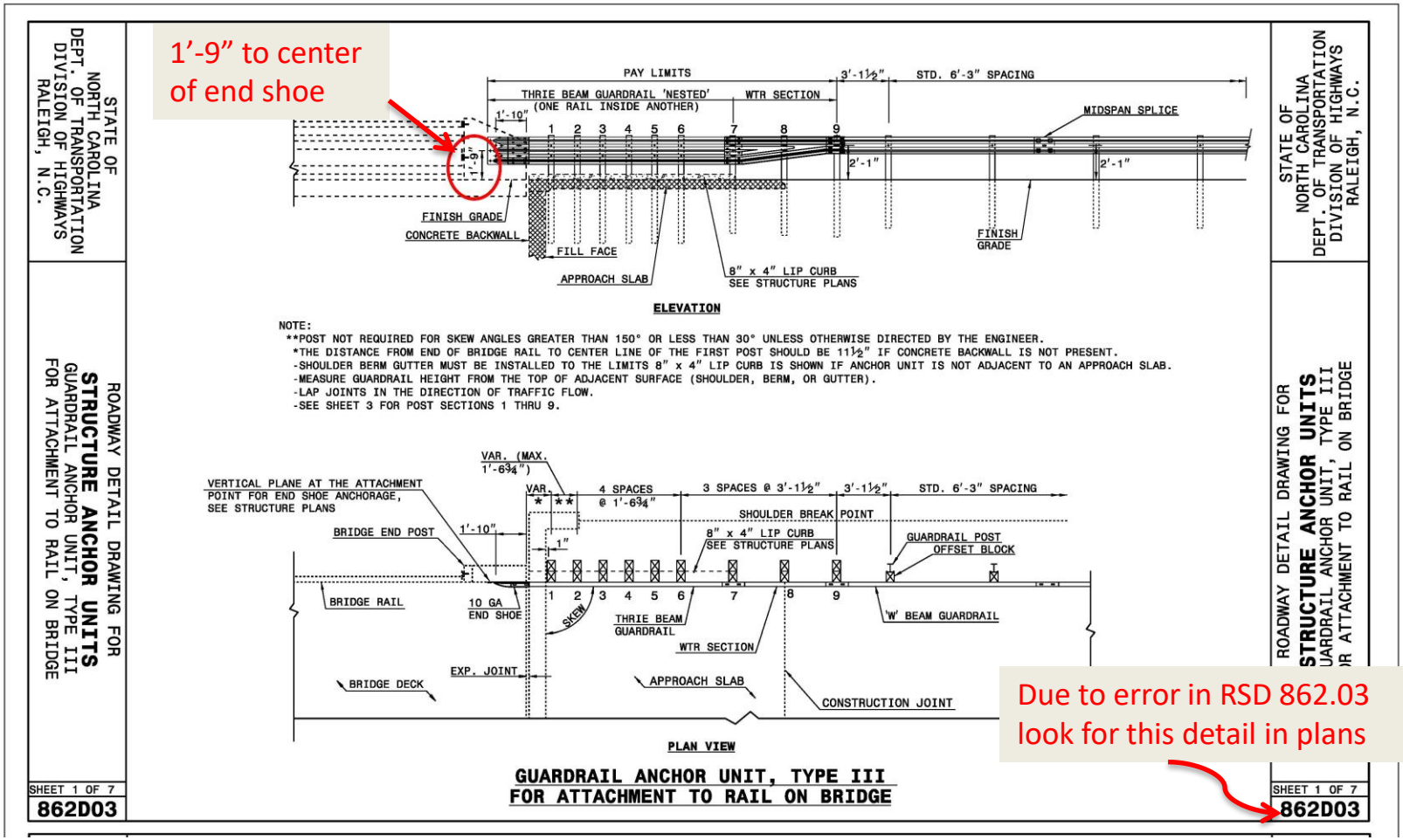
SHEET 4 OF 8
862.02

Type III Guardrail Anchor Units

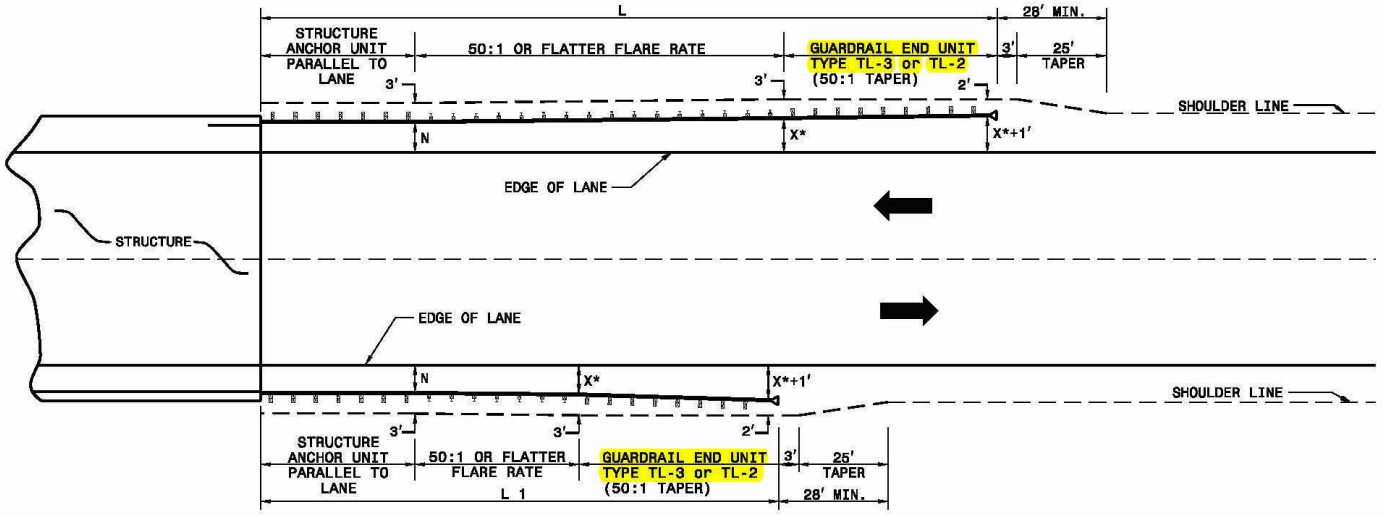
Type III Guardrail Anchor Units



Type III Guardrail Anchor Units



Guardrail End Units- MASH



* USE FLARE RATE AS THE CONTROL IF THE "X" DISTANCE IS NOT OBTAINED. ("X" IS BASED ON SHOULDER WIDTHS IN THE HIGHWAY DESIGN BRANCH MANUAL, PART 1, 1-4B, F1).

"N"= DISTANCE FROM EDGE OF LANE TO FACE OF GUARDRAIL WHERE GUARDRAIL IS PARALLEL TO LANE.

SEE STD. 862.03 FOR STRUCTURE ANCHOR UNITS

FOR POSTED SPEEDS ≥ 45mph USE GREU TYPE TL-3
FOR POSTED SPEEDS < 45mph USE GREU TYPE TL-2

GUARDRAIL INSTALLATION AT BRIDGE APPROACHES FOR TWO-LANE, TWO-WAY TRAFFIC

DESIGN SPEED (MPH)	"L" APPROACH LENGTH (FT.)				"L1" TRAILING LENGTH (FT.)			
	DESIGN YEAR ADT		CURRENT YEAR ADT		DESIGN YEAR ADT		CURRENT YEAR ADT	
	OVER 2000	1001-2000	400-1000	UNDER 400	OVER 2000	1001-2000	400-1000	UNDER 400
70	362.5'	362.5'	350.0'	287.5'	187.5'	187.5'	175.0'	75.0'
60	300.0'	287.5	275.0'	225.0'	137.5'	137.5'	100.0'	75.0'
50	212.5'	212.5'	200.0'	162.5'	87.5'	75.0'	75.0'	75.0'
40	175.0'	150.0'	137.5'	112.5'	75.0'	75.0'	75.0'	75.0'
X *	8'	6'	4'	4'	8'	6'	4'	4'

FOR POSTED SPEEDS ≥ 45 MPH USE GREU TYPE TL-3
FOR POSTED SPEEDS < 45 MPH USE GREU TYPE TL-2

LENGTHS AND OFFSETS FOR PROPOSED GUARDRAIL AT TWO LANE - TWO WAY LOCATIONS

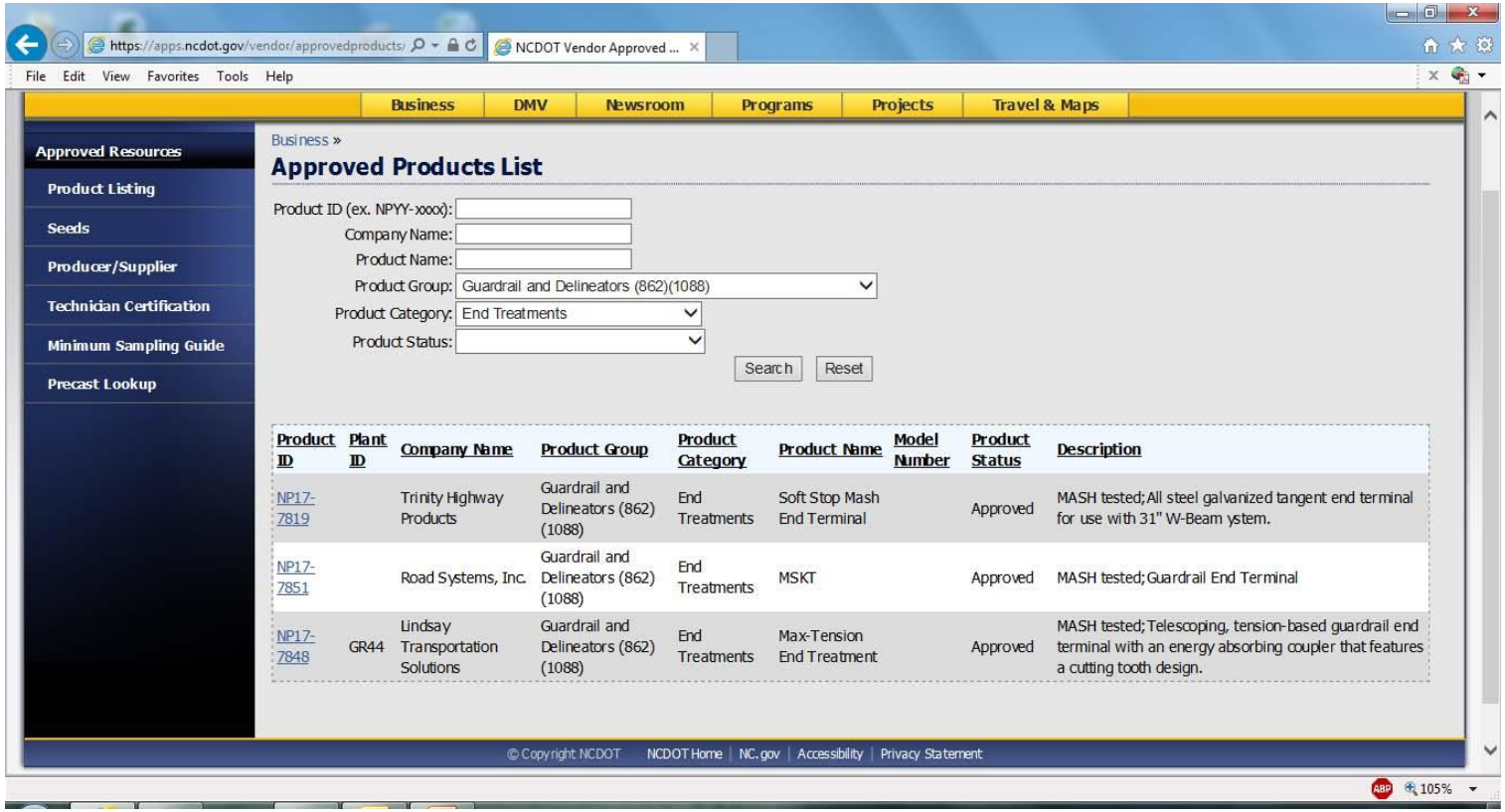
STATE OF NORTH CAROLINA
DEPT. OF TRANSPORTATION
DIVISION OF HIGHWAYS
RALEIGH, N.C.

1-18

ROADWAY STANDARD DRAWING FOR
GUARDRAIL PLACEMENT

SHEET 4 OF 11
862.01

NCDOT Vendor Approved Products List



- ***Currently only 3 MASH approved Guardrail End Units***
- ***NO Flared End MASH approved End Units at this time***

MSKT (Road Systems)

Soft Stop (Trinity)

Max Tension (Lindsay)

Project Special Provisions

U.S. Department of Transportation
Federal Highway Administration

1200 New Jersey Ave., SE
Washington, D.C. 20590

January 24, 2017

In Reply Refer To:
HSST-1/ CC-126E

Mr. Kaddo Kothman
Road Systems, Inc.
3616 Howard County Airport
Big Spring, TX 79720

Dear Mr. Kothman:

This letter is in response to your August, 1, 2016 request for the Federal Highway Administration (FHWA) to review a roadside safety device, hardware, or system for eligibility for reimbursement under the Federal-aid highway program. This FHWA letter of eligibility is assigned FHWA control number CC-126E and is valid until a subsequent letter is issued by FHWA that expressly references this device.

Decision

The following devices are eligible, with details provided in the form which is attached as an integral part of this letter:

- MASH Sequentially Kinking Terminal (MSKT) 2ft. Offset

Scope of this Letter

To be found eligible for Federal-aid funding, new roadside safety devices should meet the crash test and evaluation criteria contained in the American Association of State Highway and Transportation Officials' Manual for Assessing Safety Hardware (MASH). However, the FHWA, the Department of Transportation, and the United States Government do not regulate the manufacture of roadside safety devices. Eligibility for reimbursement under the Federal-aid highway program does not establish approval, certification or endorsement of the device for any particular purpose or use.

This letter is not a determination by the FHWA, the Department of Transportation, or the United States Government that a vehicle crash involving the device will result in any particular outcome, nor is it a guarantee of the in-service performance of this device. Proper manufacturing, installation, and maintenance are required in order for this device to function as tested.

This finding of eligibility is limited to the crashworthiness of the system and does not cover other structural features, nor conformity with the Manual on Uniform Traffic Control Devices.

R-9

YPE - TL-3:

862

units in accordance with the
the *2018 Standard Specificat*

listed on the NCDOT
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for each guardrail end unit cer
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Standard Specifications.

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be made in accordance with

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Assembly Instructions for

MSKT MASH Tangent Terminal
for 31" MGS (Midwest Guardrail System)

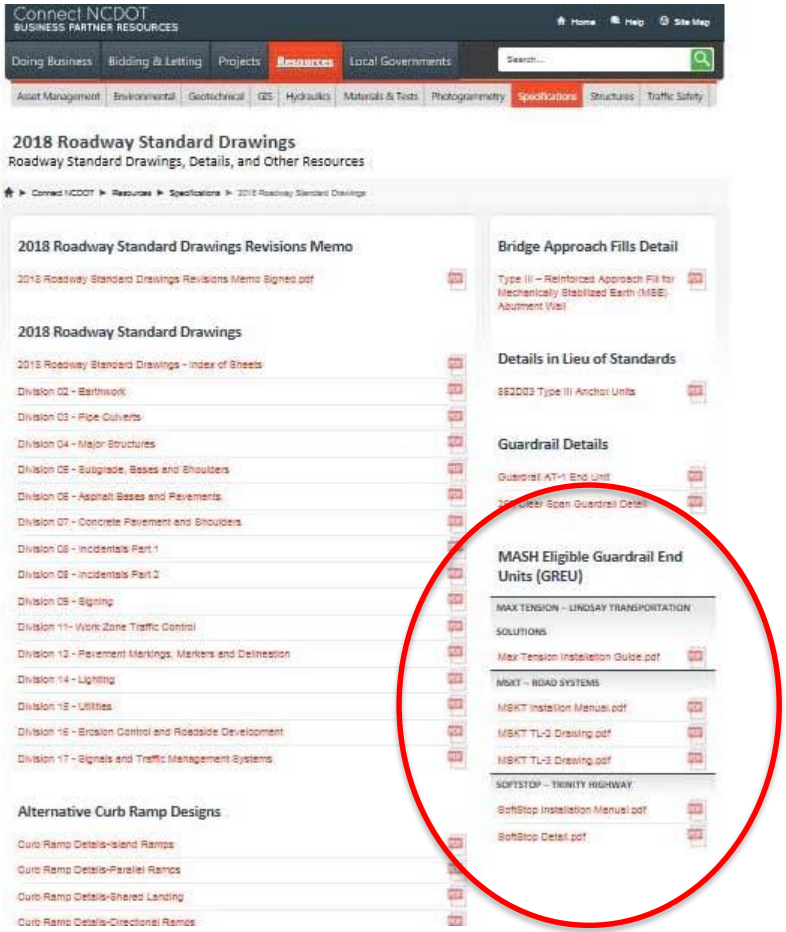
ROAD SYSTEMS, INC.

P. O. Box 2163
Big Spring, Texas 79721
Phone: (432) 263-2435 FAX: (432) 267-4039

Technical Support & Marketing Phone: (330) 346-0721
Technical Support & Marketing Fax: (330) 346-0722

www.roadsystems.com

Assembling Instructions



https://connect.ncdot.gov/resources/Specifications/Pages/2018-Roadway-Standard-Drawings.aspx