FUSS & O'NEILL

February 4, 2020

Mr. Keith A. Cota, PE
Chief Project Manager
New Hampshire Department of Transportation
7 Hazen Drive
P.O. Box 483
Concord, NH 03302

Re: Connector Road over I-93, Exit 4A
Type, Span, and Location Study
Fuss & O'Neill Reference No. 20190127.A10

Dear Mr. Cota:

Fuss & O'Neill is pleased to provide the following TSL Report for the construction of the Exit 4A I-93 overpass bridge. This report summarizes the layout, superstructure type, and evaluates the substructure types for the proposed bridge.

Executive Summary

- The bridge will be a new I-93 overpass to accommodate the Exit 4A interchange.
- A two-span, steel girder bridge with a composite concrete deck is recommended.
- Semi-integral abutments bearing on bedrock is recommended.
- The pier is recommended to be a two-column hybrid hammerhead pier bearing on bedrock.

Roadway Profile

The profile of the Connector Road is based on providing a minimum 16'-6" vertical clearance over I-93, a 18'-0" minimum vertical clearance over the future railroad median corridor envelope, and accommodating the expected structure depth of the bridge. There will be intersections for the I-93 on and off ramps directly off of either end of the bridge. The profile elevation will dictate the length of the ramps needed to match into the recently constructed I-93 roadway; however, the ramp lengths must be set to avoid impacts to the Ash Street Bridge and Exit 4 ramps. Based on this it is desirable to provide the lowest profile elevation possible, and therefore the shallowest structure depth.

Proposed Bridge Layout

Two bridge layout options have been evaluated; placing the face of the abutments at the clear zone limit, and placing the toe of a 2 to 1 slope at the back of the drainage ditch with the abutments placed at the top of the slope. These options are discussed below.

Option 1 - Abutments at Clear Zone

This layout option places the face of the abutment 34 feet from the edge of the I-93 travel way. The abutment type consists of semi-integral abutments bearing on bedrock with a pier located in the I-93 median, see below for further discussion of the substructure types. This layout results in a two-span

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configuration of 147'-6" and 147'-6", for a total bridge length of 295 feet. The abutments and pier would be placed parallel to I-93, resulting in a skew of approximately 10-degrees.

This option provides a shorter span length than Option 2, and therefore a shallower structure depth. As noted previously, the shallower structure depth allows the roadway profile to be at a lower elevation thereby providing an easier tie-in for the ramps into I-93. This option is recommended as it provides a lower profile elevation than Option 2.

Option 2- Toe of Slope at Ditch

This layout option locates the toe of the 2 to 1 slope at the back of the roadway ditch. The abutment location is set based on providing approximately 2 feet of clearance from the bottom of the girder to the slope for inspection purposes. Stubs abutments at the top of the slope would be used. A pier will be located in the I-93 median. This layout results in a two span configuration of 189 feet and 189 feet, for a total bridge length of 378 feet. Similar to Option 1, the abutments and pier will be placed parallel to I-93, resulting in a bridge skew of approximately 10-degrees.

This option eliminates the need to construct the larger abutments used in Option 1. However, the structure depth is approximately 1'-7" deeper than Option 1, which will require a higher profile elevation and longer on/off ramps. It appears there is insufficient distance to accommodate the length of the northbound off ramp between the Ash Street Bridge and the proposed interchange; therefore, this option is not recommended.

Bridge Superstructure

The bridge out-to-out width will be 73'-0". Two 11-foot travel lanes and a 5-foot shoulder will be provided in the eastbound and westbound directions; with a 6-foot concrete median island with 2-foot shoulders on either side between. There will be curb with T3 bridge rail on the western side of the bridge, and a 6'-0" sidewalk with T4 bridge rail on the eastern side; protective screening will be provided on each side of the bridge.

Given the span lengths and the need for a shallow structure depth, a steel girder bridge with a composite concrete deck was selected as the proposed bridge type. The preliminary girder design provides eight girders spaced at 9'-6" on center. The approximate structure depth for Option 1, as described above, is 5'-8"; with a girder depth of 4'-6".

Steel girders could be weathering steel, galvanized, or metalized. Galvanizing is likely to be costly due to the need to have the galvanizing completed outside of the New England region due to the available kettle lengths. Weathering steel will be more susceptible to the salt spray from the interstate, therefore metalizing is recommended.

The use of precast, prestressed concrete beams was considered. Based on the PCI design charts for a 147'-6" span length the required beam type would be a 6'-0" deep NEBT or a 5'-5" deep deck bulb-tee. The NEBT beam results in a significantly deeper structure depth than the steel option, and

therefore is not recommended. The deck bulb-tee may provide a similar structure depth as the steel section, but would require three additional beams based on a typical flange width of 6'-0". It should also be noted that the PCI design charts are based on the use of a concrete strength of 8 ksi, and allow tension in the precompressed tensile zone, which has historically not been allowed per the NHDOT bridge design manual. The deck bulb tee is not recommended based on the need for the additional beams, which would likely increase construction costs.

Geotechnical

Borings have been completed at the approximate location of each proposed abutment and pier. The borings indicate that bedrock is approximately 5-feet below the existing ground surface at the abutment locations, and 3.5-feet below the ground surface at the pier location.

Abutment Type

Several abutment types have been evaluated for the recommended bridge layout; integral, semi-integral, cantilever, and MSE wrap stub abutments. There are currently drainage structures, swales and pipe, along the I-93 corridor that will need to be modified to accommodate the placement of the proposed abutments. The abutments will have an ashlar form liner finish to match the recently constructed I-93 overpass structures throughout the corridor. The evaluated abutment types are discussed below.

Integral Abutments

Integral abutments are not feasible for this location due to the height of the abutment and the shallow depth of the bedrock surface, as noted above.

Semi-Integral Abutment on Bedrock

Tall semi-integral abutments would be supported on spread footings founded on bedrock. The centerline of bearing for the abutment would be located 1'-6" behind the face of the abutment, which results in a two-span configuration of 147'-6" and 147'-6", for a total bridge length of 295 feet as noted previously. The semi-integral abutment will conform to the current NHDOT bridge design manual details, which have been included at the end of this report.

Approach slabs supported on sleeper slabs would be used at each abutment with compression seal expansion joints located the end of the approach slabs.

This is the recommended abutment type as it moves the expansion joint back from the superstructure and is the preferred abutment type when an integral abutment is not feasible.

Cantilever Abutment

A cantilever abutment would be similar in geometry to the semi-integral, but would utilize a backwall with an expansion joint placed either in front of or behind the backwall. This abutment type is not recommended as the semi-integral type is preferred and is feasible for this location.

MSE Wrap Abutment

This abutment type consists of a MSE wall with a stub abutment constructed directly behind it. The centerline of bearing for the stub abutment would be located 5-feet behind the face of the MSE wall, which results in a span configuration of 151 feet and 151 feet, for a total bridge length of 302 feet. This increases the span length 7 feet compared to the semi-integral type.

Stub abutments behind a MSE wall are required to be pile supported. Typically the piles are driven first and then the MSE wall is built around the piles so that the MSE anchors are arranged to avoid the piles. Due to the shallow bedrock elevation, the MSE wall would bear on bedrock, which would require the piles to either be installed with a rock socket, or driven after the wall construction is complete, which is not recommended due to the risk of damaging the wall reinforcing. The resulting piles would be approximately 20-feet in length. Drilling rock sockets and driving piles this short distance would be more difficult to construct than the semi-integral and increase the cost of this abutment type; therefore, this option is not recommended.

Pier Type

Three pier types have been evaluated for the recommended piers; wall pier, hammerhead piers, and multi-column pier. The pier will be placed in the median and will accommodate the placement of a future rail line on either side. These options are discussed below.

Wall Pier

A wall pier would extend the full width of the superstructure and be supported by a footing on bedrock. The proposed pier location can accommodate a rail line on either side with the required 18-foot vertical clearance.

Wall piers are typically used for stream crossings or grade separations with a narrow median. This pier type is not recommended because it requires the greatest amount of materials to construct since it is a solid wall and the bridge is relatively wide. It is more economical to use a pier type that can use less material.

Multi-Column Pier

This pier type would consist of a continuous pier cap that runs the full width of the superstructure supported by multiple concrete columns founded on a concrete footing on bedrock. Similar to the other pier types, the pier would be located in the I-93 median and will be able to accommodate a rail line on either side with the proper 18-foot vertical clearance.

Hybrid Hammerhead Pier

A hybrid hammerhead uses two columns with a single pier cap. This pier type matches other overpass structures along the corridor and requires less materials to construct compared to the wall pier. This pier type would be supported by a footing on bedrock, similar to the wall pier type. This pier type and

location will be able to accommodate a rail line on either side with the required 18-foot vertical clearance.

Maintenance of Traffic

Maintenance of traffic across the proposed bridge is not necessary as the bridge is a new crossing. However, access to the median for construction of the pier will be from I-93. The median is wide enough to construct the pier without closing lanes of I-93, but traffic control plans should accommodate construction equipment slowing down and entering the median. The traffic control plans will also need to account for superstructure work that cannot be completed over active traffic, such as the girder erection.

Recommendations

The recommended bridge type is a 295-foot, two span steel girder with a composite concrete deck supported on semi-integral abutments and a two-column hybrid hammerhead pier located in the I-93 median.

Cost Estimate

A preliminary cost estimate, for the bridge only, has been prepared using the slope intercept method. The cost for the base bridge items was calculated using a square foot cost of $230.00. This price was based on recently bid, similar type, projects.

295-Foot Two-Span Steel Structure

Base Bridge Items:	$ 6,900,000
Mobilization (10%):	$ 690,000
Engineering & Permitting (10%)	$ 760,000
Construction Engineering (15%)	$ 1,140,000
GRAND TOTAL	$ 9,490,000

Please contact me if you have questions, comments, or require any additional information.

Sincerely,

Jaime French

Jaime French, PE
Bridge Team Lead | Project Manager

Enclosures

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

BUREAU OF BRIDGE DESIGN

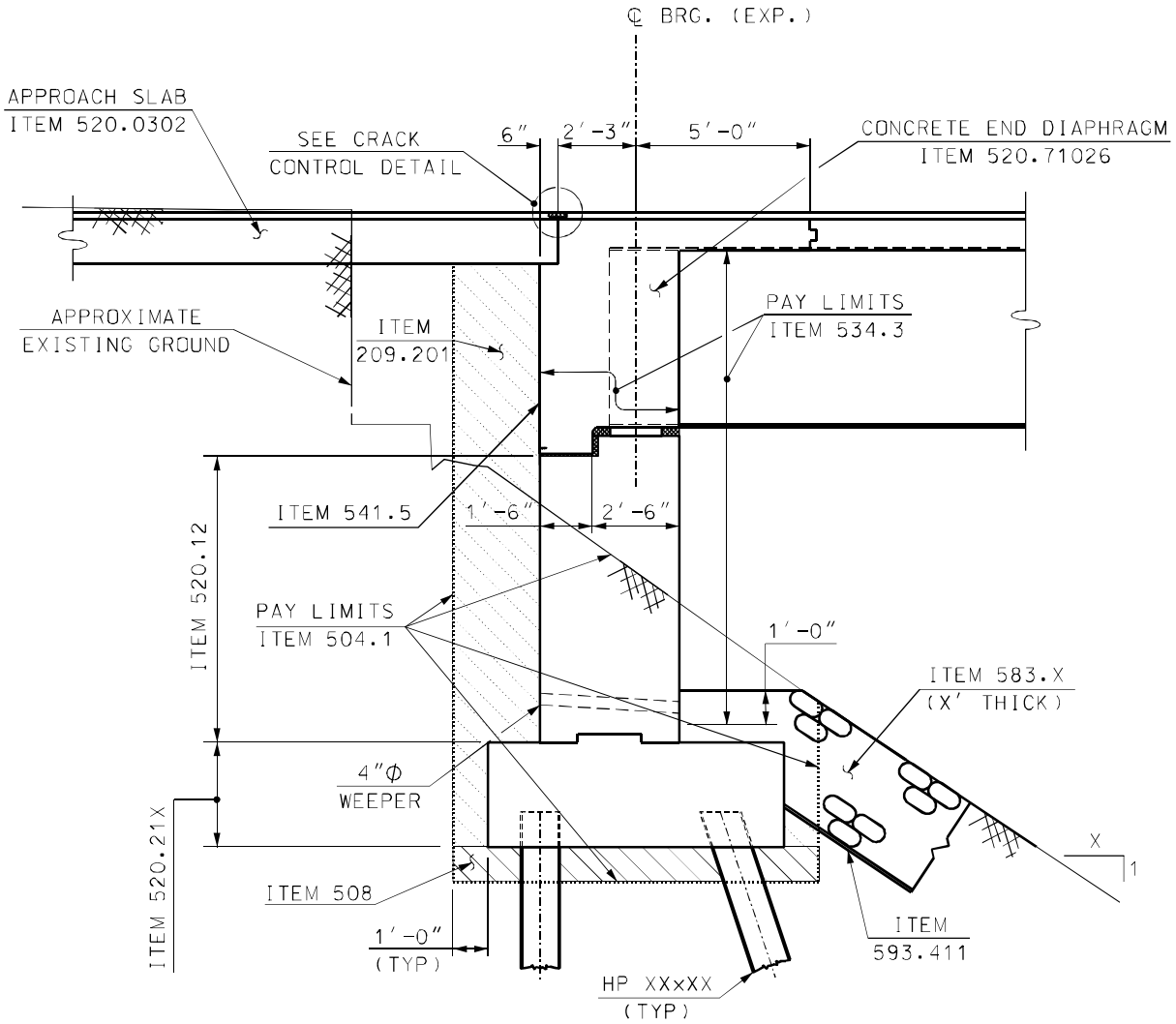
DESCRIPTION:

SUBSTRUCTURE DETAILS -

TYP. SEMI-INTEGRAL ABUTMENT SECTION

DATE REVISED:

2/8/2016



TYPICAL SEMI-INTEGRAL ABUTMENT SECTION

MODIFY TO FIT PROJECT

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

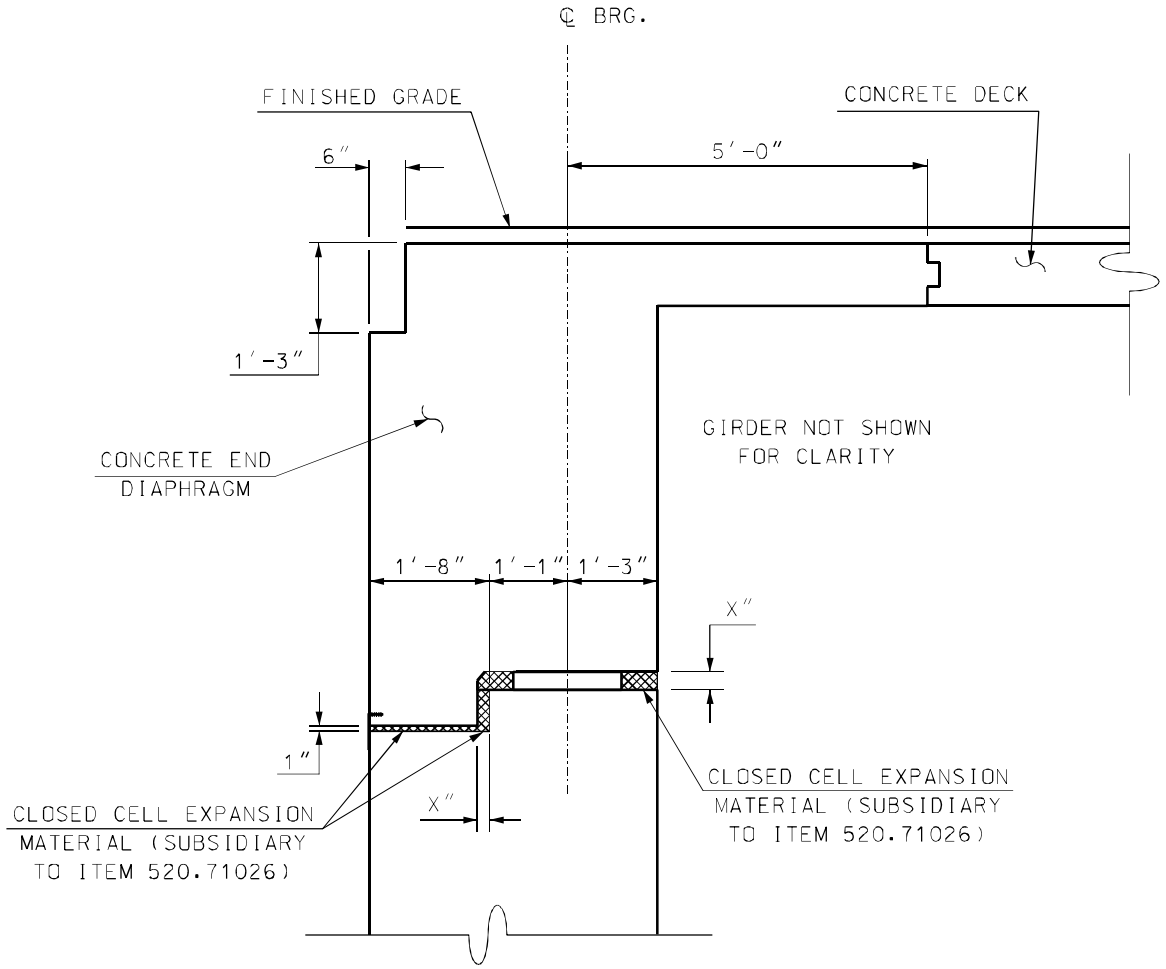
BUREAU OF BRIDGE DESIGN

DESCRIPTION:

SUBSTRUCTURE DETAILS -
TYPICAL SEMI-INTEGRAL DIAPHRAGM SECTION

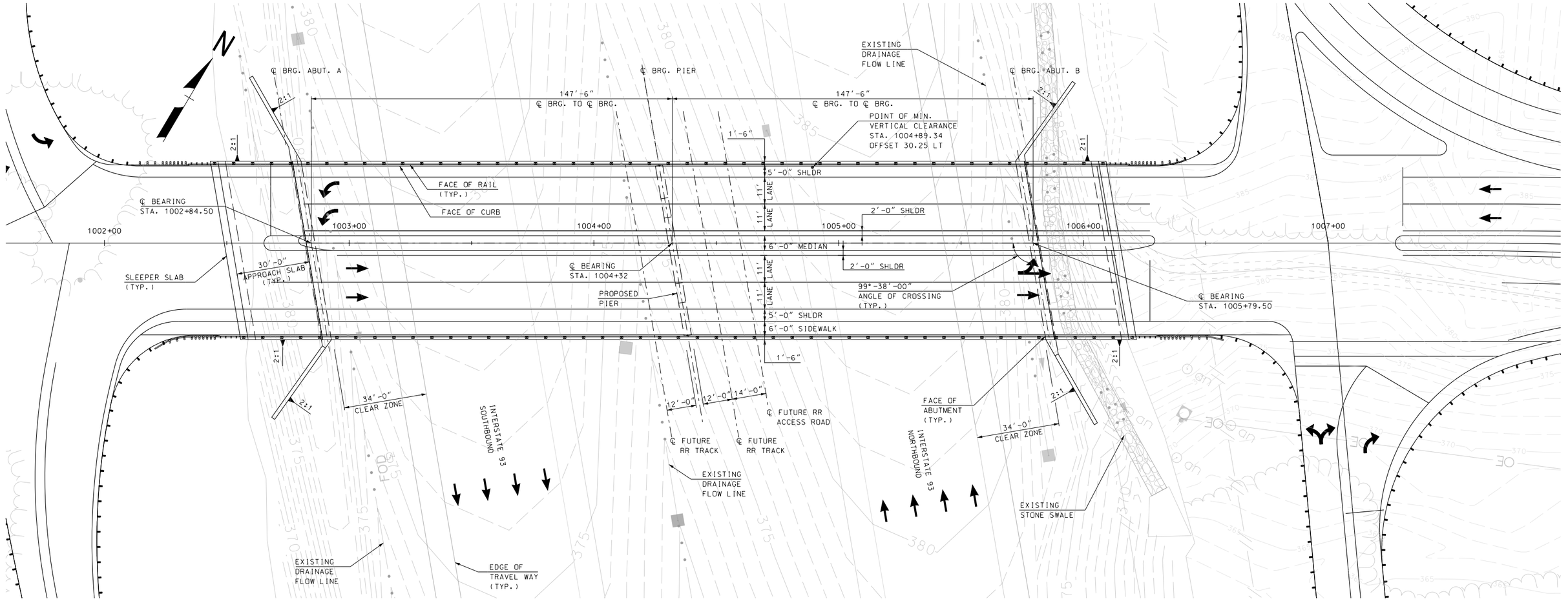
DATE REVISED:

2/8/2016



TYPICAL SEMI-INTEGRAL DIAPHRAGM SECTION

MODIFY TO FIT PROJECT

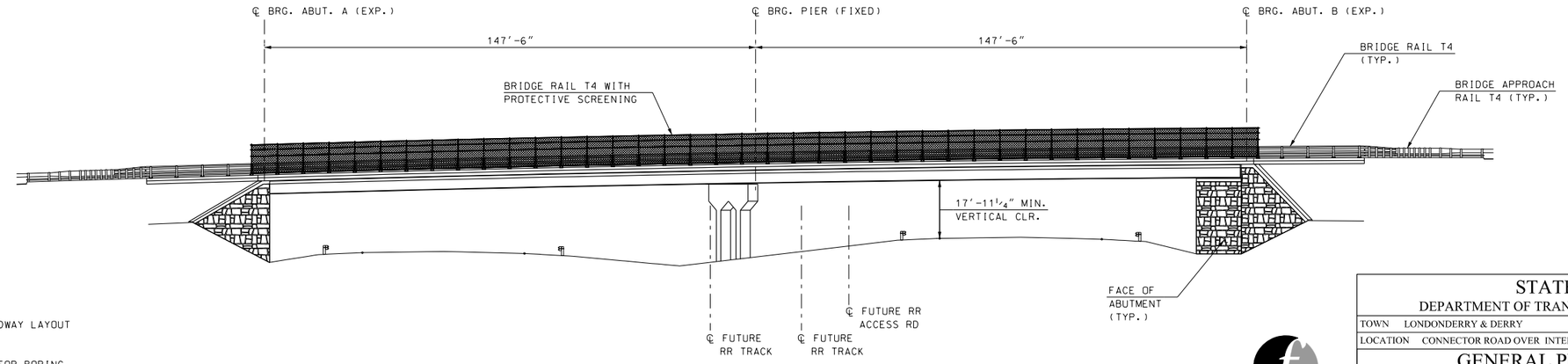


GENERAL PLAN

SCALE: 1′- 20′-0″

NOTES:

1. FOR BORING LOGS, SEE GEOTECH MEMO
2. FOR PROFILE, SEE XXX
3. FOR ROADWAY PLANS SEE XXX



ELEVATION

SCALE: 1′- 20′-0″

NOTES:

1. SEE ROLL PLANS FOR ROADWAY LAYOUT AND PROFILE.
2. SEE GEOTECHNICAL MEMO FOR BORING LOGS.

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SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
XX	13065Pre-Gen	AS NOTED

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

TOWN LONDONDERRY & DERRY BRIDGE NO. 130\129 STATE PROJECT 13065

LOCATION CONNECTOR ROAD OVER INTERSTATE 93

GENERAL PLAN AND ELEVATION

BRIDGE SHEET: 1 OF 2

FILE NUMBER:

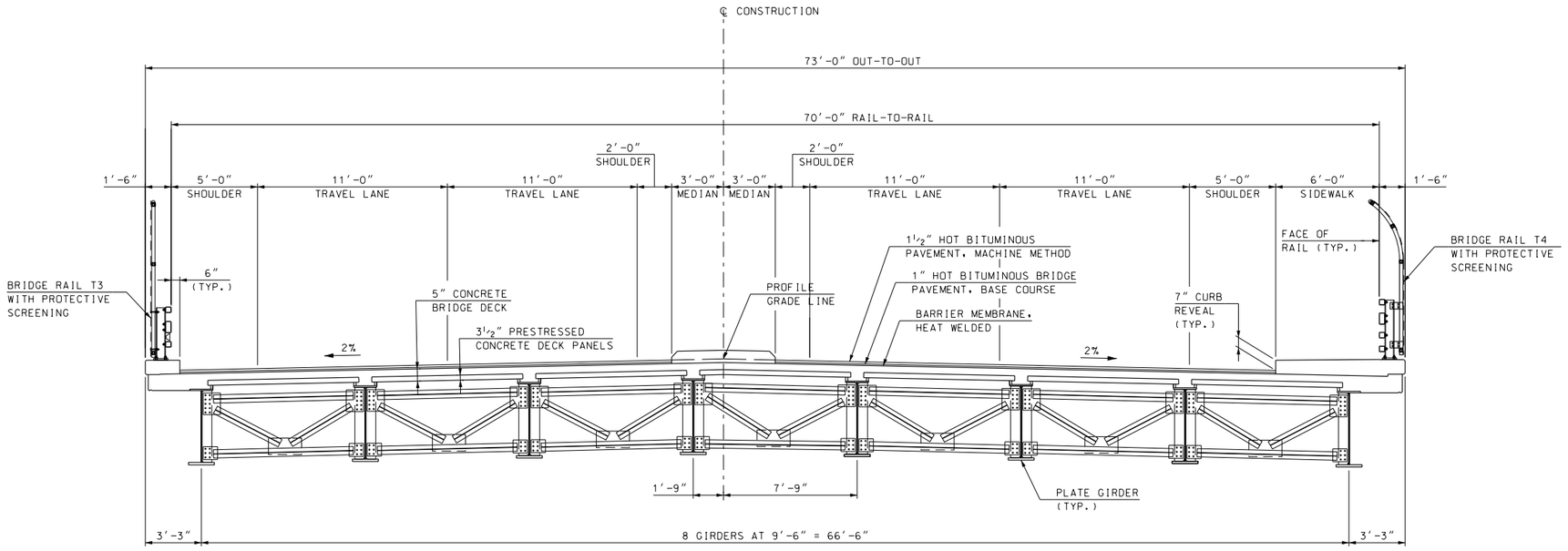
REVISIONS AFTER PROPOSAL	BY	DATE		BY	DATE
			DESIGNED	JF	1/20
			DRAWN	MWS	1/20
			QUANTITIES	ETC	1/20
			ISSUE DATE		
			REV. DATE		

CHECKED	ETC	1/20
CHECKED	JF	1/20
CHECKED	JF	1/20

FEDERAL PROJECT NO.: IM-0931(201)

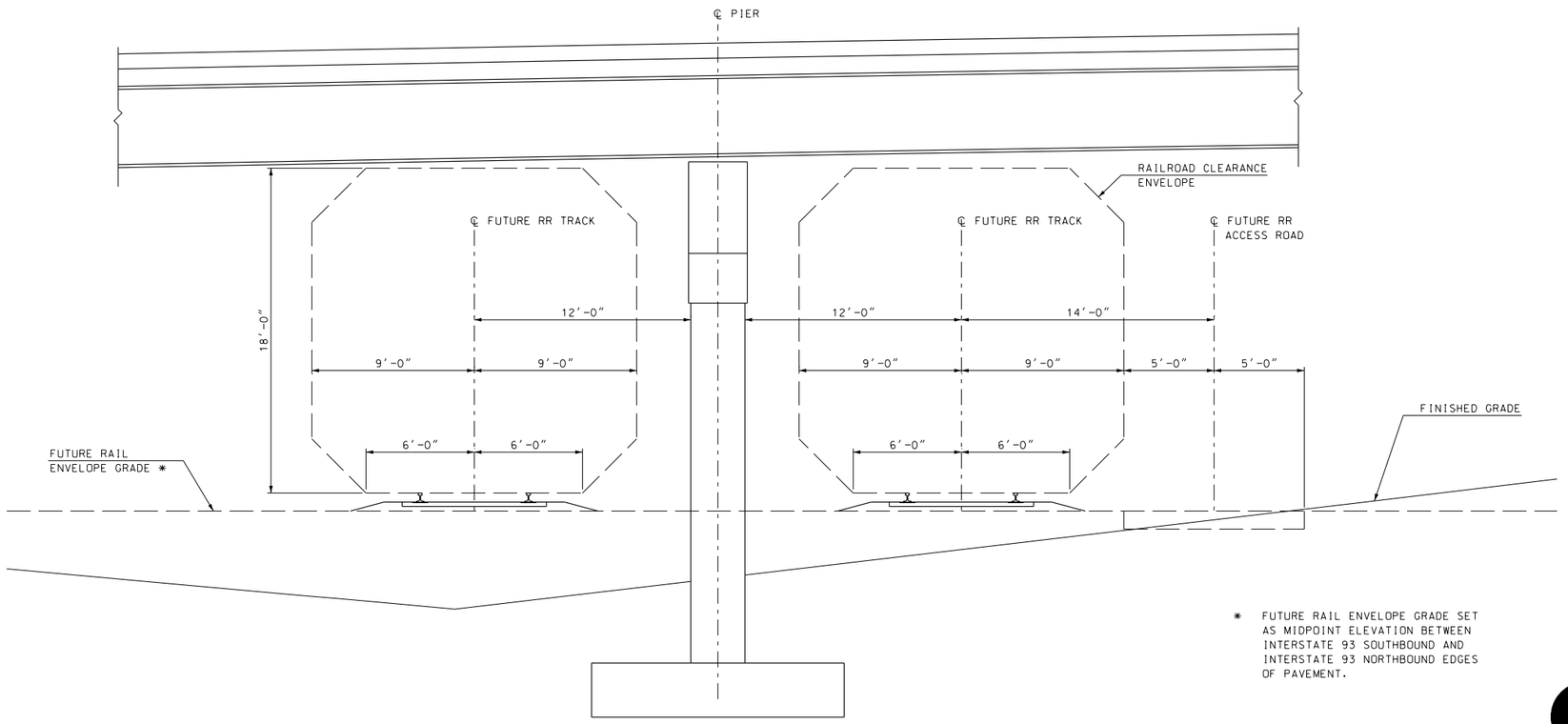
SHEET NO.: 1

TOTAL SHEETS: 2



TYPICAL DECK SECTION

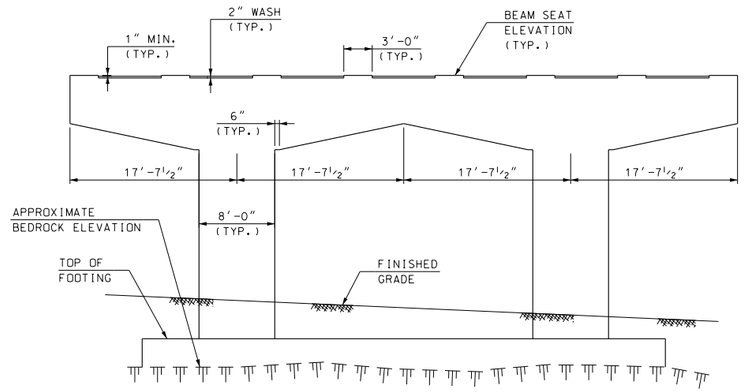
SCALE: ¼" = 1'-0"



FUTURE RAIL ENVELOPE

SCALE: ¼" = 1'-0"

* FUTURE RAIL ENVELOPE GRADE SET AS MIDPOINT ELEVATION BETWEEN INTERSTATE 93 SOUTHBOUND AND INTERSTATE 93 NORTHBOUND EDGES OF PAVEMENT.



PIER ELEVATION

SCALE: ⅛" = 1'-0"

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SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
XX	13065DeckSect	AS NOTED

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

TOWN LONDONDERRY & DERRY BRIDGE NO. 130\129 STATE PROJECT 13065

LOCATION CONNECTOR ROAD OVER INTERSTATE 93

TYPICAL BRIDGE SECTION

BRIDGE SHEET: 2 OF 2

REVISIONS AFTER PROPOSAL		BY	DATE		BY	DATE
	DESIGNED	JF	1/20	CHECKED	ETC	1/20
	DRAWN	MWS	1/20	CHECKED	JF	1/20
	QUANTITIES	ETC	1/20	CHECKED	JF	1/20
	ISSUE DATE		FEDERAL PROJECT NO.		SHEET NO.	TOTAL SHEETS
	REV. DATE		IM-0931(201)		2	2

FILE NUMBER