STATE OF NEW HAMPSHIRE
BRIDGE DESIGN MEMORANDUM

FROM: Mark W. Richardson, PE
Administrator

DATE: September 12, 2013
AT (Office): Bureau of Bridge Design

SUBJECT: **Design Memorandum 2013-01**
Vehicular Collision Pier Protection

TO: **Bureau of Bridge Design Staff, Bridge Design Consultants, FHWA, NHDOT Bureaus**

The Bureau of Bridge Design is updating the Bridge Design Manual. During this process, certain completed sections of the new manual are being issued for immediate implementation. Consequently, the Bridge Design Manual and Bridge Detail Sheets have been modified as follows:

A. Bridge Design Manual

- Chapter 4, Section 4.3.12
- Chapter 6, Section 6.6.5

B. Bridge Detail Sheets:

- 54" Single Slope Concrete Barrier, Precast
- 54" Single Slope Concrete Barrier Single-Faced, Precast
- Pier Protection Type I (54" Single Slope Concrete Barrier)
- Pier Protection Type II (54" Single Slope Concrete Barrier)
- Pier Protection Type II (54" Single Slope Concrete Barrier, Single-Faced)
- 54" to 45" Transition Single Slope Concrete Barrier, Precast

NHDOT Bridge Design
1/12/2015 9:43:16 AM

Memorandum is **inactive.**
See current NHDOT Bridge Design Manual.

C. Summary: The above noted revisions are being implemented to specify:

- Additional guidance to *AASHTO LRFD Bridge Design Specifications 3.6.5*, defining when to apply the vehicular collision force or provide pier protection.
- Types of vehicular collision pier protection and their use.
- Bridge Detail Sheets of vehicular collision pier protection (.dgn and .pdf format) located on the Bureau of Bridge Design web page:
  http://www.nh.gov/dot/org/projectdevelopment/bridgedesign/detailsheets/index.htm

D. Background:

This memorandum incorporates recommendations from the *AASHTO LRFD Bridge Design Specifications and the AASHTO Roadside Design Guide,* as well as recommendations from other state DOTs.

Truck traffic has increased on NH roadways and providing taller and crash worthy pier protection, other than the standard w-beam barrier, is warranted.

This memorandum clarifies NHDOT's procedures/requirements for the design and construction of vehicular collision pier protection, and incorporates the Bridge Detail Sheets that shall be included in contract plans.

E. Implementation:

The update to the Bridge Design Manual and the new Bridge Detail Sheets shall be implemented as of the date of this memo and shall be used on all applicable projects.

Mark W. Richardson, PE
Administrator, Bureau of Bridge Design

enclosures

4.3.12 Vehicular Collision Force

AASHTO LRFD Section 3.6.5 contains provisions for vehicular collision forces (CT) on structures that cross over roadways that routinely carry trucks and have design speeds of 50-mph (80 kph) or higher. The following shall be considered when determining if a vehicular collision force shall be applied to unprotected piers, sign structure foundations, and other structures.

- *AASHTO LRFD Section 3.6.5* states "abutments and piers located within a distance of 30.0-ft. to the edge of roadway shall be investigated for collision." For clarification, NHDOT Bridge Design defines "edge of roadway" to be "edge of travel lane".
- Substructure Type:
  - Vehicular collision force is not required for abutments or retaining walls (NHDOT Bridge Design policy) due to the soil behind the walls, which will absorb the force. Only unprotected piers, sign structure foundations, and other structures as directed by the Design Chief shall be considered for a vehicular collision force.
- Route classification, ADTT (average daily truck traffic in one direction), ADT (average daily traffic) and roadway design speed:
  - The pier may require a vehicular collision force only if it is located on a roadway that routinely carries trucks and has a design speed of 50-mph (80 kph) or higher.
- Geometry:
  - Vehicular collision force is not required for pier located a distance greater than 30-feet (9.14 m) from the edge of the travel lane. For new structures, consider planned widenings or future realignments of lower roadways when establishing limits of setback distances and clear zones or horizontal clearance limits.
- Design Exemption/Impact History:
  - The designer shall consult with the Design Chief regarding the possibility of a design exemption, as described in *AASHTO LRFD Section C3.6.5.1,* which determines the estimated annual frequency a pier may be hit by a heavy vehicle. This exemption may only be used on redundant piers (3 or more columns) or wall piers (NHDOT Bridge Design policy).

A. New Structures

- Locate piers a distance greater than 30-feet (9.14 m) from the edge of the travel lane. Clear zones for roadways at many locations are equal to or greater than 30-feet (9.14 m). Designing for a vehicular collision force is not required for piers located outside 30-feet (9.14 m) from the edge of the travel lane. Consider planned widenings or future realignments of lower roadways when establishing limits of setback distances and clear zones or horizontal clearance limits.
- If a pier needs to be located within 30-feet (9.14 m) of the edge of the travel lane, the designer shall consult with the Design Chief and investigate an exemption as described in *AASHTO LRFD Section C3.6.5.1*.
- If a pier is within 30-feet (9.144m) of the edge of the travel lane and does not have an exemption, either the pier shall be designed for the 600-kip (2670 kN) vehicular collision force (CT) *or* it shall be protected with an embankment or barrier that meets *AASHTO LRFD Section 3.6.5.1*. See Chapter 6, Section 6.6.5, for vehicular collision pier protection. When considering the options, the designer shall include aesthetics, maintenance, and cost as they apply to the bridge pier.

- If the barrier protection option is chosen, no further analysis of the collision force acting on the pier is required. The vehicle protection barrier will redirect and absorb the collision force as described and shown in Chapter 6, Section 6.6.5 Vehicle Collision Pier Protection.
- Providing structural resistance in the pier may be a better and more economical option than providing an embankment or barrier, except where a median barrier will be provided as part of the highway design. The bridge designer shall work with the roadway design engineer to determine which alternative is preferred.
- The primary design objective for extreme event load cases is preventing the loss of a span. When considering the 600-kip (2670 kN) vehicular collision force in design, the load and resistance factors shall all be set to 1.0. Plastic deformation of crashwalls, pier columns, etc., is permitted, subject to the requirement that loss of span shall be prevented.
- The vehicular collision force is a point load acting on the pier. The lateral vehicular collision force will transfer to the foundation, but resistance is provided by passive soil pressure, friction, and pile structural capacity. In addition, movement beyond what is reasonable for service loadings is allowed for an extreme event situation where survival of the bridge is the goal. Vehicle collision force transferred to the foundation will be a project specific analysis.
- Generally, a new reinforced concrete wall pier can be designed to resist the vehicular collision force.

B. Existing Structures and Widening of Existing Structures.

- If the existing pier is located within 30-feet (9.14 m) of the edge of the travel lane, the designer shall consult with the Design Chief and investigate an exemption as described in *AASHTO LRFD Section C3.6.5.1*.
- If the existing pier is within 30-feet (9.14 m) of the edge of the travel lane and does not have an exemption, either the existing pier shall be analyzed to show it is capable of resisting the 600-kip (2670 kN) vehicular collision force (CT) *or* it shall be protected with an embankment or barrier that meets *AASHTO LRFD Section 3.6.5.1*. See Chapter 6, Section 6.6.5 for vehicular collision pier protection. When considering the options, the designer shall include aesthetics, maintenance, and cost as they apply to the bridge pier.
- The existing pier can be evaluated for its capacity and connection to the foundation and beam elements to determine its resistance. Factors that affect the pier resistance include, but are not limited to:
    - The continuity of the superstructure.
    - The continuity of the superstructure to the substructure and any frame action which might aid in the distribution of force effects.
    - The condition of the bearing devices and ability to resist translations and rotations.
    - The degree of redundancy of the superstructure.
    - The continuity of the substructure to the foundation system.
    - The amount of confinement reinforcement within the column and potential ultimate reserve capacity beyond the design capacity.

6.6.5 Vehicular Collision Pier Protection

In accordance with *AASHTO LRFD Section 3.6.5*, a bridge pier that is located within 30-feet (9.14 m) of the edge of a roadway (NHDOT Bridge Design defines "edge of roadway" to be "edge of travel lane"), and does not have sufficient strength to resist the vehicular collision force, nor meet any of the criteria stated in Chapter 4, Section 4.3.12, Vehicular Collision Force, shall be protected in accordance with *AASHTO LRFD* Section 2.3.2.2.1 and by one of the following:

- A permanent single slope 54-in. (1372 mm) tall concrete barrier designed for TL-5 loading, when the distance from the back of the barrier to the face of the pier is less than or equal to 10'-0" (3 m).
- A permanent single slope 42-in. (1067 mm) tall concrete barrier designed for TL-5 loading, when the distance from the back of the barrier to the face of the pier is greater than 10'-0" (3 m). (NHDOT barrier height is 45-in. [1143 mm])
- An embankment.

A. Single Slope Concrete Barrier 54-in. (1372 mm) Tall

1) Double-Faced Barrier

- If there is enough room for the single slope double-faced barrier, the pier side toe of the barrier shall be placed a minimum of 3-ft. (1 m) from the face of the pier.
    - See the Bridge Design Detail Sheet, Pier Protection Type I and Type II (54-in. Single Slope Concrete Barrier) http://www.nh.gov/dot/org/projectdevelopment/bridgedesign/detailsheets/index.htm.

2) Single-Faced Barrier

- If there is not enough room for a double-faced barrier section, then a single-faced barrier may be used. The pier side face of the single-faced barrier shall be placed a minimum of 9-in. (229 mm) from the pier.
    - See Bridge Detail Sheet, Pier Protection Type I and Type II (54-in. Single Slope Concrete Barrier, Single-Faced) http://www.nh.gov/dot/org/projectdevelopment/bridgedesign/detailsheets/index.htm

B. Single Slope Concrete Barrier 45-in. (1143 mm) Tall

- The 45-in. (1143 mm) tall single slope double-faced barrier, the pier side toe of the barrier shall be placed a minimum of 10'-0" (3 m) from the substructure and embedded 3-in. (76 mm).
- See Highway Standard Plan, Single Slope Barrier http://www.nh.gov/dot/org/projectdevelopment/highwaydesign/standardplans/index.htm

The 45-in. (1143 mm) and the 54-in. (1372 mm) single slope concrete barrier details are in compliance with requirements per updated NCHRP Report 350 for test No. 5-11 (MASH TL-5). Documentation is included in the FHWA Acceptance Letter B64 (http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/barriers/pdf/b64.pdf) and NCHRP 157 Vol. 1 (http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w157.pdf).

The intended purpose of these barriers is to shield a pier from traffic, primarily large trucks and tractor trailers, so as to reduce the separate but related potential for damage to the pier and collapse of the bridge that might result of a truck collision with a pier.

- The designer shall use the protection barrier as indicated and shown in this Manual, unless directed otherwise by the Design Chief due to other factors such as the following:
    - Crash history indicates that larger vehicle impacts are frequent.
    - Consequence of collision with a fixed object is severe (e.g., causes light pole or sign structure to drop across travel lanes or bridge pier is non-redundant)
- For new structures, consider planned widenings or future realignments of lower roadways when establishing limits of setback distances, clear zones, or horizontal clearance limits.
- When considering the options, the designer shall include aesthetics, maintenance, and cost as they apply to the bridge pier.
- The bridge designer shall work with the roadway design engineer to determine if a median barrier is provided as part of the highway design and the method of transition from the pier protection barrier to the highway median barrier.
- Consider overall safety at a given location, including vehicle and pedestrian traffic, when selecting the appropriate type of pier protection to be used. Consider the effect that tall barriers might have on sight distances, particularly near intersections, and the end treatments that will be required for these taller barriers.
- Select the pier protection barrier terminal treatment for design speeds greater than or equal to 50-mph (80 kph) from the following options:
    - Terminate outside the clear zone of any approaching traffic.
    - Terminate within a shielded location.
    - Terminate by the use of a crash cushion system; or,
    - Terminate in conjunction with a suitably designed transition to another barrier.
- In accordance with the *Roadside Design Guide, 4th Ed., 2011, Section 5.5.2*, the pier protection barrier shall be extended 10-ft. (3 m) in advance of the pier. Beyond that point, the barrier height should be vertically transitioned on a 10:1 slope to the height of the adjoining barrier. The barrier should continue with a flare-rate in accordance with the *Roadside Design Guide* for the length of need required, or transition to another barrier.
- The above noted offsets of the barrier to the pier take into account the working widths and zone of intrusion (ZOI) width.
    - The working width is the lateral distance from the front face/toe of barrier to the greatest of vehicle extent, barrier deflection, or barrier width.
    - The zone of intrusion refers to the maximum distance a vehicle extends behind the top front face of the barrier.
    - The *Roadside Design Guide, 4th Ed., 2011, Section 5.5.2*, shows the zone of intrusion for TL-4 barriers. (See Figure 6.6.5-1)
    - The zone of intrusion for TL-5 loading and a 54-in. (1372 mm) single-slope barrier is 18-in. (457 mm) for a truck cab and 45-in. (1143 mm) for a cargo box, as presented in a paper prepared by Stephen F. Hobbs of McElhanney Engineering Services Ltd. for the 2010 Annual Conference of the Transportation Association of Canada. (See Table 6.6.5-1.)
    - The 54-in. (1372 mm) single-faced single slope concrete barrier is placed a minimum of 9-in. (229 mm) from the back of the barrier to the face of the pier. The top of the barrier

is 9 ¾-in. wide (248 mm). This provides a setback of 18 ¾-in. (476 mm), which is greater than the zone of intrusion for a truck cab, TL-5 loading.

- The NHDOT pier protection placed at the minimum offsets to the pier does not provide the required intrusion zone for a truck box. However, an impact from a cargo box would not cause major damage to the pier nor create the loss of a span and the majority of barrier impacts are from pick-up trucks or smaller vehicles.

Table 1 Zone of Intrusion with Concrete Barrier

Test Level	Height of Concrete Barrier (mm)	Cab Width of Intrusion (mm), (i)	Truck Box Width of Intrusion (mm), (i)
TL-1	508	550	no box
TL-1	810	178 (1)	no box
TL-2	508	711 (1)	no box
TL-2	690	457 (1)	no box
TL-2	810	305 (1)	no box
TL-2	1070	178 (1)	no box
TL-3	690	762 (1)	no box
TL-3	810	610 (1)(7)	no box
TL-3	1070	254 (1) (interpolated)	no box
TL-3	1420	100 (interpolated)	no box
TL-4	810	864 (1)(7)	2032 (1)(7)
TL-4	1070	610 (1)	610 (1)
TL-4	1420	230 (interpolated)	457 (interpolated)
TL-5	810	TL-5 not achievable with 810 high barrier	
TL-5	1070	1220 (1)	2200 (1)
TL-5	1370	457 (1)	1140 (1)
TL-6	2286	0 (1)	100 (1)

Note:

(i) Intrusion widths shown are for safety shaped (F-shaped or New Jersey) or constant sloped (California or Texas) concrete barrier. There is an inverse correlation between barrier height and intrusion width. For a specific result for another type of barrier and crash test level, refer to the appendix of reference (1). Alternately review video or high speed photos of the specific device crash tests to measure or estimate widths needed.

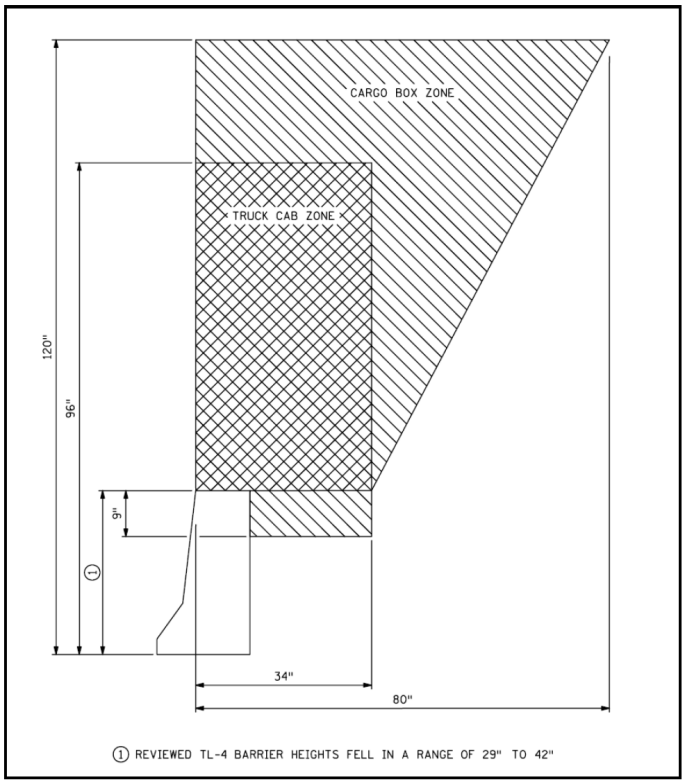
(1) "Guidelines for Attachments to Bridge Rails and Median Barriers", Keller, Sicking, Faller, Polivka & Rohde, February 26, 2003

(7) Charles Boyd, Florida Department of Transportation, Attachments to Traffic Railings, Session 23, FICE/FDOT Design Conference 2006, Designing for More Than Bridges and Roads.

Zone of Intrusion with Concrete Barrier

(Zone of Intrusion and Concrete Barrier Measure by Stephen F. Hobbs*)*[11]

Table 6.6.5-1



Intrusion Zones for TL-4 Barriers
(Roadside Design Guide, 4th Ed., 2011)

Figure 6.6.5-1

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References

1. American Association of State Highway and Transportation Officials (AASHTO), *AASHTO LRFD Bridge Design Specifications 2012*, Washington, D.C.

2. American Association of State Highway and Transportation Officials (AASHTO), *Standard Specifications for Highway Bridges, 17th Ed., 2002*, Washington, D.C.

3. New Hampshire Department of Transportation Bureau of Bridge Design, *Bridge Design Manual, October1, 2000*, Concord, NH

4. New Hampshire Department of Transportation Bureau of Highway Design, *Highway Design Manual, 2007, Vol. 1*, Concord, NH

5. New Hampshire Department of Transportation, *NHDOT Standard Specifications for Road and Bridge Construction 2010,* Concord, NH

6. Washington State Department of Transportation, *Bridge Design Manual (BFM) M 23-50.* Retrieved from http://www.wsdot.wa.gov/Publications/Manuals/M23-50.htm

7. New York Department of Transportation, *Highway Design Manual, Chapter 10 – Roadside Design, Guide Rail, and Appurtenances, Rev. 64, April 10, 2012*. Retrieved from https://www.dot.ny.gov/divisions/engineering/design/dqab/hdm/hdm-repository/rev_64_HDM_Ch10.pdf

8. Illinois Department of Transportation, *Bridge Manual 2012*. Retrieved from http://www.dot.state.il.us/bridges/brmanuals.html

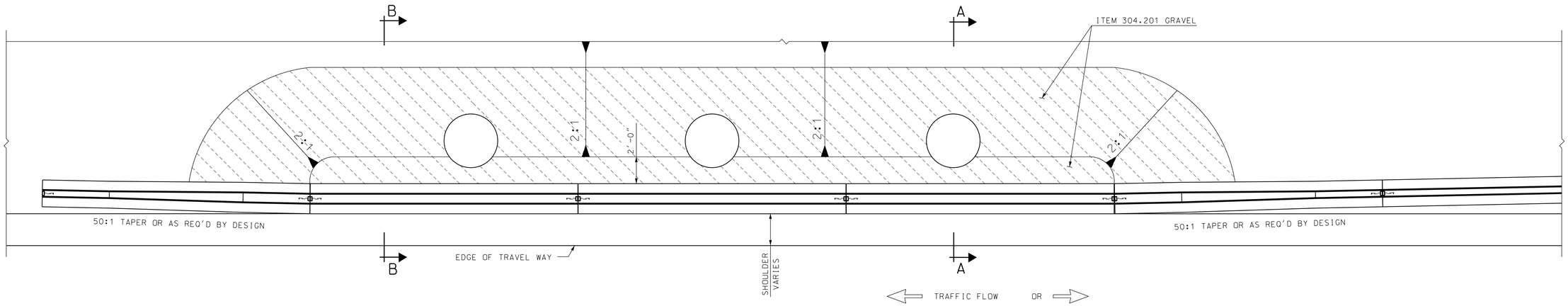
9. Federal Highway Administration (FHWA), USDOT, Safety *Memorandum: Design Considerations for Prevention of Cargo Tank Rollovers.* Retrieved from http://safety.fhwa.dot.gov/policy/memopctr090310.cfm

10. Federal Highway Administration (FHWA), USDOT, Safety *Longitudinal Barriers* Retrieved from http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/listing.cfm?code=long

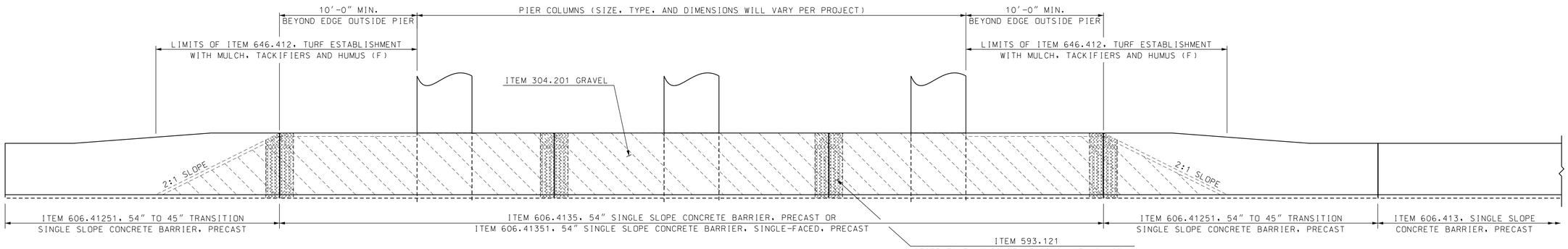
11. Hobbs, Stephen F., McElhanney Engineering Services Ltd., *Zone of Intrusion and Concrete Barrier Countermeasures,* paper prepared for presentation at the Low-Cost Road Engineering Safety Countermeasures and Their Application Across Canada, Session of the 2010 Annual Conference of the Transportation Association of Canada Halifax, Nova Scotia. Retrieved from http://www.tac-atc.ca/english/resourcecentre/readingroom/conference/conf2010/docs/k2/hobbs.pdf

12. American Association of State Highway and Transportation Officials (AASHTO), *Roadside Design Guide, 4th Ed., 2011,* Washington, D.C.

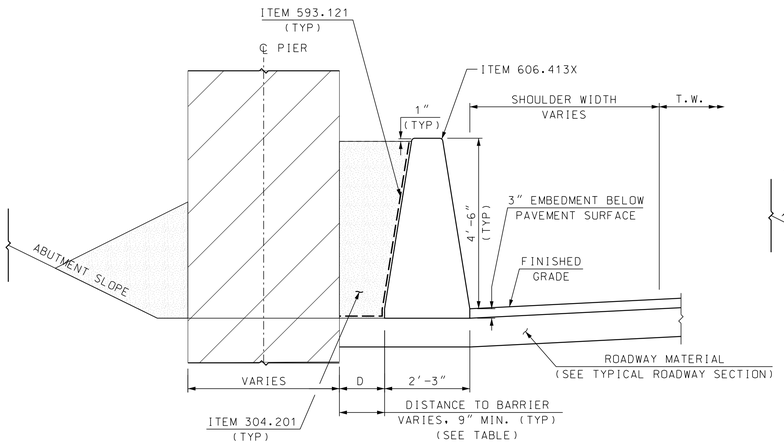
13. Precast/Prestressed Concrete Institute, *PCI Bridge Design Manual,* Chicago, IL.



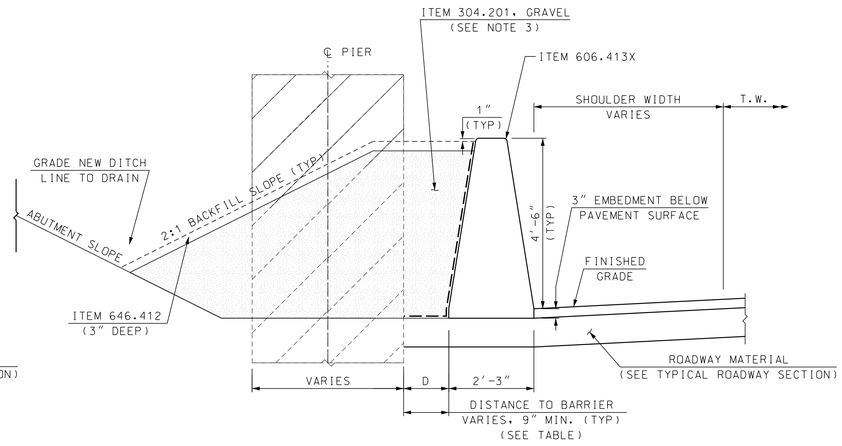
PLAN VIEW



ELEVATION VIEW



SECTION A-A



SECTION B-B

DISTANCE TO BARRIER (D)	SINGLE SLOPE CONCRETE BARRIER DETAIL	FILL BEHIND BARRIER
9"≤ D ≤ 2 FT	54" SINGLE SLOPE CONCRETE BARRIER *OR* 54" SINGLE SLOPE CONCRETE BARRIER SINGLE-FACED	YES
2 FT < D ≤ 10 FT	54" SINGLE SLOPE CONCRETE BARRIER EMBEDDED 3" **BOTH SIDES**	NO
D > 10 FT	45" SINGLE SLOPE CONCRETE BARRIER EMBEDDED 3" **BOTH SIDES**	NO

NOTES:

(1) BARRIER LAYOUT SHOWN IS FOR PROTECTION OF PIERS, SHAFTS OR OTHER STRUCTURES LOCATED IN THE MEDIAN OR THE NON-MEDIAN SIDE OF ROADWAY. FOR BARRIER DETAILS SEE SHEETS FOR 54" SINGLE SLOPE CONCRETE BARRIER, PRECAST OR 54" SINGLE SLOPE CONCRETE BARRIER, SINGLE-FACED, PRECAST.

(2) THE 54" SINGLE SLOPE CONCRETE BARRIER SHALL EXTEND A MINIMUM 10'-0" BEYOND THE EDGE OF OUTSIDE PIER COLUMNS.

(3) FREE DRAINING MATERIAL, GRAVEL, SHALL BE PLACED BEHIND THE CONCRETE BARRIER FOR THE FULL DEPTH. FLOWABLE FILL SHALL NOT BE PLACED BEHIND THE BARRIER.

(4) DOUBLE-FACED 54" SINGLE SLOPE CONCRETE BARRIER SHOWN. SINGLE-FACED CONCRETE BARRIER SIMILAR.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN | BRIDGE NO. | STATE PROJECT

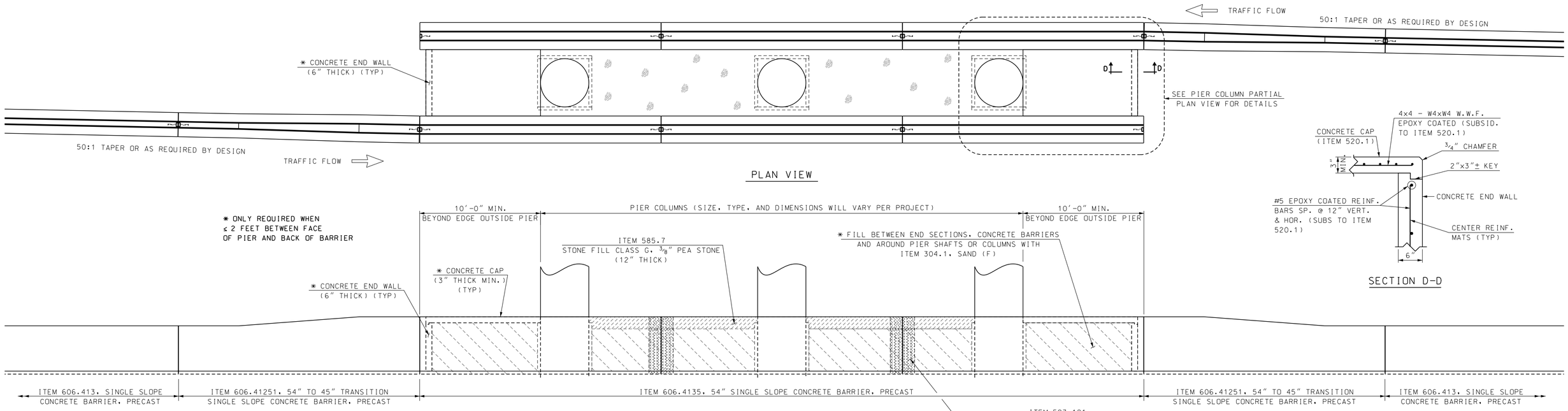
LOCATION

PIER PROTECTION TYPE I (54" SINGLE SLOPE CONCRETE BARRIER)

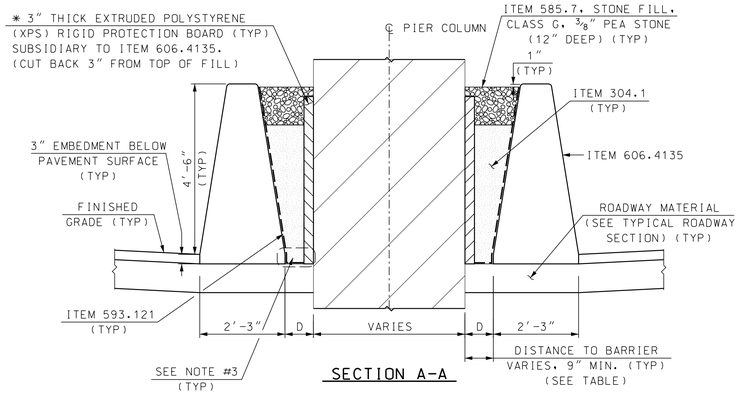
BRIDGE SHEET OF FILE NUMBER

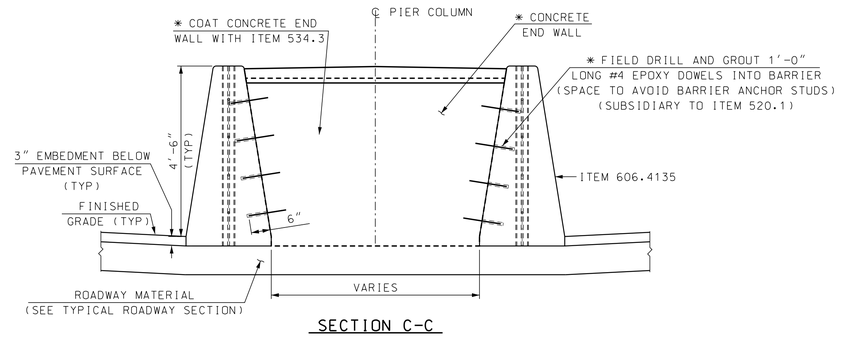
REVISIONS AFTER PROPOSAL		BY	DATE		BY	DATE
	DESIGNED	NHDOT	2/13	CHECKED	NHDOT	2/13
	DRAWN	GMC	2/13	CHECKED	ABH	2/13
	QUANTITIES	XX	XX	CHECKED	XX	XX
	ISSUE DATE	9/20/13	FEDERAL PROJECT NO.		SHEET NO.	TOTAL SHEETS
	REV. DATE	---				

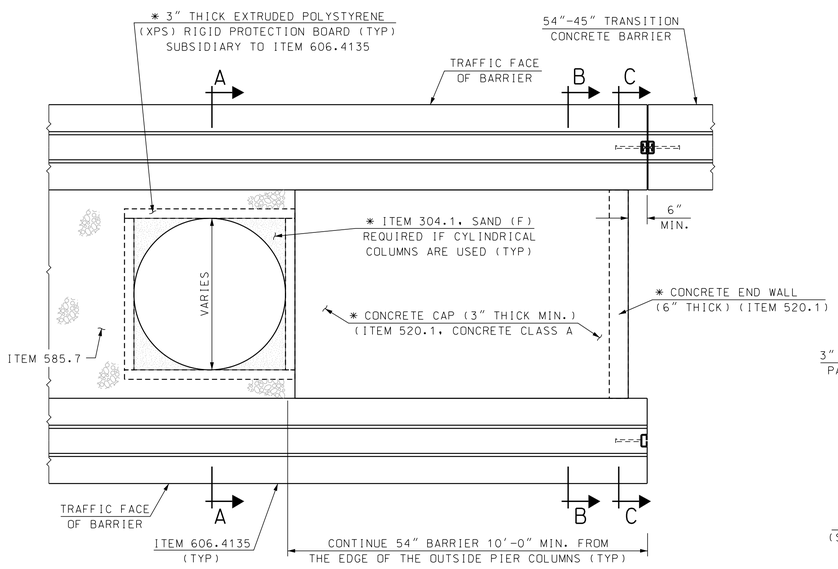
SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
English/VC PIER PRO	54SS-TYPE I_PIER	NOT TO SCALE

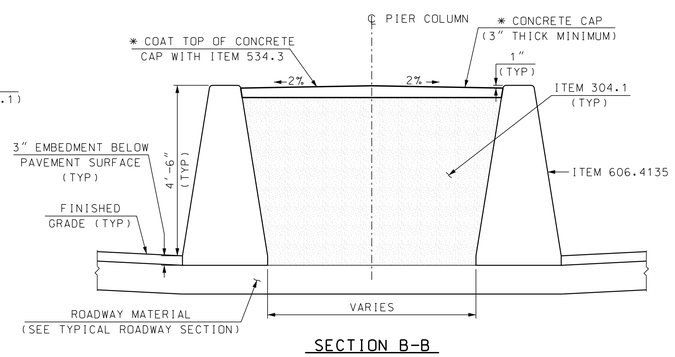


DISTANCE TO BARRIER (D)	SINGLE SLOPE CONCRETE BARRIER DETAIL	FILL BEHIND BARRIER
9"≤ D ≤ 2 FT	54" SINGLE SLOPE CONCRETE BARRIER *OR* 54" SINGLE SLOPE CONCRETE BARRIER SINGLE-FACED	YES
2 FT < D ≤ 10 FT	54" SINGLE SLOPE CONCRETE BARRIER EMBEDDED 3" **BOTH SIDES**	NO
D > 10 FT	45" SINGLE SLOPE CONCRETE BARRIER EMBEDDED 3" **BOTH SIDES**	NO









NOTES:

(1) BARRIER LAYOUT SHOWN IS FOR PROTECTION OF PIERS, SHAFTS OR OTHER STRUCTURES LOCATED IN THE MEDIAN. FOR BARRIER DETAILS, SEE 54" SINGLE SLOPE CONCRETE BARRIER, PRECAST SHEET.

(2) THE 54" SINGLE SLOPE CONCRETE BARRIER SHALL EXTEND A MINIMUM 10'-0" BEYOND THE EDGE OF OUTSIDE PIER COLUMNS.

(3) FREE DRAINING MATERIAL, SAND, SHALL BE PLACED BEHIND THE CONCRETE BARRIER FOR THE FULL DEPTH. FLOWABLE FILL SHALL NOT BE PLACED BEHIND THE BARRIER.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN | BRIDGE NO. | STATE PROJECT

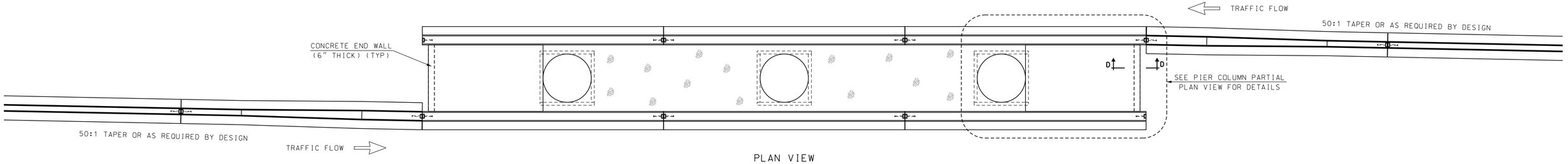
LOCATION

PIER PROTECTION TYPE II (54" SINGLE SLOPE CONCRETE BARRIER)

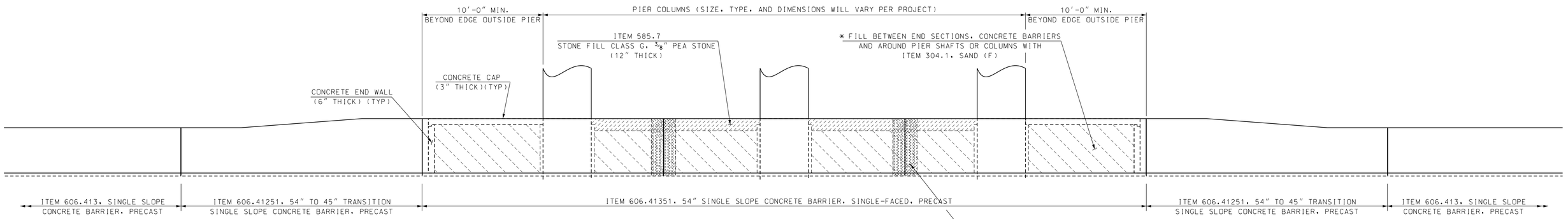
BRIDGE SHEET OF FILE NUMBER

REVISIONS AFTER PROPOSAL		BY	DATE		BY	DATE
	DESIGNED	NHDOT	2/13	CHECKED	NHDOT	2/13
	DRAWN	GMC	2/13	CHECKED	ABH	2/13
	QUANTITIES	XX	XX	CHECKED	XX	XX
	ISSUE DATE	9/20/13	FEDERAL PROJECT NO.		SHEET NO.	TOTAL SHEETS
	REV. DATE	---				

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
English/VC PIER PRO	54SS-TYPE II_PIER	NOT TO SCALE



PLAN VIEW



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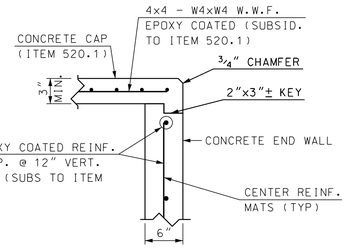
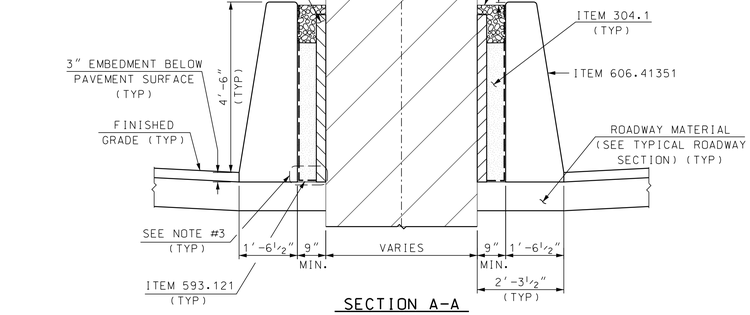
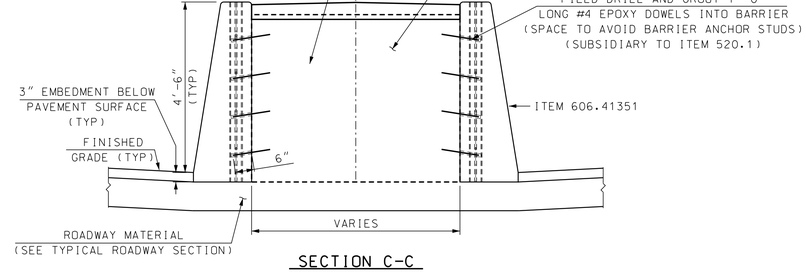


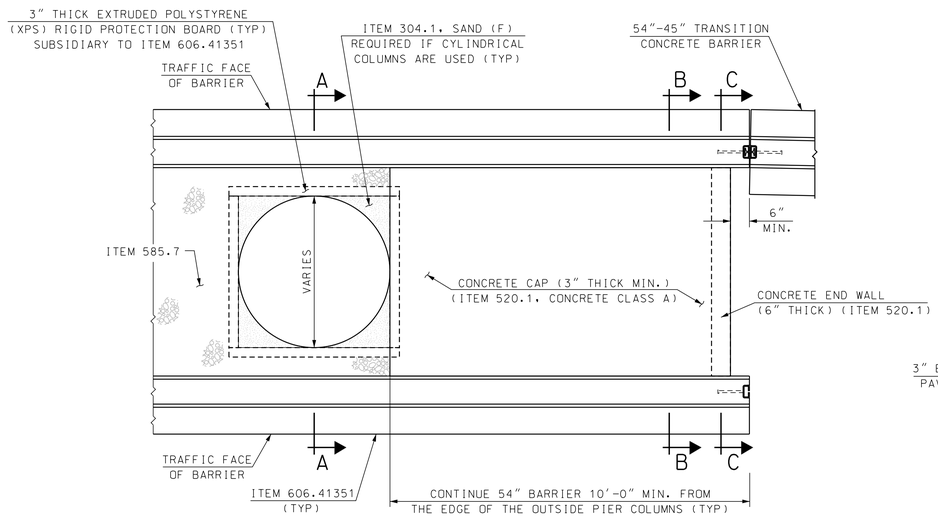
SECTION D-D



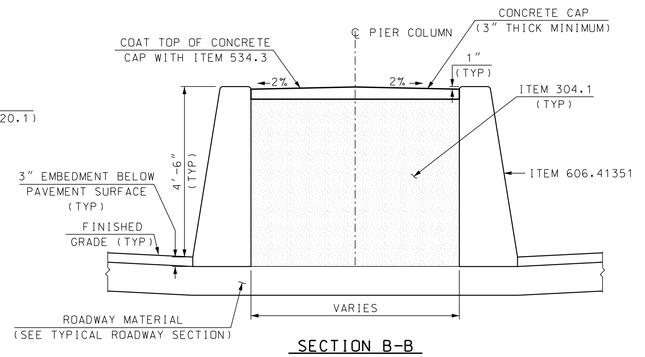
SECTION A-A



SECTION C-C



PIER COLUMN PARTIAL PLAN VIEW



SECTION B-B

NOTES:

(1) BARRIER LAYOUT SHOWN IS FOR PROTECTION OF PIERS, SHAFTS OR OTHER STRUCTURES LOCATED IN THE MEDIAN. FOR BARRIER DETAILS SEE 54" SINGLE SLOPE CONCRETE BARRIER SINGLE-FACED, PRECAST SHEET.

(2) THE 54" SINGLE SLOPE CONCRETE BARRIER SHALL EXTEND A MINIMUM 10'-0" BEYOND THE EDGE OF OUTSIDE PIER COLUMNS.

(3) FREE DRAINING MATERIAL, SAND, SHALL BE PLACED BEHIND THE CONCRETE BARRIER FOR THE FULL DEPTH. FLOWABLE FILL SHALL NOT BE PLACED BEHIND THE BARRIER.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN	BRIDGE NO.	STATE PROJECT
LOCATION		

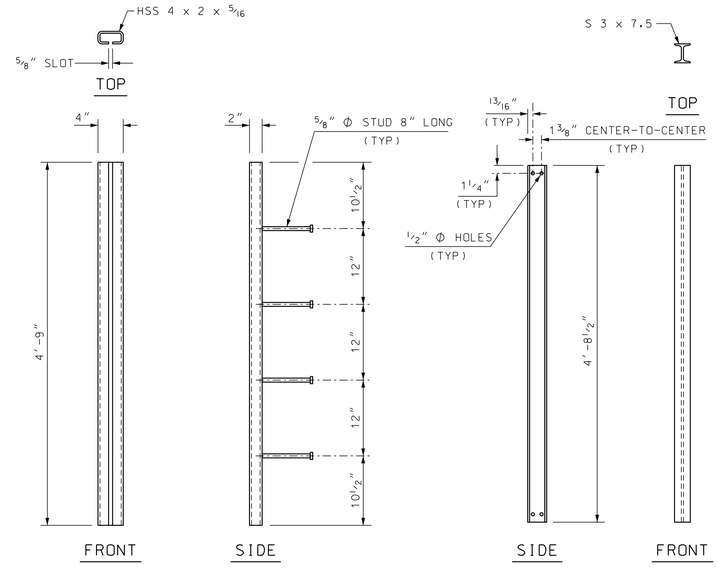
PIER PROTECTION TYPE II (54" SINGLE SLOPE CONCRETE BARRIER, SINGLE-FACED)

BRIDGE SHEET OF

REVISIONS AFTER PROPOSAL		BY	DATE		BY	DATE
	DESIGNED	NHDOT	2/13	CHECKED	NHDOT	2/13
	DRAWN	GMC	2/13	CHECKED	ABH	2/13
	QUANTITIES	XX	XX	CHECKED	XX	XX
	ISSUE DATE	9/20/13	FEDERAL PROJECT NO.		SHEET NO.	TOTAL SHEETS
	REV. DATE	---				

FILE NUMBER

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
English/VC PIER PRO	54SF-TYPE II_PIER	NOT TO SCALE

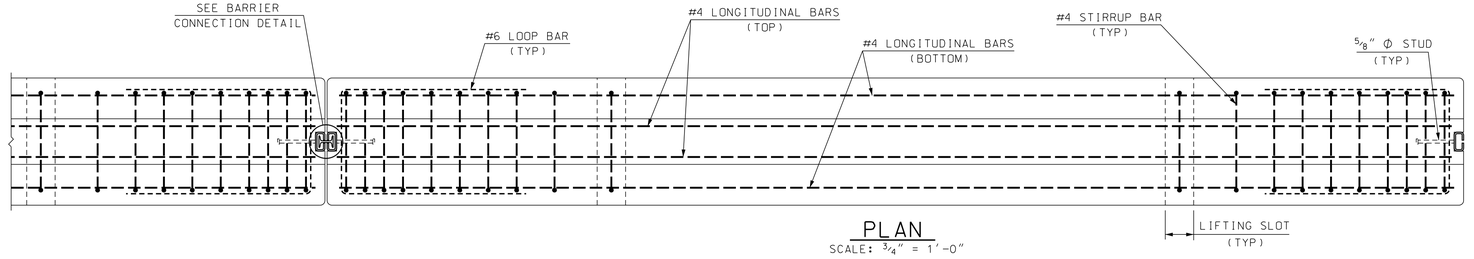


STRUCTUAL SECTION DETAILS

SCALE: 1" = 1'-0"

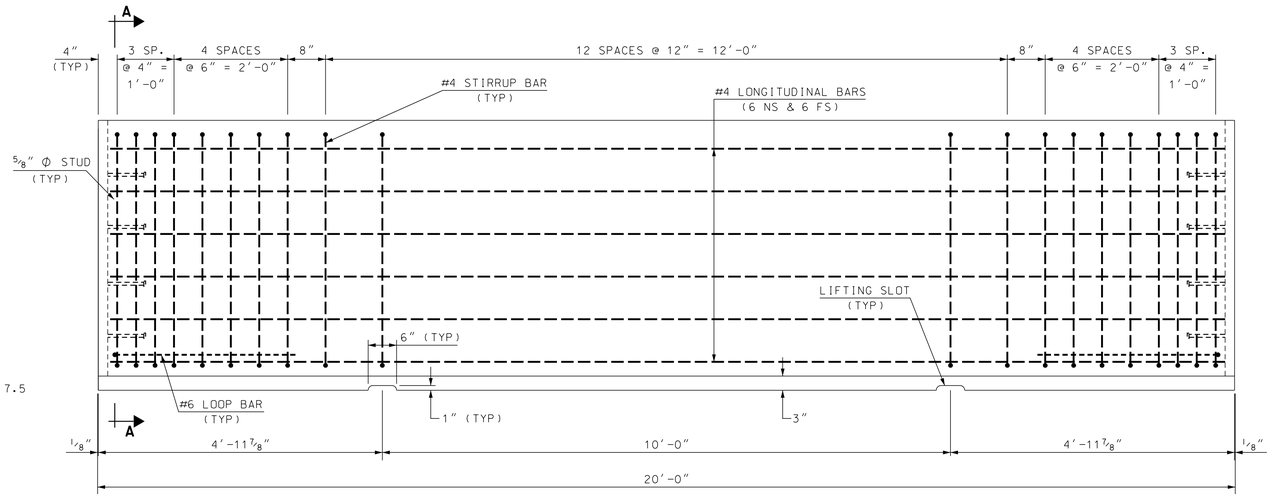
I-BEAM DETAILS

SCALE: 1" = 1'-0"



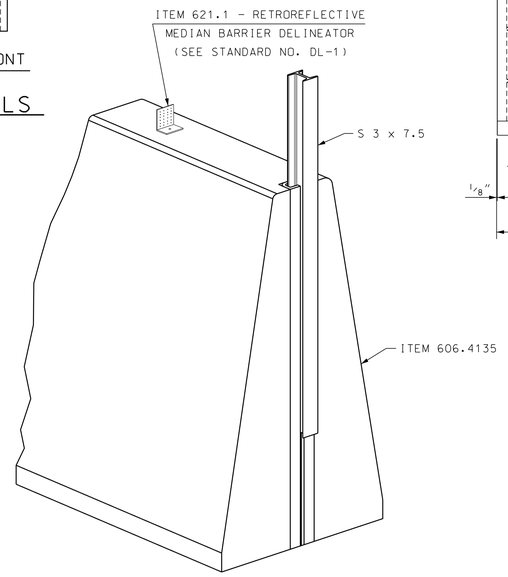
PLAN

SCALE: 3/4" = 1'-0"



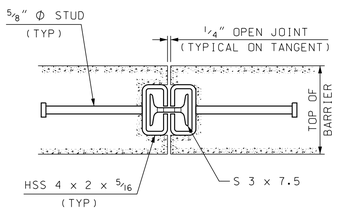
ELEVATION

SCALE: 3/4" = 1'-0"



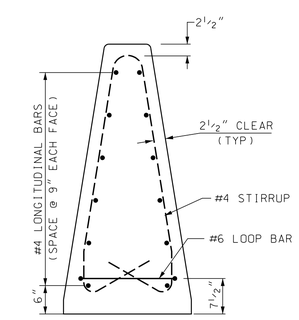
PERSPECTIVE VIEW

SCALE: 1" = 1'-0"



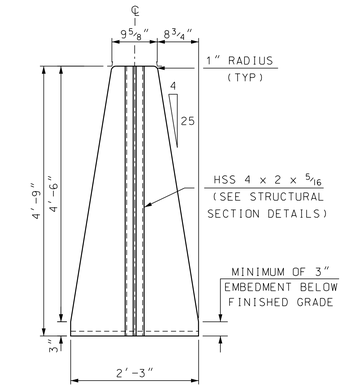
BARRIER CONNECTION DETAIL

SCALE: 2" = 1'-0"



SECTION A-A (REINFORCEMENT)

SCALE: 3/4" = 1'-0"

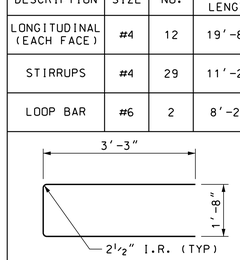


END VIEW (MASONRY)

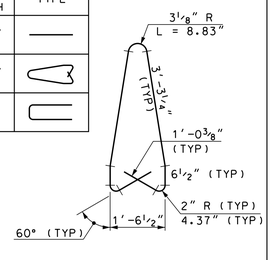
SCALE: 3/4" = 1'-0"

CONCRETE BARRIER REINFORCING SCHEDULE

DESCRIPTION	SIZE	NO.	UNBENT LENGTH	TYPE
LONGITUDINAL (EACH FACE)	#4	12	19'-8"	
STIRRUPS	#4	29	11'-2"	
LOOP BAR	#6	2	8'-2"	



#6 LOOP BAR (TOP VIEW)



#4 STIRRUP BAR

NO MODIFICATIONS SHALL BE MADE TO THIS SHEET.

GENERAL NOTES

1. CONCRETE BARRIER AND ALL ITS COMPONENTS SHALL BE FURNISHED BY THE CONTRACTOR AND PAID AS ITEM 606.4135, 54" SINGLE SLOPE CONCRETE BARRIER, PRECAST.
2. STUD WELDING SHALL BE IN ACCORDANCE WITH SECTION 547.
3. SLOTS IN STRUCTURAL TUBES SHALL BE CUT WITH MECHANICALLY GUIDED MEANS TO A SMOOTH, UNIFORM SURFACE MEETING A SURFACE ROUGHNESS OF 25 μ OR BETTER (ANSI B46.1).
4. CONCRETE BARRIER DETAILS SHOWN ON THIS SHEET ARE IN COMPLIANCE WITH REQUIREMENTS PER UPDATED NCHRP REPORT 350 FOR TEST NO. 5-11 (MASH TL-5), NCHRP 157 VOL. 1.

MATERIAL NOTES

1. THE BARRIERS SHALL BE LIGHT COLORED CLASS AA CONCRETE HAVING A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 4,000 PSI. BARRIERS SHALL HAVE A SMOOTH UNIFORM SURFACE FREE OF DEFECTS AND IRREGULARITIES. CASTING DATE SHALL BE SHOWN ON BARRIER. ALL EXPOSED EDGES OF CONCRETE SHALL BE CHAMFERED 3/4", UNLESS NOTED OTHERWISE.
2. I-BEAMS AND STRUCTURAL TUBES SHALL BE ASTM A36 OR A572 GALVANIZED AFTER FABRICATION, IN ACCORDANCE WITH SECTION 550.
3. ALL REINFORCING STEEL SHALL BE AASHTO M31 (ASTM-A615) GRADE 60, EPOXY COATED. REINFORCEMENT SHOWN IS THE MINIMUM REQUIRED.
4. EACH BARRIER UNIT SHALL INCLUDE ONE S 3 x 7.5.
5. SHOP DRAWINGS SHALL INCLUDE REINFORCING SCHEDULE.
6. LEVELING PADS, SHIMMING MATERIAL, AND FLOWABLE FILL SHALL BE SUBSIDIARY TO THE CONCRETE BARRIER.

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN	BRIDGE NO.	STATE PROJECT
LOCATION		

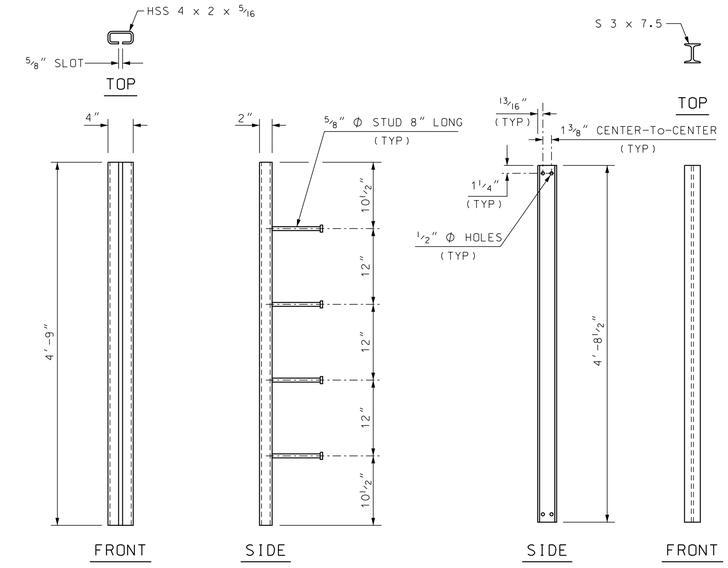
54" SINGLE SLOPE CONCRETE BARRIER, PRECAST

BRIDGE SHEET OF

FILE NUMBER

REVISIONS AFTER PROPOSAL		BY	DATE		BY	DATE
	DESIGNED	NHDOT	2/13	CHECKED	NHDOT	2/13
	DRAWN	GMC	2/13	CHECKED	ABH	2/13
	QUANTITIES	XX	XX	CHECKED	XX	XX
	ISSUE DATE	9/20/13	FEDERAL PROJECT NO.		SHEET NO.	TOTAL SHEETS
	REV. DATE	---				

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
English/VC PIER PRO	54SS-MED BARRIER	AS NOTED

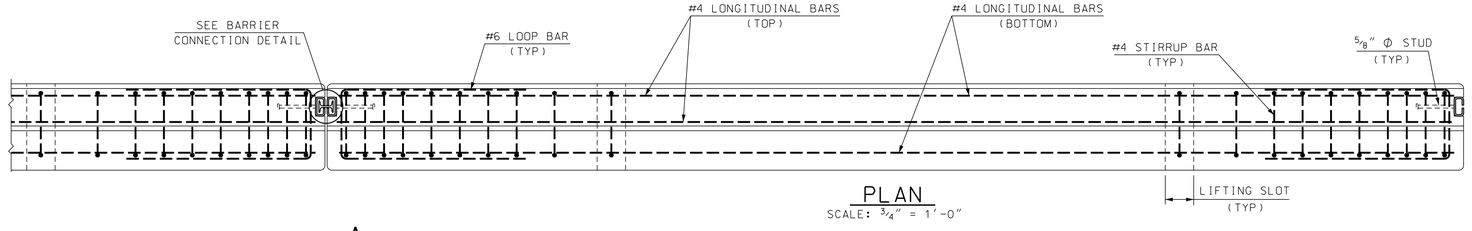


STRUCTURAL SECTION DETAILS

SCALE: 1" = 1'-0"

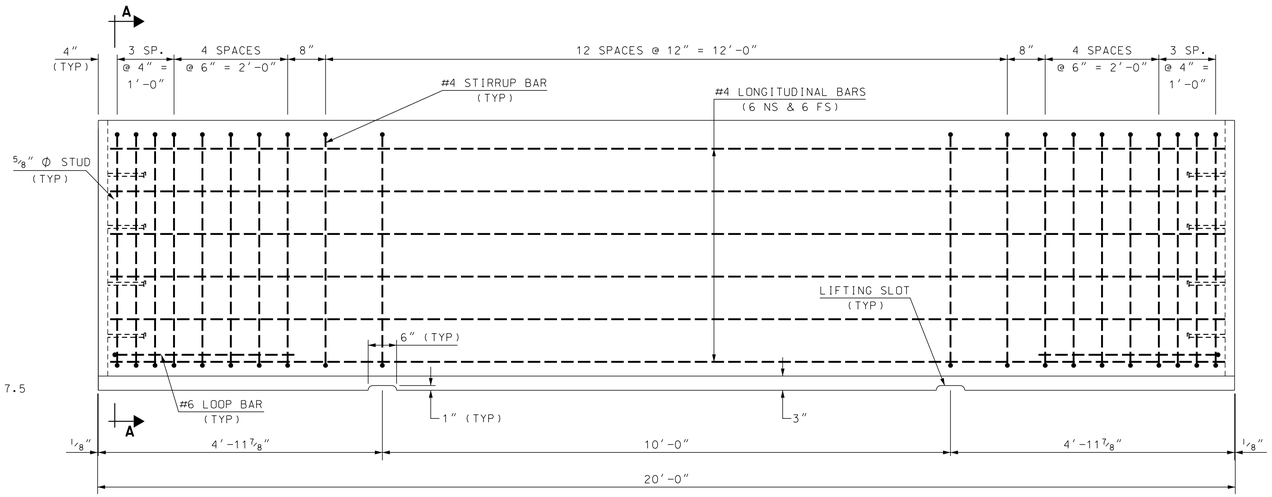
I-BEAM DETAILS

SCALE: 1" = 1'-0"



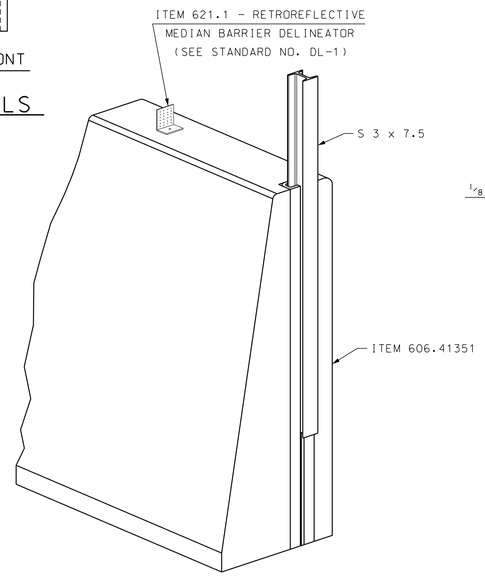
PLAN

SCALE: 3/4" = 1'-0"



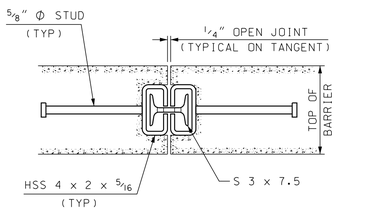
ELEVATION

SCALE: 3/4" = 1'-0"



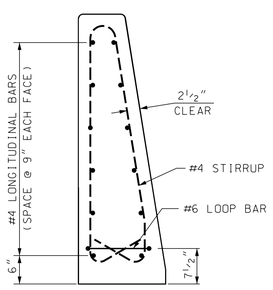
PERSPECTIVE VIEW

SCALE: 1" = 1'-0"



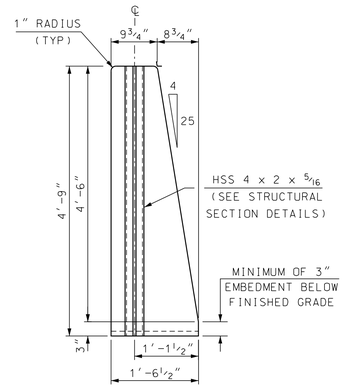
BARRIER CONNECTION DETAIL

SCALE: 2" = 1'-0"



SECTION A-A (REINFORCEMENT)

SCALE: 3/4" = 1'-0"

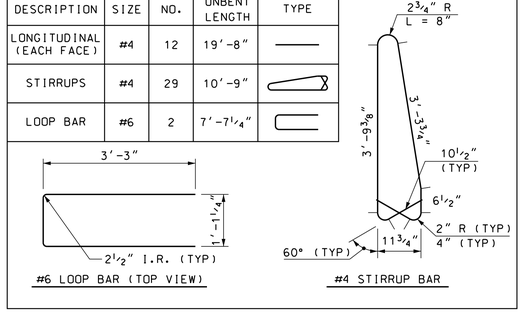


END VIEW (MASONRY)

SCALE: 3/4" = 1'-0"

CONCRETE BARRIER REINFORCING SCHEDULE

DESCRIPTION	SIZE	NO.	UNBENT LENGTH	TYPE
LONGITUDINAL (EACH FACE)	#4	12	19'-8"	
STIRRUPS	#4	29	10'-9"	
LOOP BAR	#6	2	7'-7 1/4"	



NO MODIFICATIONS SHALL BE MADE TO THIS SHEET.

GENERAL NOTES

1. CONCRETE BARRIER AND ALL ITS COMPONENTS SHALL BE FURNISHED BY THE CONTRACTOR AND PAID AS ITEM 606.41351, 54" SINGLE SLOPE CONCRETE BARRIER, SINGLE-FACED, PRECAST.
2. STUD WELDING SHALL BE IN ACCORDANCE WITH SECTION 547.
3. SLOTS IN STRUCTURAL TUBES SHALL BE CUT WITH MECHANICALLY GUIDED MEANS TO A SMOOTH, UNIFORM SURFACE MEETING A SURFACE ROUGHNESS OF 25 μ OR BETTER (ANSI B46.1).
4. CONCRETE BARRIER DETAILS SHOWN ON THIS SHEET ARE IN COMPLIANCE WITH REQUIREMENTS PER UPDATED NCHRP REPORT 350 FOR TEST NO. 5-11 (MASH TL-5), NCHRP 157 VOL. 1.

MATERIAL NOTES

1. THE BARRIERS SHALL BE LIGHT COLORED CLASS AA CONCRETE HAVING A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 4,000 PSI. BARRIERS SHALL HAVE A SMOOTH UNIFORM SURFACE FREE OF DEFECTS AND IRREGULARITIES. CASTING DATE SHALL BE SHOWN ON BARRIER. ALL EXPOSED EDGES OF CONCRETE SHALL BE CHAMFERED 3/4", UNLESS NOTED OTHERWISE.
2. I-BEAMS AND STRUCTURAL TUBES SHALL BE ASTM A36 OR A572 GALVANIZED AFTER FABRICATION, IN ACCORDANCE WITH SECTION 550.
3. ALL REINFORCING STEEL SHALL BE AASHTO M31 (ASTM-A615) GRADE 60, EPOXY COATED. REINFORCEMENT SHOWN IS THE MINIMUM REQUIRED.
4. EACH BARRIER UNIT SHALL INCLUDE ONE S 3 x 7.5.
5. SHOP DRAWINGS SHALL INCLUDE REINFORCING SCHEDULE.
6. LEVELING PADS, SHIMMING MATERIAL, AND FLOWABLE FILL SHALL BE SUBSIDIARY TO THE CONCRETE BARRIER.

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN	BRIDGE NO.	STATE PROJECT
LOCATION		

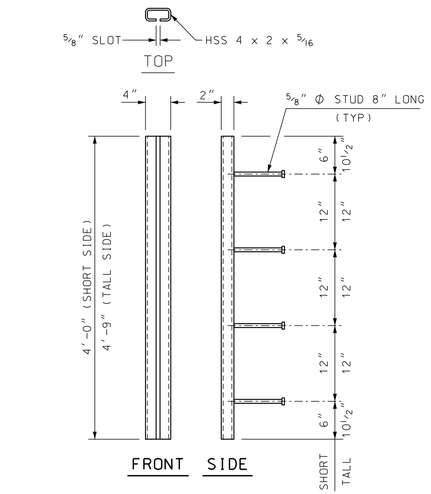
54" SINGLE SLOPE CONCRETE BARRIER SINGLE-FACED, PRECAST

BRIDGE SHEET OF

FILE NUMBER

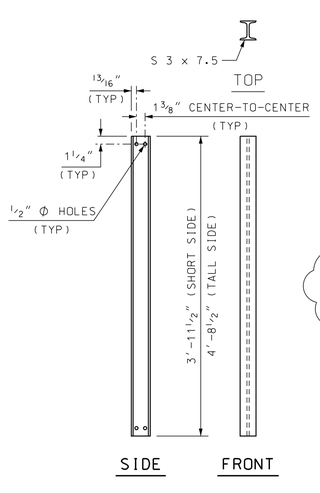
REVISIONS AFTER PROPOSAL		BY	DATE		BY	DATE
	DESIGNED	NHDOT	2/13	CHECKED	NHDOT	2/13
	DRAWN	GMC	2/13	CHECKED	ABH	2/13
	QUANTITIES	XX	XX	CHECKED	XX	XX
	ISSUE DATE	9/20/13	FEDERAL PROJECT NO.		SHEET NO.	TOTAL SHEETS
	REV. DATE	---				

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
English/VC PIER PRO	54SF-MED BARRIER	AS NOTED



STRUCTURAL SECTION DETAILS

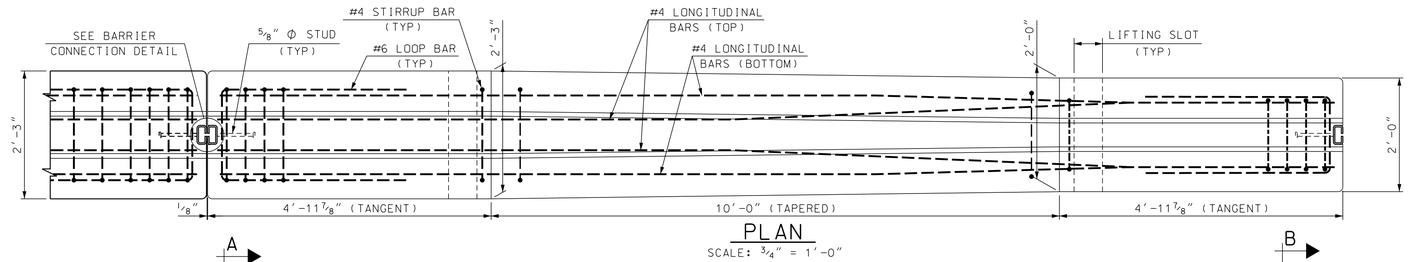
SCALE: 1" = 1'-0"



I-BEAM DETAILS

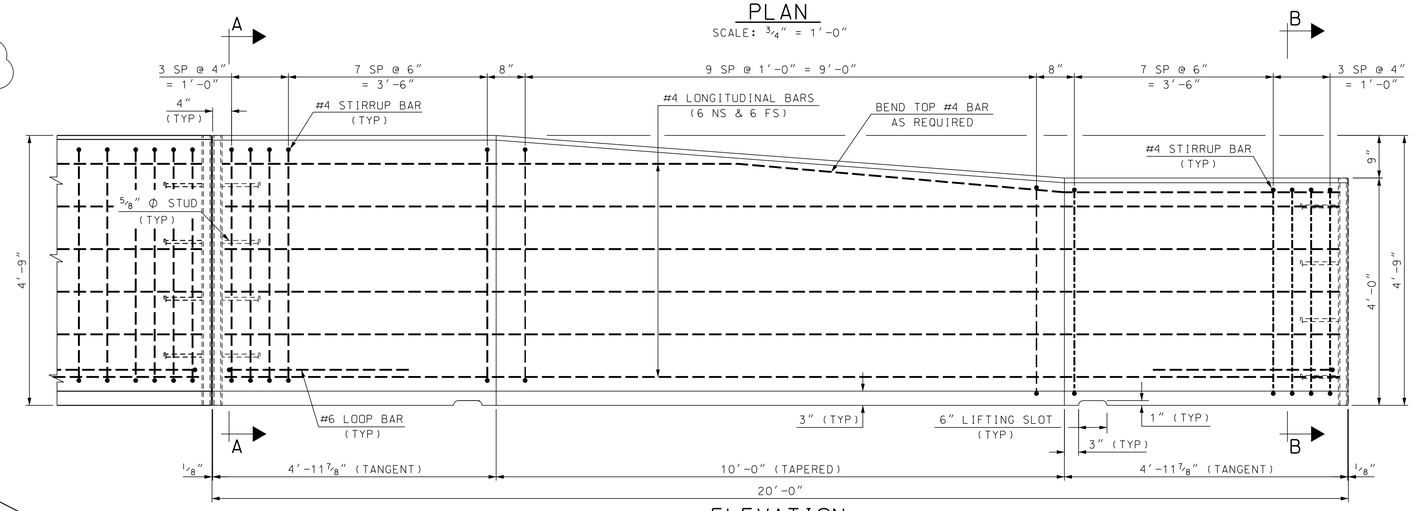
SCALE: 1" = 1'-0"

NO MODIFICATIONS SHALL BE MADE TO THIS SHEET.



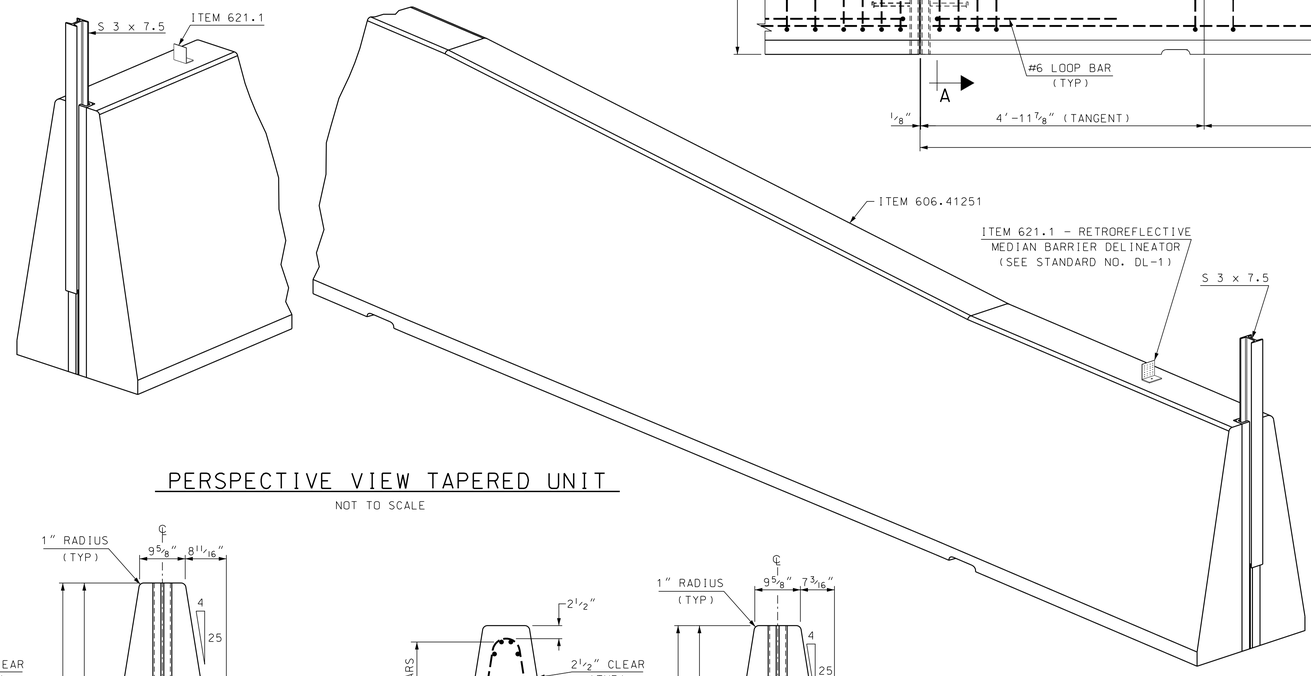
PLAN

SCALE: 3/4" = 1'-0"



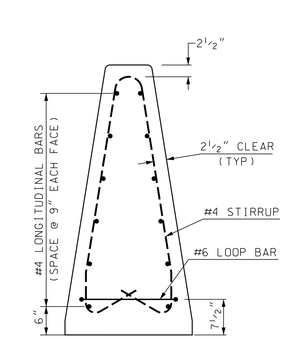
ELEVATION

SCALE: 3/4" = 1'-0"



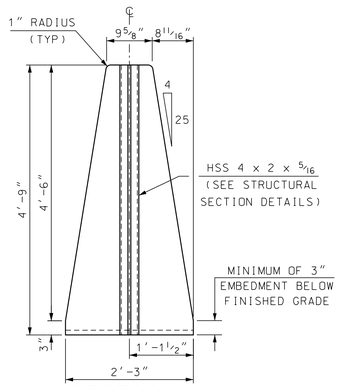
PERSPECTIVE VIEW TAPERED UNIT

NOT TO SCALE



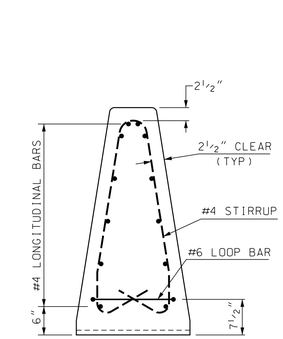
SECTION A-A (REINFORCEMENT)

SCALE: 3/4" = 1'-0"



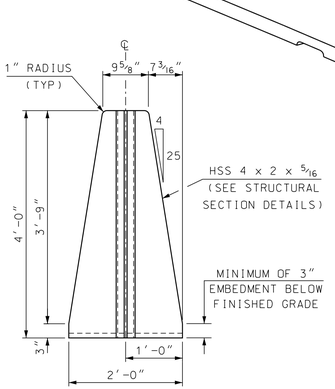
SECTION A-A (MASONRY)

SCALE: 3/4" = 1'-0"



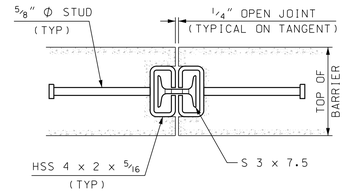
SECTION B-B (REINFORCEMENT)

SCALE: 3/4" = 1'-0"



SECTION B-B (MASONRY)

SCALE: 3/4" = 1'-0"



BARRIER CONNECTION DETAIL

SCALE: 2" = 1'-0"

GENERAL NOTES

1. CONCRETE BARRIER AND ALL ITS COMPONENTS SHALL BE FURNISHED BY THE CONTRACTOR AND PAID AS ITEM 606.41251, 54" TO 45" TRANSITION SINGLE SLOPE CONCRETE BARRIER, PRECAST.
2. STUD WELDING SHALL BE IN ACCORDANCE WITH SECTION 547.
3. SLOTS IN STRUCTURAL TUBES SHALL BE CUT WITH MECHANICALLY GUIDED MEANS TO A SMOOTH, UNIFORM SURFACE MEETING A SURFACE ROUGHNESS OF 25 μ OR BETTER (ANSI B46.1).
4. CONCRETE BARRIER DETAILS SHOWN ON THIS SHEET ARE IN COMPLIANCE WITH REQUIREMENTS PER UPDATED NCHRP REPORT 350 FOR TEST NO. 5-11 (MASH TL-5), NCHRP 157 VOL. 1.

MATERIAL NOTES

1. THE BARRIERS SHALL BE LIGHT COLORED CLASS AA CONCRETE HAVING A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 4,000 PSI. BARRIERS SHALL HAVE A SMOOTH UNIFORM SURFACE FREE OF DEFECTS AND IRREGULARITIES. CASTING DATE SHALL BE SHOWN ON BARRIER. ALL EXPOSED EDGES OF CONCRETE SHALL BE CHAMFERED 3/4", UNLESS NOTED OTHERWISE.
2. I-BEAMS AND STRUCTURAL TUBES SHALL BE ASTM A36 OR A572 GALVANIZED AFTER FABRICATION, IN ACCORDANCE WITH SECTION 550.
3. ALL REINFORCING STEEL SHALL BE AASHTO M31 (ASTM-A615) GRADE 60, EPOXY COATED. REINFORCEMENT SHOWN IS THE MINIMUM REQUIRED.
4. EACH BARRIER UNIT SHALL INCLUDE ONE S 3x7.5.
5. SHOP DRAWINGS SHALL INCLUDE REINFORCING SCHEDULE.
6. LEVELING PADS, SHIMMING MATERIAL, AND FLOWABLE FILL SHALL BE SUBSIDIARY TO THE CONCRETE BARRIER.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN	BRIDGE NO.	STATE PROJECT
LOCATION		

54" TO 45" TRANSITION SINGLE SLOPE CONCRETE BARRIER, PRECAST

BRIDGE SHEET OF FILE NUMBER

REVISIONS AFTER PROPOSAL		BY	DATE		BY	DATE
	DESIGNED	NHDOT	2/13	CHECKED	NHDOT	2/13
	DRAWN	GMC	2/13	CHECKED	ABH	2/13
	QUANTITIES	XX	XX	CHECKED	XX	XX
	ISSUE DATE	9/20/13	FEDERAL PROJECT NO.		SHEET NO.	TOTAL SHEETS
	REV. DATE	---				

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
English/VC PIER PRO	54SS-TAPERED UNIT	AS NOTED