PRELIMINARY SLOPE STUDY REPORT

State Project No. 63-703
Relocation of I-91 NB Interchange 29 and
Widening of I-91 NB and State Route 5/15 NB to I-84 EB
Hartford and East Hartford, Connecticut

Prepared For:
State of Connecticut
Department of Transportation
Newington, Connecticut

Submitted: March 2016

Resubmitted: June 2016

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EXECUTIVE SUMMARY

Introduction

CME Associates, Inc. has been retained by the Connecticut Department of Transportation (ConnDOT) to re-design the Exit 29 off ramp from I-91 NB to Route 5/15 NB in Hartford under State Project Number 63-703. Part of this project involves widening I-91 NB and Route 5/15 NB before and after the proposed left hand exit ramp to accommodate an additional lane. Widening requires 5 steepened slopes to be constructed in order to avoid roadway, wetland, and right of way impacts. CME has been charged with developing a preliminary type study report for all of the slopes during the Preliminary Design (PD) Phase.

The I-91/I-84 Interchange and Charter Oak Bridge Project impacts many structures including the Charter Oak Bridge, see next page for a global map of the required slopes, impacted bridges, and proposed walls. This report is preliminary since the final alignment of the interchange is not yet approved. This type study describes the existing sites, provides at least three alternates for each reinforced slope, and presents our recommendations.

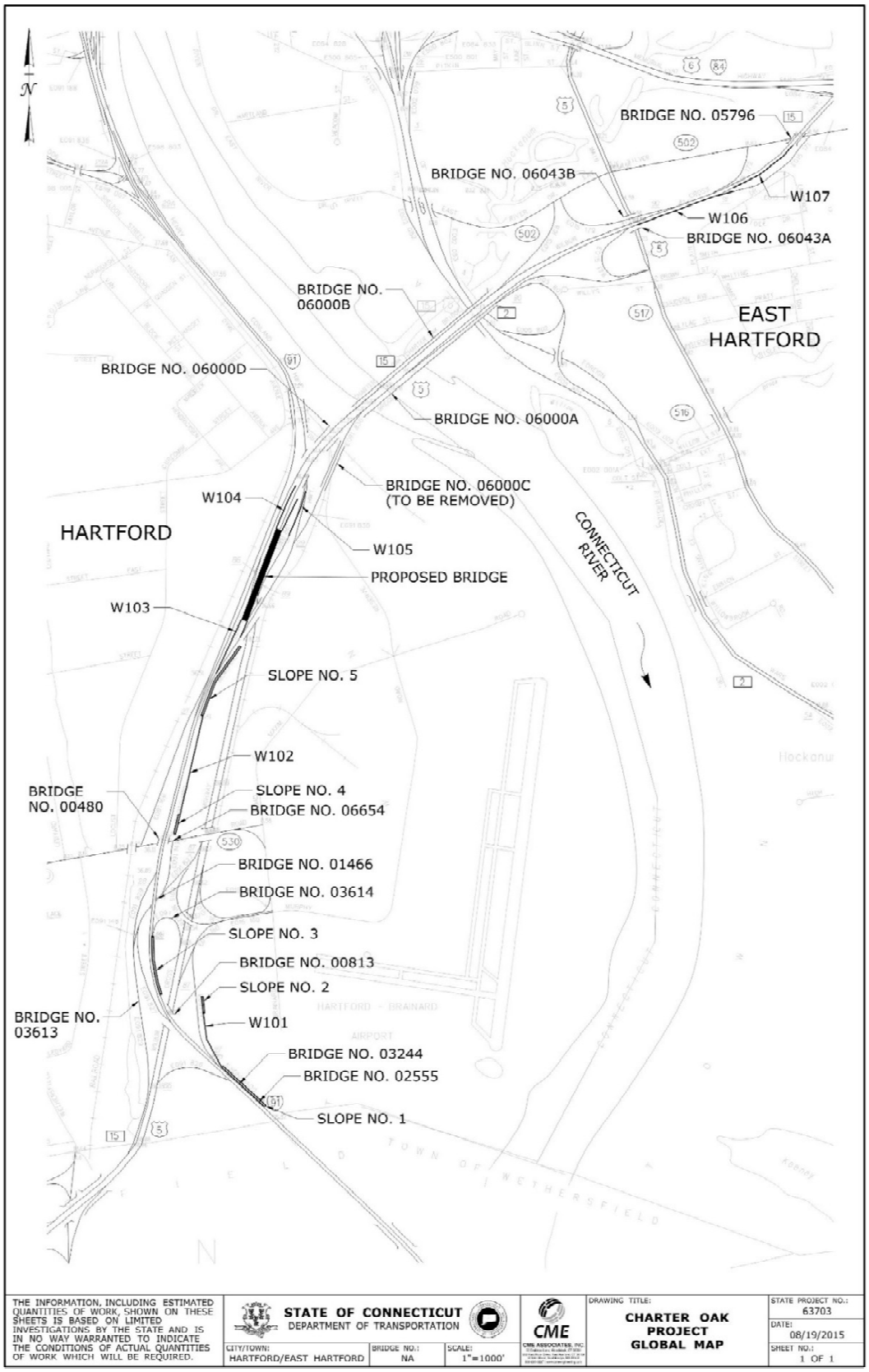
A locus map is enclosed for informational purposes as well as plan sheets showing the layout and limits of the slope. The historical and proposed borings are shown on the plan sheets and subsurface boring program is anticipated to be completed by the end of June 2016. Preliminary geotechnical analysis and calculations were completed based on historical borings in order to provide the recommended alternates discussed throughout this Slope Study Report. These results are discussed further in the sections below. Once subsurface explorations and laboratory tests are complete, we will conduct limit equilibrium analyses in each slope area. These evaluations will be summarized in the geotechnical report.

Preliminary slope stability evaluations based on the historical borings determined that each alternate provides a minimum factor of safety of 1.3 which is greater than the minimum required of 1.25 based on the CTDOT Geotechnical Engineering Manual.

Maintenance and Protection of Traffic

Maintenance and Protection of Traffic (MPT) on I-91 and Route 5/15 for the proposed slopes will be part of a project-wide traffic management plan.

This report contains more detailed descriptions of the anticipated construction staging including details of lane layouts on I-91 and Route 5/15 in the vicinity of the slope work zones. During construction, temporary shoulder and lane closures may be required in the vicinity of proposed reinforced slope for delivery of materials or installation of reinforcement.


N
BRIDGE NO. 05796
BRIDGE NO. 06043B
W107
W106
BRIDGE NO. 06043A
BRIDGE NO. 06000B
EAST HARTFORD
BRIDGE NO. 06000D
BRIDGE NO. 06000A
BRIDGE NO. 06000C (TO BE REMOVED)
W104
HARTFORD
W105
PROPOSED BRIDGE
CONNECTICUT RIVER
W103
SLOPE NO. 5
W102
BRIDGE NO. 00480
SLOPE NO. 4
BRIDGE NO. 06654
BRIDGE NO. 01466
BRIDGE NO. 03614
SLOPE NO. 3
BRIDGE NO. 00813
SLOPE NO. 2
BRIDGE NO. 03613
W101
BRIDGE NO. 03244
BRIDGE NO. 02555
SLOPE NO. 1
THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK, SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE CONDITIONS OF ACTUAL QUANTITIES OF WORK WHICH WILL BE REQUIRED.
STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION
CME
CME ASSOCIATES, INC.
DRAWING TITLE:
CHARTER OAK PROJECT
GLOBAL MAP
STATE PROJECT NO.: 63703
DATE: 08/19/2015
SHEET NO.: 1 OF 1
CITY/TOWN: HARTFORD/EAST HARTFORD
BRIDGE NO.: NA
SCALE: 1"=1000'

1.0 SLOPE NO. 1

1.1 Description

This section discusses the slope/structure types studied for Slope No. 1, located east of I-91 NB approximately between stations 105+50 and 112+60. It also describes the existing site, provides three alternates for the proposed slope, and presents CME's recommendations for the proposed soil/structure type.

Based upon the evaluation of the proposed slope, CME recommends Alternate 1, which consists of a reinforced slope.

The property to the east of I-91 NB at the location of widening is owned by the Metropolitan District (MDC). The widening along I-91 NB of up to 11' without a steepened slope would encroach on the MDC property. A steepened slope at this location can eliminate any fill slopes beyond the ROW limits eliminating the need for permanent easements and eliminate impacts to existing culverts, Bridge Nos. 02555 and 03244. The proposed alternates presented in this report were evaluated based on: construction duration, construction cost, existing conditions, and future maintenance concerns. All estimates are based on ConnDOT's estimating guidelines.

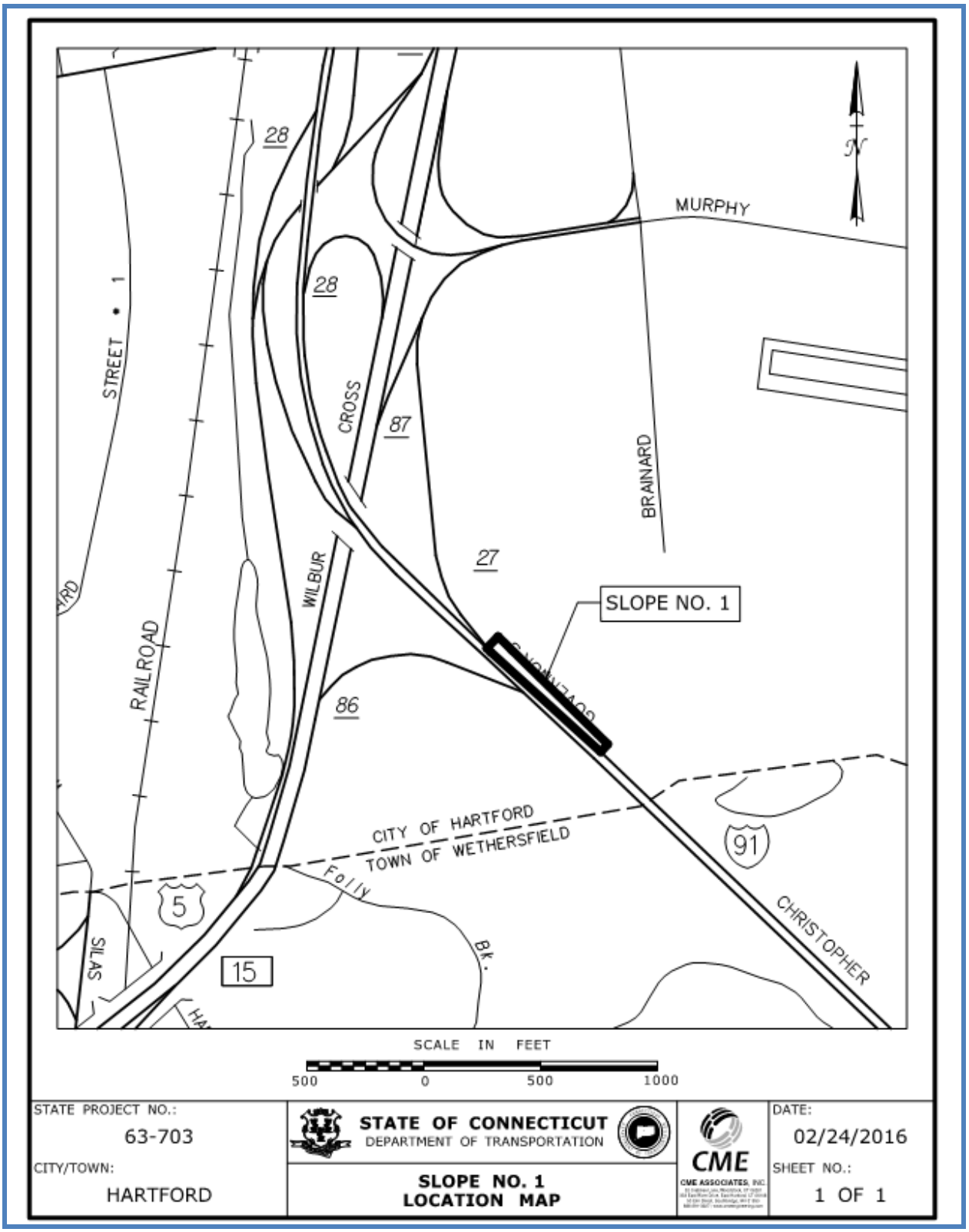
Highway Geometrics

The proposed roadway at Slope No. 1, I-91 NB, begins on a horizontal tangent which transitions to a horizontal curve with a 2836' radius. I-91 NB is located within a +1.0% back tangent for a 450' long crest vertical curve with a forward tangent of -3.70%.

Traffic

According to the most recent ConnDOT Traffic Log, the 2014 Average Daily Traffic (ADT) is approximately 128,200 vehicles for I-91 NB and SB traffic.

1.2 Location Map



1.3 Field Observations

Geotechnical Information

Previous subsurface explorations located near Slope No. 1 include test borings B-1, B-2, and CD3 which were drilled for Bridge No. 03244, I-91 and TR-826 SB over Drainage. Recent borings included, R-1, SRW-1 and S3244-1 which are shown on the enclosed plan sheets in Section 1.10. The following conditions were encountered:

Existing Borings

Thickness Range (ft.)	Stratum	Generalized Description
25 to 30	Sand and Silt	Gray and gray-brown, coarse to fine SAND, little coarse to fine SILT. Standard Penetration Test N-Values typically ranged from about 14 to 20 blows per foot (bpf).
20 to 30	Silt and Clay	Red-brown SILT, CLAY and silty CLAY with trace of fine SAND, layered with red-brown SILT, trace of coarse to fine SAND. SPT N-Values typically range from 6 to 13 bpf.
5 to 15	Glacial Till	Gray-brown and dark brown coarse to fine SAND, some coarse to fine gravel, little coarse to fine silt. SPT N-Values typically exceed 100 bpf.
	Bedrock	Red Shale
	Groundwater	Elevation -1 to 4 feet (5 to 10 feet below ground surface)

Recent Borings

Thickness Range (ft.)	Stratum	Generalized Description
1.5 to 29	Fill	Medium dense to dense, brown, coarse to fine SAND, little to trace medium to fine gravel, little to trace silt,.
27.5 to 47	Alluvium	Medium dense to dense, brown to gray coarse to fine SAND, little to trace silt
Greater than 9	Lacustrine Deposit	Very soft, varved red CLAY and gray SILT, silt varves approximately 1/8 inch thick and clay varves 1/16 inch thick, varying to Silty CLAY
Greater than 2	Glacial Till	Very dense, red-brown, Clayey SILT, little gravel, little fine sand, varying to red-brown fine SAND, some silt, little gravel. Only in boring S-3244-1
	Groundwater	6.5 feet to 32 feet below existing ground surface

Based on conditions encountered in the previous and recent borings, the subsurface conditions appear suitable to provide support to the proposed slope regrading. Preliminary review of the data suggests that settlement due to the increase in stress from the addition of fill to support the I-91 NB Exit 27 lane will be tolerable (less than about 1 inch) and will occur within a short period of time following fill placement. Further evaluation of subsurface conditions and settlement will be conducted following completion of the proposed subsurface exploration and laboratory testing program which are currently underway.

There will be a required transition area from the 1.5:1 slope to the 2:1 embankment slope behind wall W101, which is located at the end of the slope. This transition will take place behind the wall. When slope is steeper than 2:1 a reinforced slope shall be required.

Property

Considering the width of the existing right-of-way, permanent easements are not anticipated. Construction easements are shown on the Preliminary Design Plans paralleling the property line to allow the constructor adequate space for construction. Noise impacts to commercial and private property owners in the immediate vicinity surrounding the bridge are anticipated to be minimal and the noise level is not anticipated to exceed ambient noise generated by current highway traffic.

Cultural Resources

Developed commercial areas are present to the north. Brainard Airport is approximately 0.5 miles to the northeast. To the west approximately 0.3 miles, the Providence & Worcester Railroad provides freight service to the Wethersfield Secondary.

Environmental Resources

The Connecticut River is located approximately 0.6 miles east of the bridge with access at Charter Oak Landing approximately 1.7 miles to the north. Wethersfield Cove is approximately 0.2 miles to the south.

1.4 Design Criteria

Slopes will be designed in accordance with the FHWA publication *Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines* and Connecticut Department of Transportation Geotechnical Engineering Manual.

1.5 Seismic Considerations

Slope structures are resistant to dynamic forces from a seismic event due to their flexibility. In viewing a reinforced embankment similar to a retaining wall, a seismic design is not required according to the ConnDOT Bridge Manual Section 4.4.

1.6 Slope/Structure Type Alternates

Based on the preliminary design layout for the interchange, the proposed slope will begin at Sta. 105+50 and end at Wall W101 at Sta. 112+60, see Figure 1.1 below. Two slope types have been studied as well as a retaining structure. Each alternate will prevent impacts.

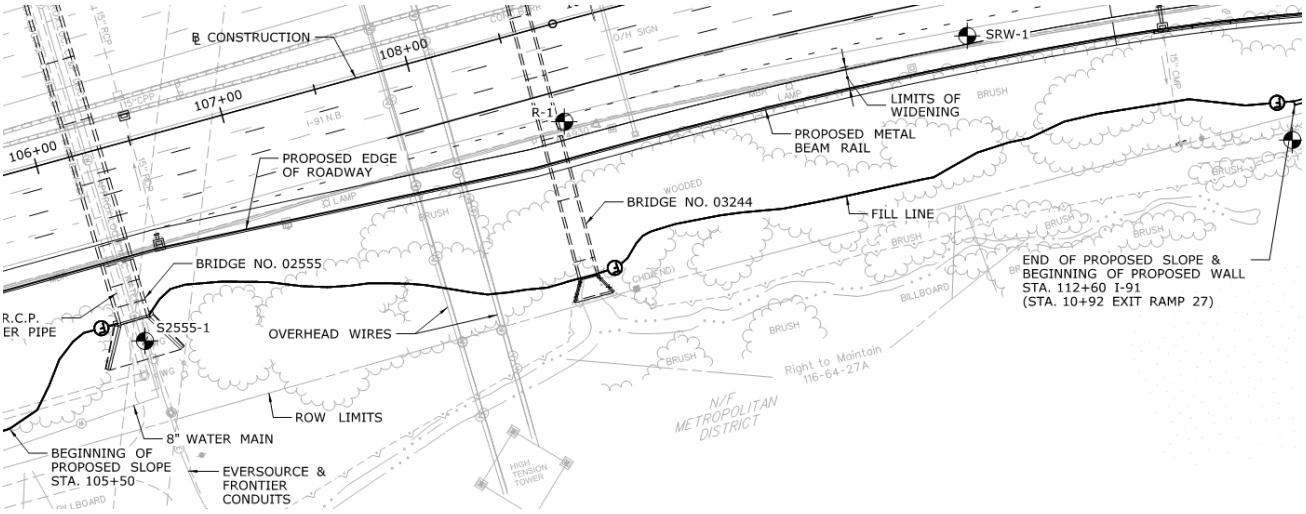


Figure 1.1 – Plan View

Slopes will be evaluated for global stability under both static and seismic conditions, as well as for anticipated settlement.

The constructability was investigated as part of this study and a general sequence is outlined. The slope can be constructed during Stage 2 of the overall project.

Cost Considerations

Section 1.10 contains an itemized cost estimate for all of the alternatives including the percentages used for the additional costs. The table below provides a summary of the total costs.

Proposed Alternates	Cost of Structure Only	Additional Costs	Rounded Total Cost
1 – Reinforced Slope	$ 540,000	$ 553,000	$1,093,000
2 – Stone Stabilization	$ 517,000	$ 535,000	$1,052,000
3 – Retaining Wall	$ 1,190,000	$ 1,086,000	$2,276,000

Additional Costs – Breakdown*	Alternate 1	Alternate 2	Alternate 3
Minor Items (10% of Structure Cost)	$ 54,000	$ 52,000	$ 119,000
Clearing and Grubbing	$ 9,000	$ 9,000	$ 9,000
Maintenance and Protection of Traffic	$ 50,000	$ 520,000	$ 50,000
Mobilization	$ 30,000	$ 29,000	$ 66,000
Construction Staking	$ 9,000	$ 9,000	$ 9,000
Incidentals and Contingencies	$ 209,000	$ 201,000	$ 434,000
Escalation to Midpoint Construction Year	$ 192,000	$ 185,000	$ 399,000
Total:	$ 553,000	$ 535,000	$ 1,086,000

Alternate 1 – Reinforced Slope

This alternate includes placement of uniaxial geogrid reinforcement layers to help strengthen the proposed fill slope areas and provide a required factor of safety. The slope height varies from 16' to 36'. Maximum height is located at Bridge No. 03244, a drainage culvert at Sta. 108+66. Slopes vary from 2:1 to 1.5:1 between Sta.105+50 to 109+00 and a constant slope of 1.5:1 from Sta. 109+00 to Sta. 112+60. Slope heights are found where existing grade and proposed slopes intersect.

The preliminary evaluation indicates that slopes with heights up to 20' tall will require a primary geogrid reinforcing length of 6', while a slope between 20' and 40' tall will require a geogrid length of 12', spaced at 3' intervals over the height of the slope. In addition to primary reinforcing, assume additional secondary reinforcing made up of shorter lengths of uniaxial geogrid to limit shallow, surficial failures. This reinforcing is generally placed at 1' intervals between the primary reinforcing with a length of 3' to 5'. It is assumed that slopes steeper than 2:1 will require reinforcing. Actual geogrid lengths are dependent on final slope geometry. See Figure 1.2 below.

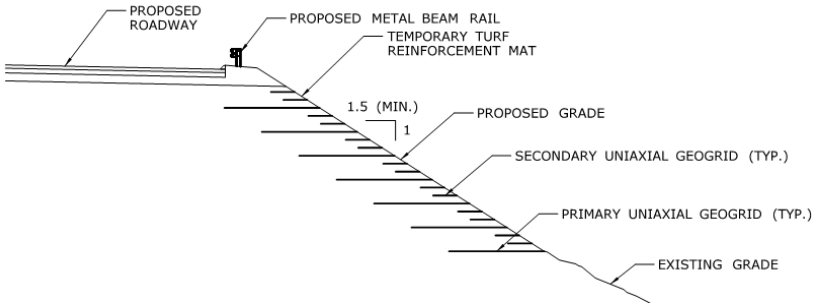


Figure 1.2 – Reinforced Slope

The following are the advantages and disadvantages of a reinforced slope:

Advantages Alternate 1	Disadvantages Alternate 1
+ Cost is less than other alternates	– More excavation required for long geogrid reinforcement tiebacks than Alternate 3
+ More desirable aesthetics than Alternate 2	–

Alternate 2 – Stone Stabilization

This alternate consists of stabilizing a steepened slope. Typical CTDOT steepened slopes are protected with crush stone with only a 1 foot blanket of crushed stone placed on 6" granular fill base. Preliminary slope stability evaluations based on the historical borings suggest that additional stone is necessary. Additional evaluations will be conducted once the subsurface exploration program and results of laboratory testing are complete.

Slopes vary from 2:1 to 1.5:1 between Sta.105+50 to 109+00 and a constant slope of 1.5:1 from Sta. 109+00 to Sta. 112+60. The steepened slope is stabilized with use of CTDOT No. 4 (2 inch minus) stone. Based on preliminary evaluation, slopes less than 20' high will require a toe thickness of 5' (measured horizontally) at the toe. Slopes 20' to 40' will require a slope toe stone thickness of approximately 13'. Stone geometry is dependent on final slope geometry. See Figure 1.3 below.

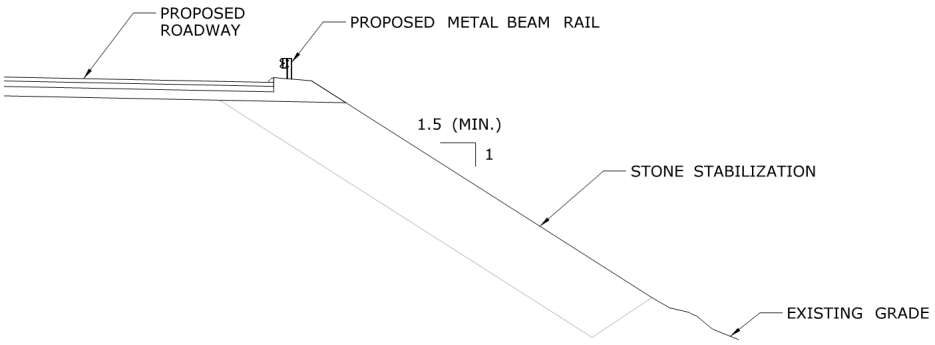


Figure 1.3 – Stone Stabilization

The following are the advantages and disadvantages of a slope stabilization:

Advantages Alternate 2	Disadvantages Alternate 2
+ Cost is less than Alternate 3	– Undesirable impact on aesthetics
+	– Cost is greater than Alternate 1
+	– More excavation required for long geogrid reinforcement tiebacks than Alternate 3

Alternate 3 – Retaining Wall

This alternate consists of a retaining wall backfilled with pervious structure backfill. The wall is located at the base of the slope. This wall is an embankment wall with an embankment slope of 2:1, see Figure 1.4 below. The proposed wall will require modifications to the following culvert headwalls to allow for the 2:1 slope, Bridge No. 02555 and 03244.

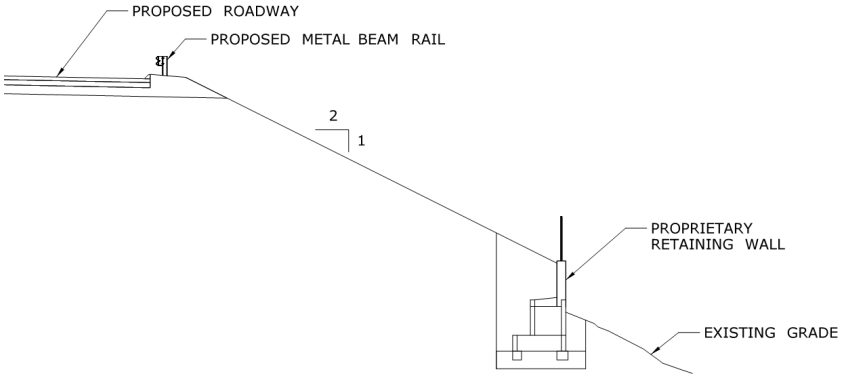


Figure 1.4 – Retaining Wall

A proprietary wall is chosen over a CIP wall based on ConnDOT Bridge Design Manual criteria. Where a wall height less than 8' (measured from front slope to back slope) an embankment wall is preferred. Maximum wall height is 7.1'. An embankment wall is defined by the Bridge Design Manual as a proprietary wall system and supports an embankment.

The following are the advantages and disadvantages of a retaining wall:

Advantages Alternate 3	Disadvantages Alternate 3
+ No slope greater than 2:1 will be required	– Impact to traffic is greater due to delivery of precast materials
+ Less excavation required than other alternates	– Cost is greater than other alternates
+	– Additional cost required for a vertical headwall extension at the following culverts, Bridges Nos. 02555 and 03244

1.7 Recommendations for Construction

Although Alternate 2 is less expensive than Alternate 1, Alternate 2 has an undesirable impact on aesthetics based on the CTDOT Highway Design Manual Section 10-2.02 and the use of crushed stone should be minimized. Therefore CME recommends Alternate 1 as the preferred alternative for the proposed slope. During the Final Design Phase, the two culverts, Bridge Nos. 02555 and 03244, will be analyzed with a load rating due to an increase of fill on the existing culvert.

1.8 Utility and Drainage Impacts

Below I-91 the following utilities are located in the culvert below Clark Dike Service Road, Bridge No. 02555. These utilities may be effected by the compressive soils added on the culvert due to widening:

- 42” R.C.P sewer pipe
- 8” water main
- (2) 3” Iron Conduits for Frontier Communications
- (3) 4” Iron Conduits for Eversource

No modifications are required to Bridge No. 03244 a drainage box culvert below I-91 or the 15” corrugated metal drainage pipe due to the proposed slope.

There is also roadway luminaires along I-91 NB and catch basin drainage pipes which may require location due to widening. The high tension powerlines located above the proposed wall are not anticipated to be modified. Currently there are two drainage catch basins proposed along on the showers in the limits of Slope No. 1. AASHTO requires design modifications for catch basins within the limits of reinforcement which includes one of the follow:

- Assume reinforcements layers are severed in location of catch basin and design the surrounding layers to carry the additional load.
- Place a structural frame around catch basin.
- May be possible to splay the layers around catch basin if soil reinforcement consist of discrete strips.

1.9 Construction Sequence and Maintenance & Protection of Traffic

The construction of the proposed slope is part of a larger interchange reconstruction project. Full construction staging plans are developed. Based on work to date and staging plans submitted in the PD submittal, the overall sequence of construction is as follows:

Stage 2

1. Shift I-91 NB and Exit 27 to the left, maintaining 3 lanes and 1 lane of traffic respectively.
2. Construct reinforced slope.

Stage 3

1. Shift I-91 NB and Exit 27 to the right.

1.10 Backup Data

Cost Comparisons

Proposed Plans

Stage Construction Plans

CME	COMPUTATION BY: JLS	DATE: 2/23/16	SHEET: 1 OF: 1
	CHECKED BY: TEG	DATE: 3/3/16	CME PROJECT NO.
	CLIENT: ConnDOT Charter Oak Bridge Project		CLIENT PROJECT NO.: 063-0703
ITEM: Slope No. 1 - Alternate 1 - Soil Reinforcement			

Alternate 1: Soil Reinforcement

1. Excavate for reinforced slopes
2. Install reinforced slopes

STRUCTURE ITEMS

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
0203000	Structure Excavation - Earth (Complete)	CY	6,225	$29.00	$181,000
0712010	Reinforced Soil Slope	SF	17,620	$20.37	$359,000
				Structure Total:	$540,000
				STRUCTURE PLUS ROADWAY SUBTOTAL 1:	$540,000

MINOR ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Minor Items (10% of Subtotal 1)	LS	1	$54,000.00	$54,000
			SUBTOTAL 2:	$54,000

LUMP SUM ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Clearing and Grubbing (1.0% of Subtotal 1 and 2)	LS	1	$8,240.00	$9,000
M & P of Traffic (6.0% of Subtotal 1 and 2)	LS	1	$49,440.00	$50,000
Mobilization (5% of Subtotal 1 and 2)	LS	1	$29,700.00	$30,000
Construction Staking (1.0% of Subtotal 1 and 2)	LS	1	$8,240.00	$9,000
			SUBTOTAL 3:	$98,000

ENGINEERING PERCENTAGES		TOTAL
Incidentals (10% of Subtotal 1, 2, and 3)	10% INCIDENTALS	$70,000
Contingency (20% of Subtotal 1, 2, and 3)	20% CONTINGENCY	$139,000
	SUBTOTAL 4:	$209,000

ESCALATION TO YEAR OF CONSTRUCTION		TOTAL
5% INFLATION FOR 4.25 YEARS (from estimate date to midpoint of construction=Subtotal*0.05*4.25)	SUBTOTAL 6:	$192,000
	TOTAL	**$1,093,000**

CME	COMPUTATION BY: JLS	DATE: 2/23/16	SHEET: 1	OF: 1
	CHECKED BY: TEG	DATE: 3/3/16	CME PROJECT NO.	
	CLIENT: ConnDOT Charter Oak Bridge Project		CLIENT PROJECT NO.: 063-0703	

ITEM
Slope No. 1 - Alternate 2 - Stone Stabilization

Alternate 2: Stone Stabilization

1. Excavate for stone stabilization slope
2. Install stones

STRUCTURE ITEMS

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
0203000	Structure Excavation - Earth (Complete)	CY	5,255	$29.00	$153,000
0728031	No. 4 Crushed Stone	CF	226,898	$1.60	$364,000
				Structure Total:	$517,000
				STRUCTURE PLUS ROADWAY SUBTOTAL 1:	$517,000

MINOR ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Minor Items (10% of Subtotal 1)	LS	1	$51,700.00	$52,000
			SUBTOTAL 2:	$52,000

LUMP SUM ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Clearing and Grubbing (1.0% of Subtotal 1 and 2)	LS	1	$8,240.00	$9,000
M & P of Traffic (6.0% of Subtotal 1 and 2)	LS	1	$49,440.00	$50,000
Mobilization (5% of Subtotal 1 and 2)	LS	1	$28,450.00	$29,000
Construction Staking (1.0% of Subtotal 1 and 2)	LS	1	$8,240.00	$9,000
			SUBTOTAL 3:	$97,000

ENGINEERING PERCENTAGES		TOTAL
Incidentals (10% of Subtotal 1, 2, and 3)	10% INCIDENTALS	$67,000
Contingency (20% of Subtotal 1, 2, and 3)	20% CONTINGENCY	$134,000
	SUBTOTAL 4:	$201,000

ESCALATION TO YEAR OF CONSTRUCTION		TOTAL
5% INFLATION FOR 4.25 YEARS (from estimate date to midpoint of construction=Subtotal*0.05*4.25)	SUBTOTAL 6:	$185,000
	TOTAL	**$1,052,000**

	COMPUTATION BY	DATE	SHEET	OF
CME	JLS	2/25/16	1	1
	CHECKED BY	DATE	CME PROJECT NO.	
	TEG	3/3/16		
	CLIENT		CLIENT PROJECT NO.	
	ConnDOT Charter Oak Bridge Project		063-0703	

ITEM
Slope No. 1 - Alternate 3 - Prefabricated Modular Wall

Alternate 3: Prefabricated Modular Wall

1. Excavate for new wall
2. Install Granular Fill
3. Install prefabricated modular wall
4. Backfill with Pervious Structure Fill
5. Install 5' Chain Link Fence

STRUCTURE ITEMS

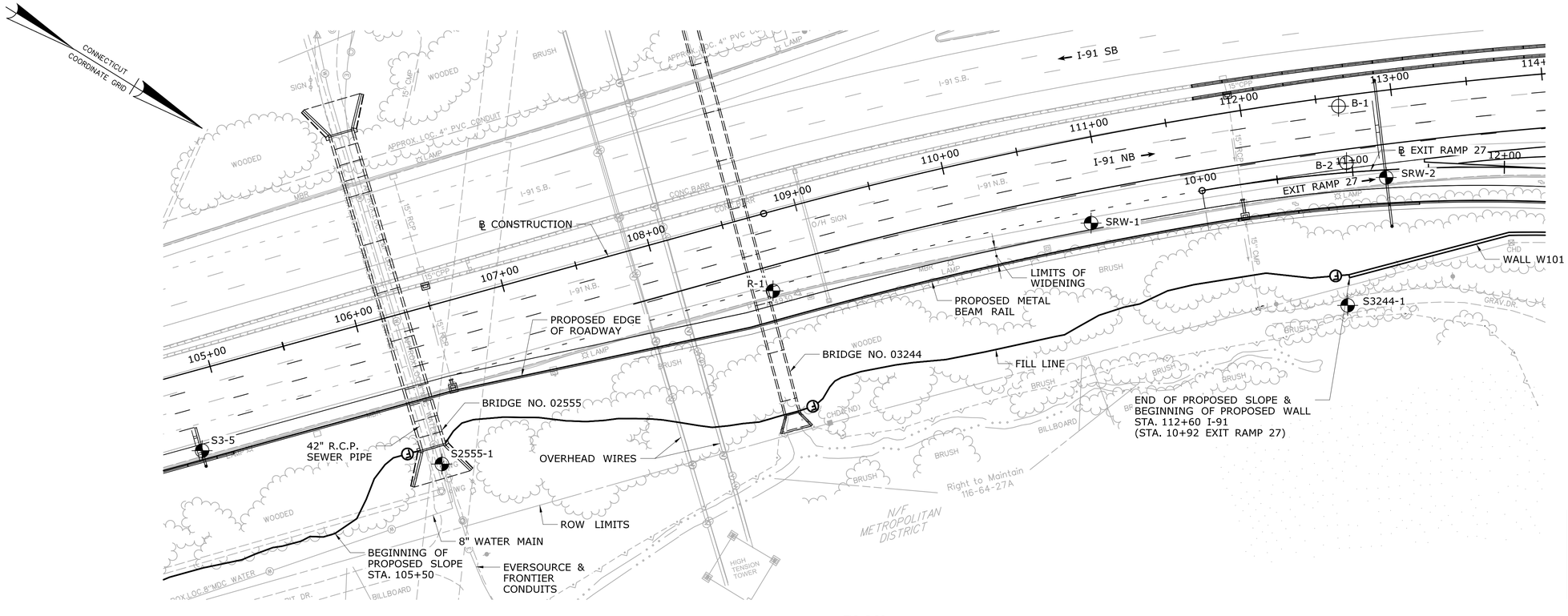
ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
0203000	Structure Excavation - Earth (Complete)	CY	2,660	$29.00	$78,000
0213100	Granular Fill	CY	600	$45.80	$28,000
0216000	Pervious Structure Backfill	CY	2,890	$52.00	$151,000
0506017	Retaining Wall	SF	6,730	$100.00	$673,000
0714050	Temporary Earth Retaining System	SF	12,220	$15.00	$184,000
0913952	Protective Fence (5' High)	LF	710	$106.20	$76,000
				Structure Total:	$1,190,000
				STRUCTURE PLUS ROADWAY SUBTOTAL 1:	$1,190,000

MINOR ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Minor Items (10% of Subtotal 1)	LS	1	$119,000.00	$119,000
			SUBTOTAL 2:	$119,000

LUMP SUM ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Clearing and Grubbing (1.0% of Subtotal 1 and 2)	LS	1	$8,240.00	$9,000
M & P of Traffic (6.0% of Subtotal 1 and 2)	LS	1	$49,440.00	$50,000
Mobilization (5% of Subtotal 1 and 2)	LS	1	$65,450.00	$66,000
Construction Staking (1.0% of Subtotal 1 and 2)	LS	1	$8,240.00	$9,000
			SUBTOTAL 3:	$134,000

ENGINEERING PERCENTAGES		TOTAL
Incidentals (10% of Subtotal 1, 2, and 3)	10% INCIDENTALS	$145,000
Contingency (20% of Subtotal 1, 2, and 3)	20% CONTINGENCY	$289,000
	SUBTOTAL 4:	$434,000

ESCALATION TO YEAR OF CONSTRUCTION		TOTAL
5% INFLATION FOR 4.25 YEARS (from estimate date to midpoint of construction=Subtotal*0.05*4.25)	SUBTOTAL 6:	$399,000
	TOTAL	**$2,276,000**



PLAN
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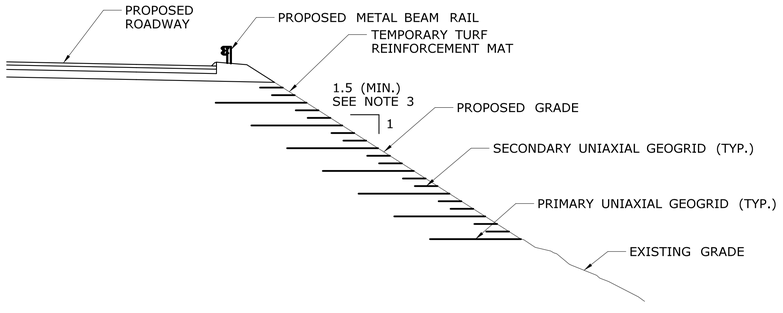


SECTION
SCALE: 1" = 10'

NOTES:

1. SLOPE LIMITS ARE APPROXIMATE
2. SLOPE TYPE SHOWN IN SECTION IS SCHEMATIC OF RECOMMENDED ALTERNATE
3. TO ACCOMPLISH WIDENING THE PROPOSED SLOPE VARIES FROM EXISTING TO 1.5H:1V (MAX.)

LEGEND

HISTORIC BORING	⊕
PROPOSED BORING	⊕

PROPOSED SLOPE NO. 1
EAST OF I-91

PRELIMINARY DESIGN REVIEW

REV.	DATE	REVISION DESCRIPTION	SHEET NO.

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK, SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE CONDITIONS OF ACTUAL QUANTITIES OF WORK WHICH WILL BE REQUIRED.

Plotted Date: 6/22/2016

DESIGNER/DRAFTER: JLS
CHECKED BY: BLB
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\SB_MSH_SLOPE_S_01_Gen Plan.dgn

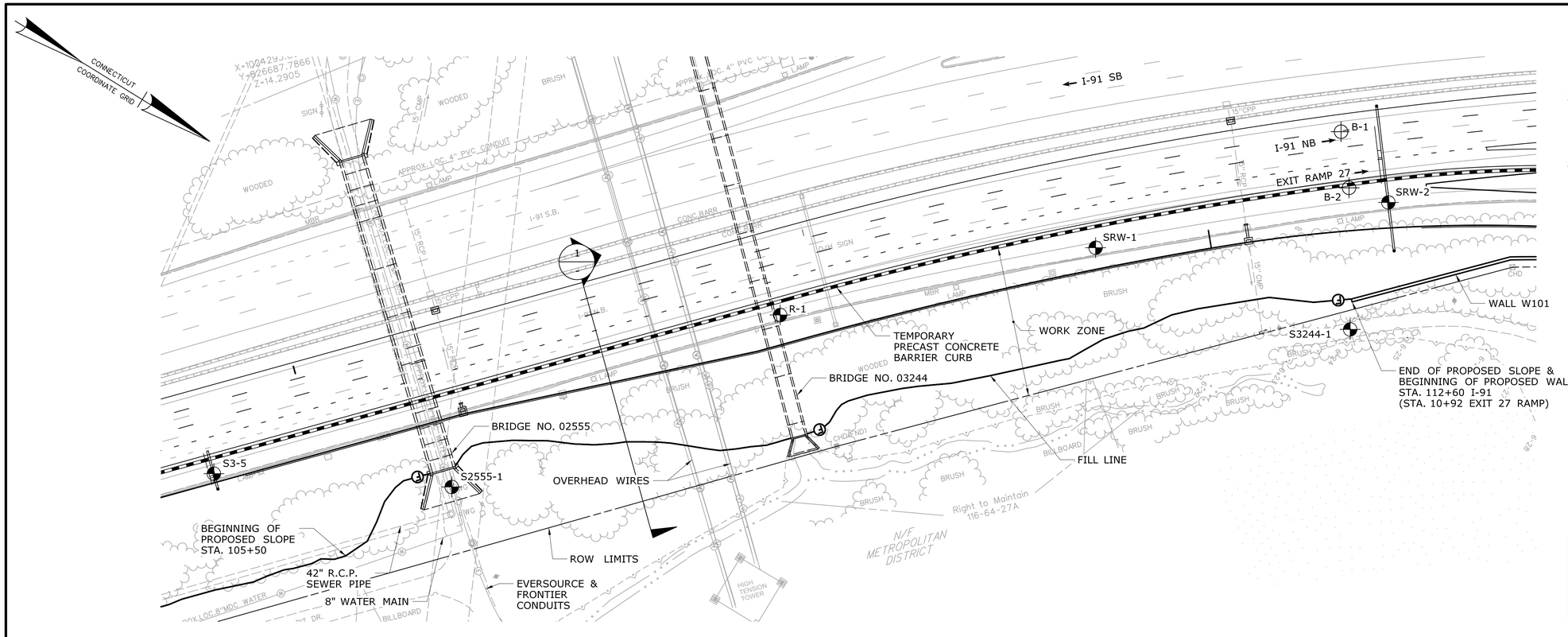
SIGNATURE/ BLOCK:

PROJECT TITLE:
RELOCATION OF I-91 NB INTERCHANGE 29 AND WIDENING OF I-91 NB AND ROUTE 15 NB TO I-84 EB

TOWN: **CITY OF HARTFORD**

DRAWING TITLE: **PLAN & SECTION**

PROJECT NO. **63-703**
DRAWING NO.
SHEET NO.



STAGE 2

SCALE: 1" = 40'

STAGE 2 - I-91 NB

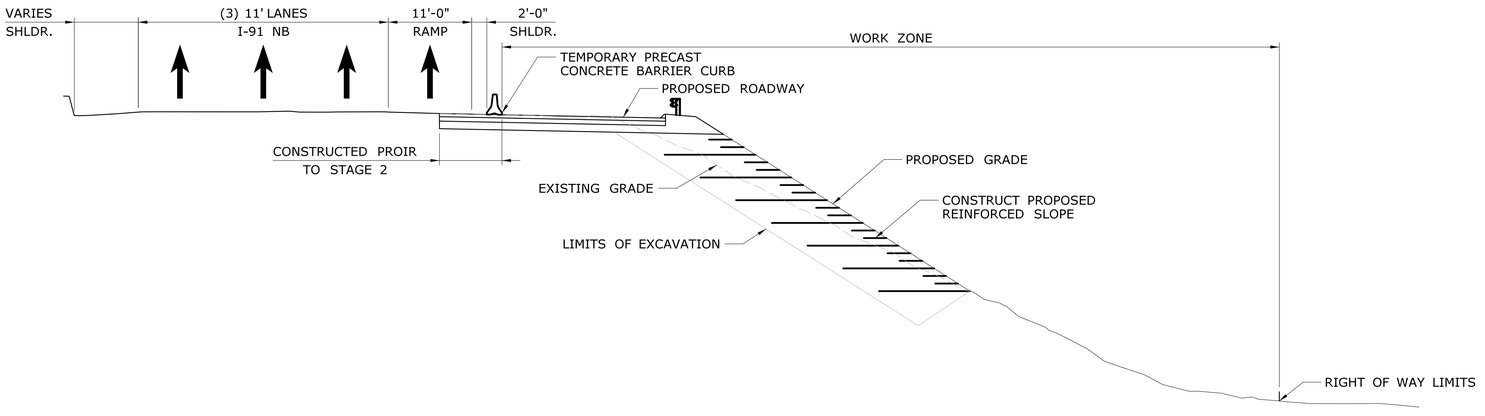
1. SHIFT I-91 NB AND EXIT 27 TO THE LEFT, MAINTAINING 3 LANES AND 1 LANE OF TRAFFIC RESPECTIVELY
2. CONSTRUCT REINFORCED SLOPE

STAGE 3 - I-91 NB

1. SHIFT I-91 NB AND EXIT 27 TO THE RIGHT

LEGEND

HISTORIC BORING	⊕
PROPOSED BORING	⊕



1 - STAGE 2 - I-91 NB

SCALE: 1" = 10'

PROPOSED SLOPE NO. 1 EAST OF I-91

PRELIMINARY DESIGN REVIEW

REV.	DATE	REVISION DESCRIPTION	SHEET NO.

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK, SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE CONDITIONS OF ACTUAL QUANTITIES OF WORK WHICH WILL BE REQUIRED.

Plotted Date: 6/22/2016

DESIGNER/DRAFTER: JLS
CHECKED BY: BLB
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\SB_MSH_SLOPE_S_01_StagIng.dgn

SIGNATURE/ BLOCK:

PROJECT TITLE:
RELOCATION OF I-91 NB INTERCHANGE 29 AND WIDENING OF I-91 NB AND ROUTE 15 NB TO I-84 EB

TOWN: **CITY OF HARTFORD**

DRAWING TITLE: **STAGE CONSTRUCTION**

PROJECT NO. **63-703**

DRAWING NO.

SHEET NO.

2.0 SLOPE NO. 2

2.1 Description

This section discusses the structure types studied for Slope No. 2, located east of the Exit 27 off ramp which carries traffic from I-91 NB to Brainard Road. The slope is located approximately between Exit 27 off ramp Sta. 15+66 and 18+00. This section describes the existing site, provides three alternates for the proposed slope, and presents CME's recommendations for the proposed soil/structure type.

Based upon the evaluation of the proposed slope, CME recommends Alternate 1, which consists of a reinforced slope.

The property to the east of Exit 27 at the location of widening is owned by the MDC. The relocation/widening along the ramp of up to 8' combined with a 2:1 slope would encroach on the MDC property. A steepened slope at this location can eliminate any fill slope impacts and the need for permanent easements. The proposed alternates presented in this report were evaluated based on: construction duration, construction cost, existing conditions, and future maintenance concerns. All estimates are based on ConnDOT's estimating guidelines.

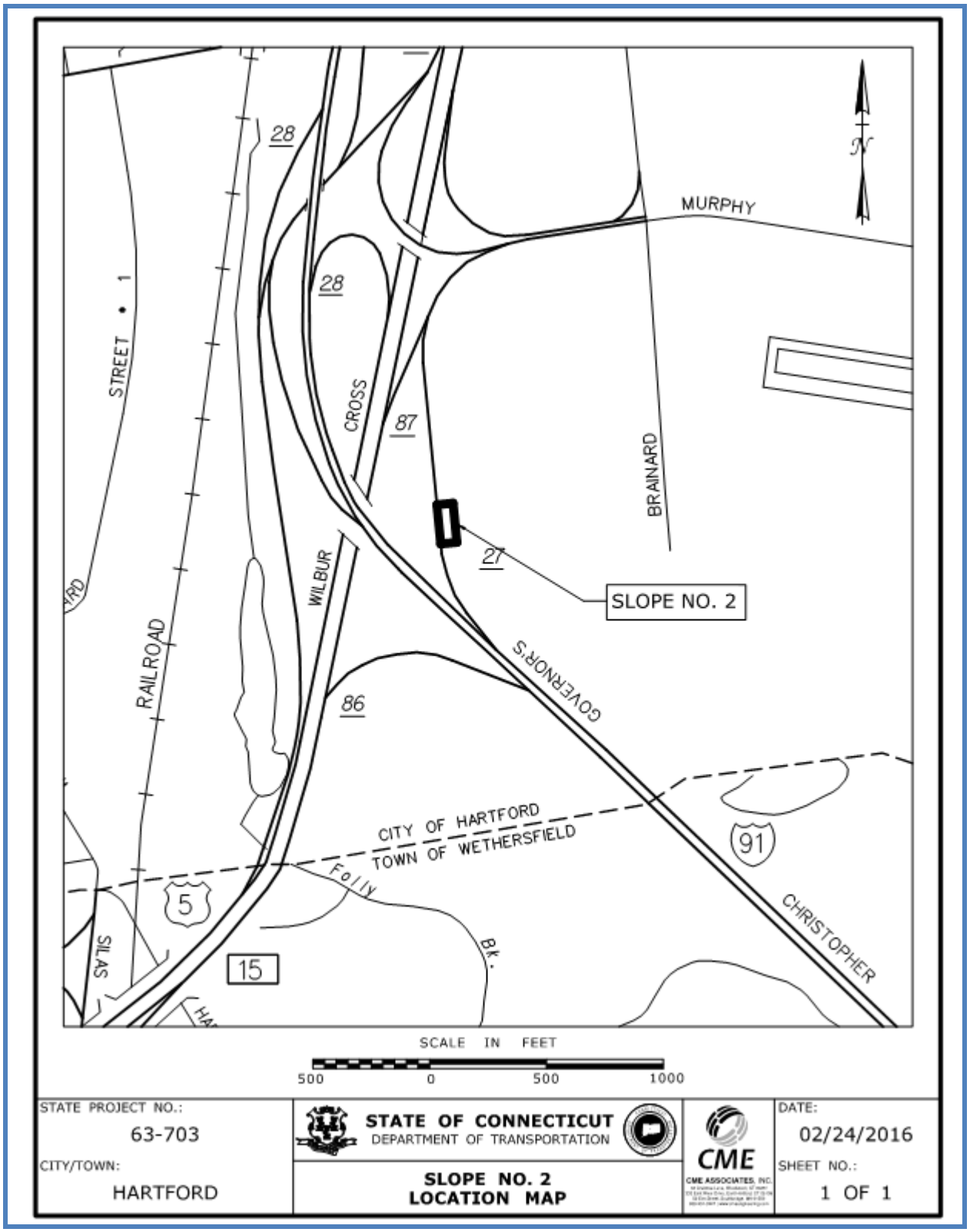
Highway Geometrics

The proposed slope is located right of the proposed Exit 27 baseline from Sta. 15+66 to 18+00. The proposed baseline for Exit 27 begins at 48' offset right of I-91 NB Sta. 111+66.3. The exit ramp begins on a 688.96' long horizontal curve with a radius of 1100'. This transitions to a horizontal tangent which ties into the existing baseline at station 18+50. The ramp begins on a -1.00% grade which is the back tangent for a 450' long crest vertical curve with a forward tangent of -3.70%. It is on this tangent that the proposed grade meets existing.

Traffic

According to the most recent ConnDOT Traffic Log, the 2014 Average Daily Traffic (ADT) on the Exit 27 off ramp is 9,200 vehicles per day.

2.2 Location Map



2.3 Field Observations

Geotechnical Information

Previous subsurface explorations located near Slope No. 2 include test borings B-4 to B-13 which were drilled for Bridge No. 00813, I-91 over Route 5/15. Recent borings completed includes SRW-3 and R-4 which are shown on the enclosed plan sheets in Section 2.10. The following conditions were encountered:

Existing Borings

Thickness Range (ft.)	Stratum	Generalized Description
0 to 10	Sand and Silt	Gray and grey-brown, coarse to fine SAND, some silt, some clay, trace of roots. Standard Penetration Test N-Values ranged from about 3 to 27 blows per foot (bpf).
20 to 30	Sand	Gray and grey-brown, coarse to fine SAND, trace of coarse silt, trace of fine gravel. SPT N-Values typically range from 54 to 58 bpf.
10 to 20	Varved Clay	Soft, layered grey-brown and red-brown, silty CLAY and clayey silt, trace of medium to fine SAND. SPT N-Values range from 2 to 16 bpf.
5 to 20	Glacial Till	Red-brown, coarse to fine SAND, trace of fine silt and little fine gravel with subordinate coarse to fine gravel, clay, and occasional cobbles and boulders. SPT N-Values typically exceed 50 bpf.
	Bedrock	Not described

Recent Borings

Thickness Range (ft.)	Stratum	Generalized Description
17 to 20	Fill	Medium dense to dense, brown, coarse to fine SAND, some to trace silt, little to trace medium to fine gravel.
Greater than 5 to Greater than 30	Alluvium	Medium dense to dense, brown to gray coarse to fine SAND, some to trace silt, little to trace gravel
	Groundwater	23 feet below existing ground surface in boring SRW-3

Based on conditions encountered in the previous borings, the subsurface conditions appear suitable to provide support to the proposed slope regrading. Preliminary review of the data suggests that settlement due to the increase in stress from the addition of fill to support the I-91 NB Exit 27 lane will be tolerable (less than about 1 inch) and will occur within a short period of time following the placement. Further evaluation of subsurface conditions and settlement will be conducted following completion of the proposed subsurface exploration and laboratory testing program which are currently underway.

There will be a required transition area from the 1.5:1 slope to the 2:1 embankment slope behind wall W101, which is located at the beginning of the slope. This transition will take place behind the wall. When slope is steeper than 2:1 a reinforced slope shall be required.

Property

Considering the width of the existing right-of-way, permanent easements are not anticipated. Construction easements are shown on the Preliminary Design Plans paralleling the property line to allow the Contractor adequate space for construction. Noise impacts to commercial and private property owners in the immediate vicinity surrounding the bridge are anticipated to be minimal and the noise level is not anticipated to exceed ambient noise generated by current highway traffic.

Cultural Resources

Developed commercial areas are present to the north. Brainard Airport is approximately 0.5 miles to the northeast. To the west approximately 0.3 miles, the Providence & Worcester Railroad provides freight service to the Wethersfield Secondary.

Environmental Resources

The Connecticut River is located approximately 0.6 miles east of the bridge with access at Charter Oak Landing approximately 1.7 miles to the north. Wethersfield Cove is approximately 0.2 miles to the south. There are wetlands on the MDC property just beyond the right of way limits.

2.4 Design Criteria

Slopes will be designed in accordance with the FHWA publication *Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines* and Connecticut Department of Transportation Geotechnical Engineering Manual.

2.5 Seismic Considerations

Slope structures are resistant to dynamic forces from a seismic event due to their flexibility. In viewing a reinforced embankment similar to a retaining wall, a seismic design is not required according to the ConnDOT Bridge Manual Section 4.4.

2.6 Slope/Structure Type Alternates

Based on the preliminary design layout for the interchange, the proposed slope will begin at the end of Wall W101 at Sta. 15+66 and end at Sta. 18+00, see Figure 2.1 below. Two slope types have been studied as well as a retaining structure to prevent encroaching of the ROW limits.

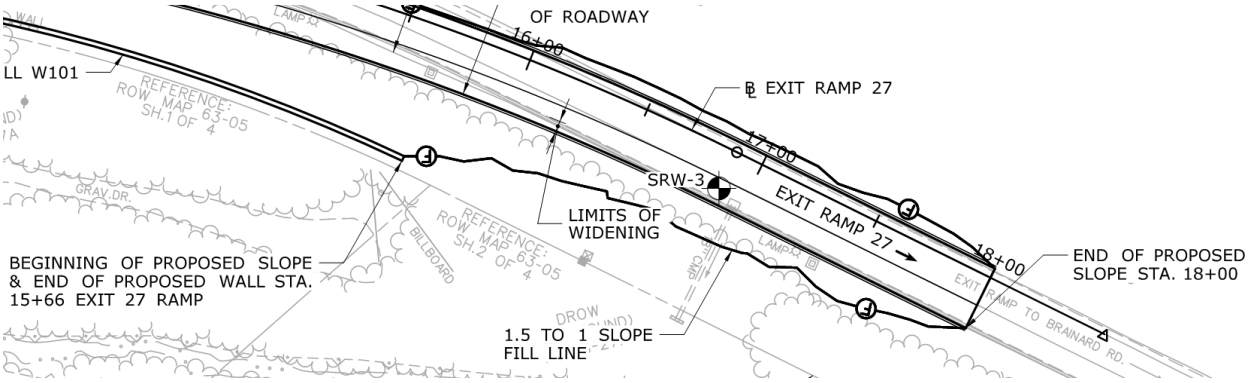


Figure 2.1 – Plan View

Slopes will be evaluated for global stability under both static and seismic conditions, as well as for anticipated settlement.

Constructability was investigated as part of this study and a general sequence is outlined. The slope can be constructed during Stage 2 of the overall project staging plan.

Cost Considerations

Section 2.10 contains an itemized cost estimate for all of the alternatives including the percentages used for the additional costs. The table below provides a summary of the total costs.

Proposed Alternates	Cost of Structure Only	Additional Costs	Rounded Total Cost
1 – Reinforced Slope	$ 57,000	$ 70,000	$127,000
2 – Stone Stabilization	$ 26,000	$ 45,000	$71,000
3 – Retaining Wall	$ 318,000	$ 285,000	$603,000

Additional Costs – Breakdown*	Alternate 1	Alternate 2	Alternate 3
Minor Items (10% of Structure Cost)	$ 6,000	$ 3,000	$ 32,000
Clearing and Grubbing	$ 2,000	$ 2,000	$ 2,000
Maintenance and Protection of Traffic	$ 9,000	$ 9,000	$ 9,000
Mobilization	$ 4,000	$ 2,000	$ 18,000
Construction Staking	$ 2,000	$ 2,000	$ 2,000
Incidentals and Contingencies	$ 24,000	$ 14,000	$ 116,000
Escalation to Midpoint Construction Year	$ 22,000	$ 13,000	$ 106,000
Total:	$ 70,000	$ 45,000	$ 285,000

Alternate 1 – Reinforced Slope

This alternate includes placement of uniaxial geogrid reinforcement layers to help strengthen the proposed fill slope areas and provide a required factor of safety. The maximum slope height is 17.3'. Slope heights are found where existing grade and proposed 1.5:1 slopes intersect.

The preliminary evaluation indicates that slopes with heights up to 20' tall will require a primary geogrid reinforcing length of 6' spaced at 3' intervals over the height of the slope. In addition to primary reinforcing, assume additional secondary reinforcing made up of shorter lengths of uniaxial geogrid to limit shallow, surficial failures. This reinforcing is generally placed at 1' intervals between the primary reinforcing with a length of 3' to 5'. It is assumed that slopes steeper than 2:1 will require reinforcing. Actual geogrid lengths are dependent on final slope geometry. See Figure 2.2 below.

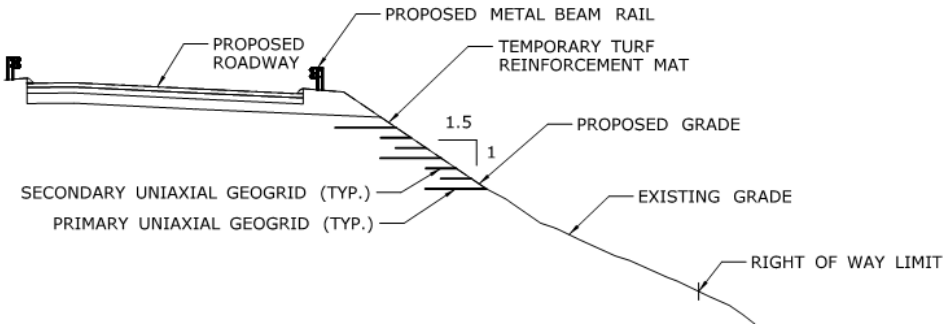


Figure 2.2 – Reinforced Slope

The following are the advantages and disadvantages of a reinforced slope:

Advantages Alternate 1	Disadvantages Alternate 1
+ More desirable aesthetics than Alternate 2	– Cost is more than Alternate 2

Alternate 2 – Stone Stabilization

This alternate consists of stabilizing a steepened slope. Typical CTDOT steepened slopes are protected with crush stone with only a 1 foot blanket of crushed stone placed on 6" granular fill base. Preliminary slope stability evaluations based on the historical borings suggest that additional stone is necessary. Additional evaluations will be conducted once the subsurface exploration program and results of laboratory testing are complete.

The steepened slope is stabilized with use of CTDOT No. 4 (2 inch minus) stone. Based on preliminary evaluation, slopes less than 20' high will require a toe thickness of 5' measured horizontally. Stone geometry is dependent on final slope geometry. See Figure 2.3 below.

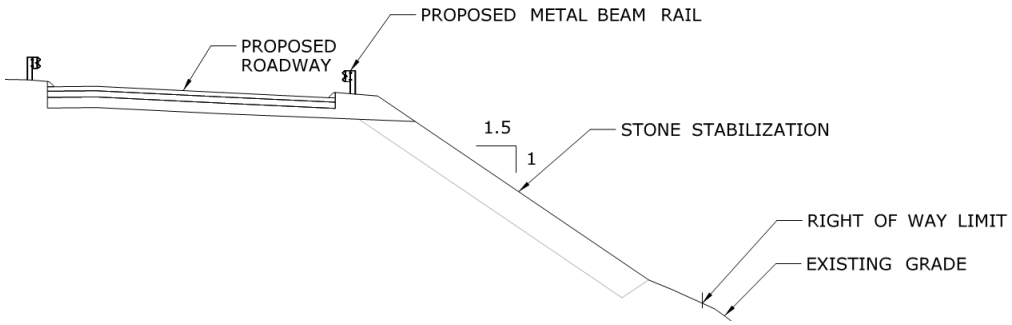


Figure 2.3 – Stone Stabilization

The following are the advantages and disadvantages of a slope stabilization:

Advantages Alternate 2	Disadvantages Alternate 2
+ Cost is less than other alternates	– Undesirable impact on aesthetics

Alternate 3 – Retaining Wall

This alternate consists of a retaining wall backfilled with pervious structure backfill. The wall is located at the base of the slope, holding 5' offset from the right of way limit to remain consistent with Wall W101. The wall type is an embankment wall with a 2:1 slope behind. See Figure 2.4 below.

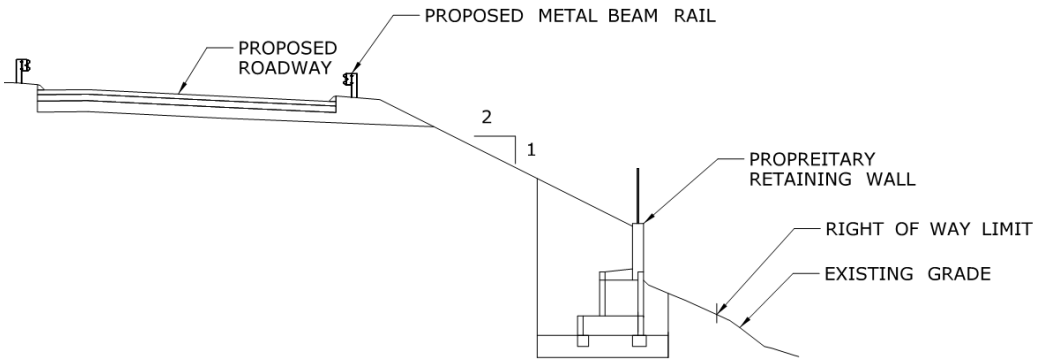


Figure 2.4 – Retaining Wall

A proprietary wall is chosen over a CIP wall based on ConnDOT Bridge Design Manual criteria. Where a wall height less than 8', measured from front slope to back slope, an embankment wall is preferred. The maximum wall height is 5.2' at this location. An embankment wall is defined by the Bridge Design Manual as a proprietary wall system and supports an embankment.

The following are the advantages and disadvantages of a retaining wall:

Advantages Alternate 3	Disadvantages Alternate 3
+	– Cost is greater than other alternates
+	– Impact to traffic is greater due to delivery of precast materials

2.7 Recommendations for Construction

Although Alternate 2 is less expensive than Alternate 1, Alternate 2 has an undesirable impact on aesthetics based on the CTDOT Highway Design Manual Section 10-2.02 and the use of crushed stone treatment should be minimized. Therefore CME recommends Alternate 1 as the preferred alternative for the proposed slope.

2.8 Utility and Drainage Impacts

There is an 18" corrugated metal pipe at an unknown elevation carrying runoff water from catch basins in the adjacent roadway. The pipe may need to be relocated or taken into consideration with the reinforced slope design. Currently there is one drainage catch basin proposed along on the shoulders in the limits of Slope No. 2. AASHTO requires design modifications for catch basins within the limits of reinforcement which includes one of the follow:

- Assume reinforcements layers are severed in location of catch basin and design the surrounding layers to carry the additional load.
- Place a structural frame around catch basin.
- May be possible to splay the layers around catch basin if soil reinforcement consist of discrete strips.

2.9 Construction Sequence and Maintenance & Protection of Traffic

The construction of the proposed slope is part of a larger interchange reconstruction project. Full construction staging plans are developed. Based on work to date and staging plans submitted in the PD submittal, the overall sequence of construction is as follows:

Stage 1

1. Shift Exit 27 traffic to the right, maintaining 1 lane of traffic.
2. Widen Exit 27 to the left.

Stage 2

1. Shift Exit 27 to the left, maintaining 1 lane of turning ramp traffic.
2. Construct reinforced slope.

Stage 3

1. Shift Exit 27 to the right.

2.10 Backup Data

Cost Comparisons

Proposed Plans

Stage Construction Plans

CME	COMPUTATION BY: JLS	DATE: 2/24/16	SHEET: 1 OF: 1
	CHECKED BY: TEG	DATE: 2/25/16	CME PROJECT NO.
	CLIENT: ConnDOT Charter Oak Bridge Project		CLIENT PROJECT NO.: 063-0703
ITEM: Slope No. 2 - Alternate 1 - Soil Reinforcement			

Alternate 1: Soil Reinforcement

1. Excavate for reinforced slopes
2. Install reinforced slopes

STRUCTURE ITEMS

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
0203000	Structure Excavation - Earth (Complete)	CY	325	$29.00	$10,000
0712010	Reinforced Soil Slope	SF	1,920	$24.00	$47,000
				Structure Total:	$57,000
				STRUCTURE PLUS ROADWAY SUBTOTAL 1:	$57,000

MINOR ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Minor Items (10% of Subtotal 1)	LS	1	$5,700.00	$6,000
			SUBTOTAL 2:	$6,000

LUMP SUM ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Clearing and Grubbing (1.0% of Subtotal 1 and 2)	LS	1	$1,473.33	$2,000
M & P of Traffic (6.0% of Subtotal 1 and 2)	LS	1	$8,840.00	$9,000
Mobilization (5% of Subtotal 1 and 2)	LS	1	$3,150.00	$4,000
Construction Staking (1.0% of Subtotal 1 and 2)	LS	1	$1,473.33	$2,000
			SUBTOTAL 3:	$17,000

ENGINEERING PERCENTAGES		TOTAL
Incidentals (10% of Subtotal 1, 2, and 3)	10% INCIDENTALS	$8,000
Contingency (20% of Subtotal 1, 2, and 3)	20% CONTINGENCY	$16,000
	SUBTOTAL 4:	$24,000

ESCALATION TO YEAR OF CONSTRUCTION		TOTAL
5% INFLATION FOR 4.25 YEARS (from estimate date to midpoint of construction=Subtotal*0.05*4.25)	SUBTOTAL 6:	$23,000
	TOTAL	**$127,000**

CME	COMPUTATION BY: JLS	DATE: 2/24/16	SHEET: 1 OF: 1
	CHECKED BY: TEG	DATE: 3/1/16	CME PROJECT NO.
	CLIENT: ConnDOT Charter Oak Bridge Project		CLIENT PROJECT NO.: 063-0703
ITEM: Slope No. 2 - Alternate 2 - Stone Stabilization			

Alternate 2: Stone Stabilization

1. Excavate for stone stabilization slope
2. Install stones

STRUCTURE ITEMS

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
0203000	Structure Excavation - Earth (Complete)	CY	200	$29.00	$6,000
0728031	No. 4 Crushed Stone	CF	12,110	$1.60	$20,000
				Structure Total:	$26,000
				STRUCTURE PLUS ROADWAY SUBTOTAL 1:	$26,000

MINOR ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Minor Items (10% of Subtotal 1)	LS	1	$2,600.00	$3,000
			SUBTOTAL 2:	$3,000

LUMP SUM ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Clearing and Grubbing (1.0% of Subtotal 1 and 2)	LS	1	$1,473.33	$2,000
M & P of Traffic (6.0% of Subtotal 1 and 2)	LS	1	$8,840.00	$9,000
Mobilization (5% of Subtotal 1 and 2)	LS	1	$1,450.00	$2,000
Construction Staking (1.0% of Subtotal 1 and 2)	LS	1	$1,473.33	$2,000
			SUBTOTAL 3:	$15,000

ENGINEERING PERCENTAGES		TOTAL
Incidentals (10% of Subtotal 1, 2, and 3)	10% INCIDENTALS	$5,000
Contingency (20% of Subtotal 1, 2, and 3)	20% CONTINGENCY	$9,000
	SUBTOTAL 4:	$14,000

ESCALATION TO YEAR OF CONSTRUCTION		TOTAL
5% INFLATION FOR 4.25 YEARS (from estimate date to midpoint of construction=Subtotal*0.05*4.25)	SUBTOTAL 6:	$13,000
	TOTAL	**$71,000**

	COMPUTATION BY	DATE	SHEET	OF
CME	JLS	2/24/16	1	1
	CHECKED BY	DATE	CME PROJECT NO.	
	TEG	3/1/16		
	CLIENT		CLIENT PROJECT NO.	
	ConnDOT Charter Oak Bridge Project		063-0703	

ITEM
Slope No. 2 - Alternate 3 - Prefabricated Modular Wall

Alternate 3: Prefabricated Modular Wall

1. Excavate for new wall
2. Install Granular Fill
3. Install prefabricated modular wall
4. Backfill with Pervious Structure Fill
5. Install 5' Chain Link Fence

STRUCTURE ITEMS

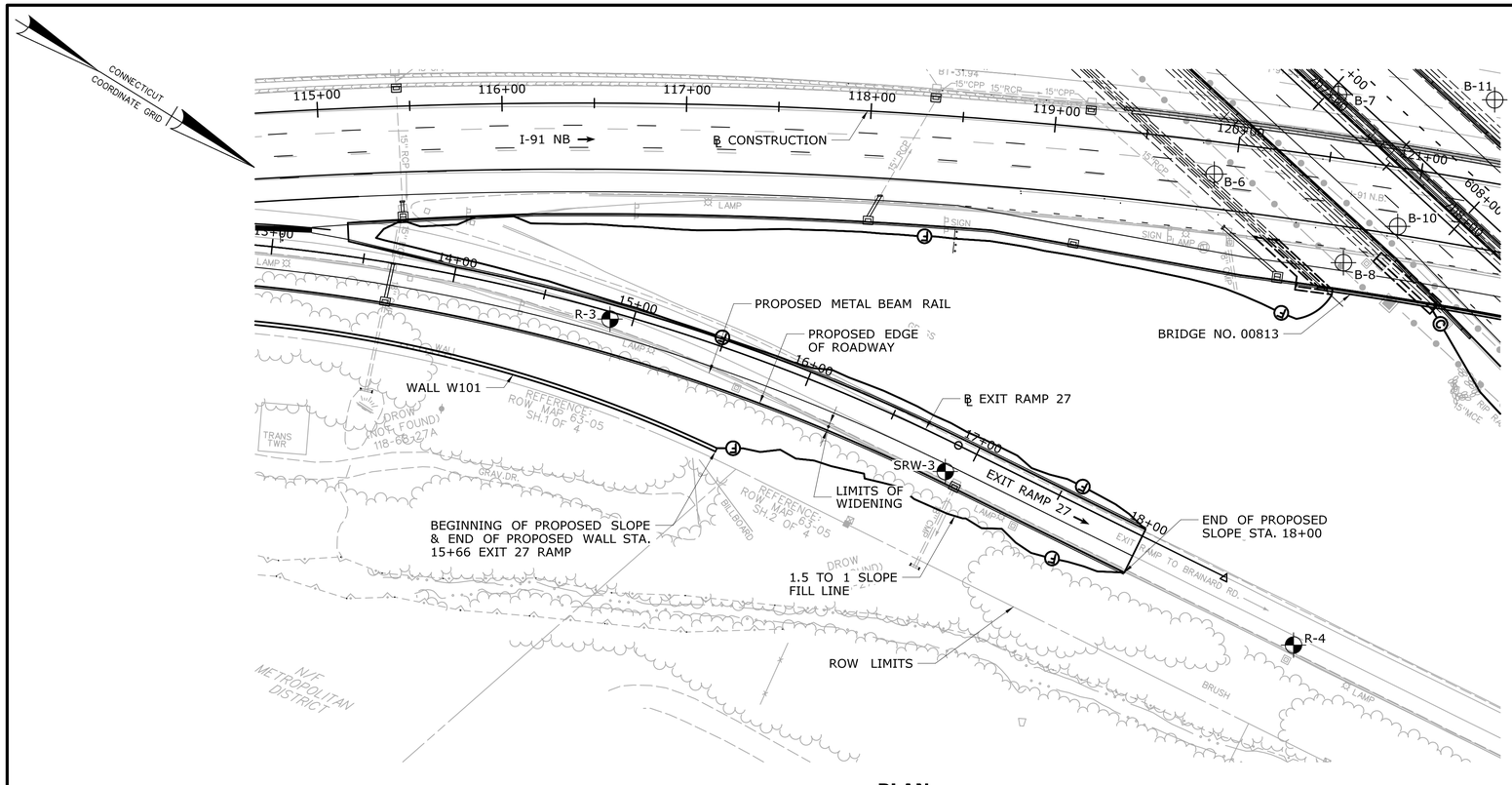
ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
0203000	Structure Excavation - Earth (Complete)	CY	755	$29.00	$22,000
0213100	Granular Fill	CY	200	$45.80	$10,000
0216000	Pervious Structure Backfill	CY	370	$52.00	$20,000
0506017	Retaining Wall	SF	1,825	$100.00	$183,000
0714050	Temporary Earth Retaining System	SF	3,780	$15.00	$57,000
0913952	Protective Fence (5' High)	LF	240	$106.20	$26,000
				Structure Total:	$318,000
				STRUCTURE PLUS ROADWAY SUBTOTAL 1:	$318,000

MINOR ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Minor Items (10% of Subtotal 1)	LS	1	$31,800.00	$32,000
			SUBTOTAL 2:	$32,000

LUMP SUM ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Clearing and Grubbing (1.0% of Subtotal 1 and 2)	LS	1	$1,473.33	$2,000
M & P of Traffic (6.0% of Subtotal 1 and 2)	LS	1	$8,840.00	$9,000
Mobilization (5% of Subtotal 1 and 2)	LS	1	$17,500.00	$18,000
Construction Staking (1.0% of Subtotal 1 and 2)	LS	1	$1,473.33	$2,000
			SUBTOTAL 3:	$31,000

ENGINEERING PERCENTAGES		TOTAL
Incidentals (10% of Subtotal 1, 2, and 3)	10% INCIDENTALS	$39,000
Contingency (20% of Subtotal 1, 2, and 3)	20% CONTINGENCY	$77,000
	SUBTOTAL 4:	$116,000

ESCALATION TO YEAR OF CONSTRUCTION		TOTAL
5% INFLATION FOR 4.25 YEARS (from estimate date to midpoint of construction=Subtotal*0.05*4.25)	SUBTOTAL 6:	$106,000
	TOTAL	**$603,000**



PLAN
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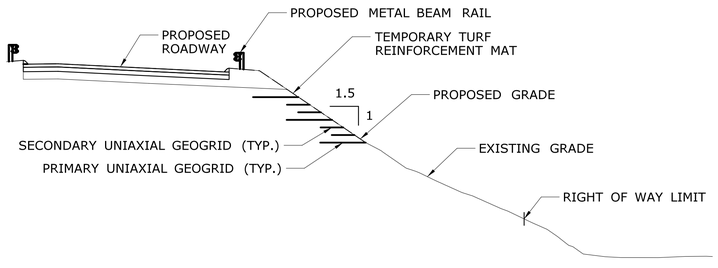


SECTION
SCALE: 1" = 10'

NOTES:

1. SLOPE LIMITS ARE APPROXIMATE
2. SLOPE TYPE SHOWN IN SECTION IS SCHEMATIC OF RECOMMENDED ALTERNATE

LEGEND

HISTORIC BORING	⊕
PROPOSED BORING	◒

PROPOSED SLOPE NO. 2 EAST OF EXIT 27

PRELIMINARY DESIGN REVIEW

REV.	DATE	REVISION DESCRIPTION	SHEET NO.

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK, SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE CONDITIONS OF ACTUAL QUANTITIES OF WORK WHICH WILL BE REQUIRED.

Plotted Date: 6/22/2016

DESIGNER/DRAFTER: JLS
CHECKED BY: BLB
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\SB_MSH_SLOPE_S_02_Gen Plan.dgn

SIGNATURE/ BLOCK:

PROJECT TITLE:
RELOCATION OF I-91 NB INTERCHANGE 29 AND WIDENING OF I-91 NB AND ROUTE 15 NB TO I-84 EB

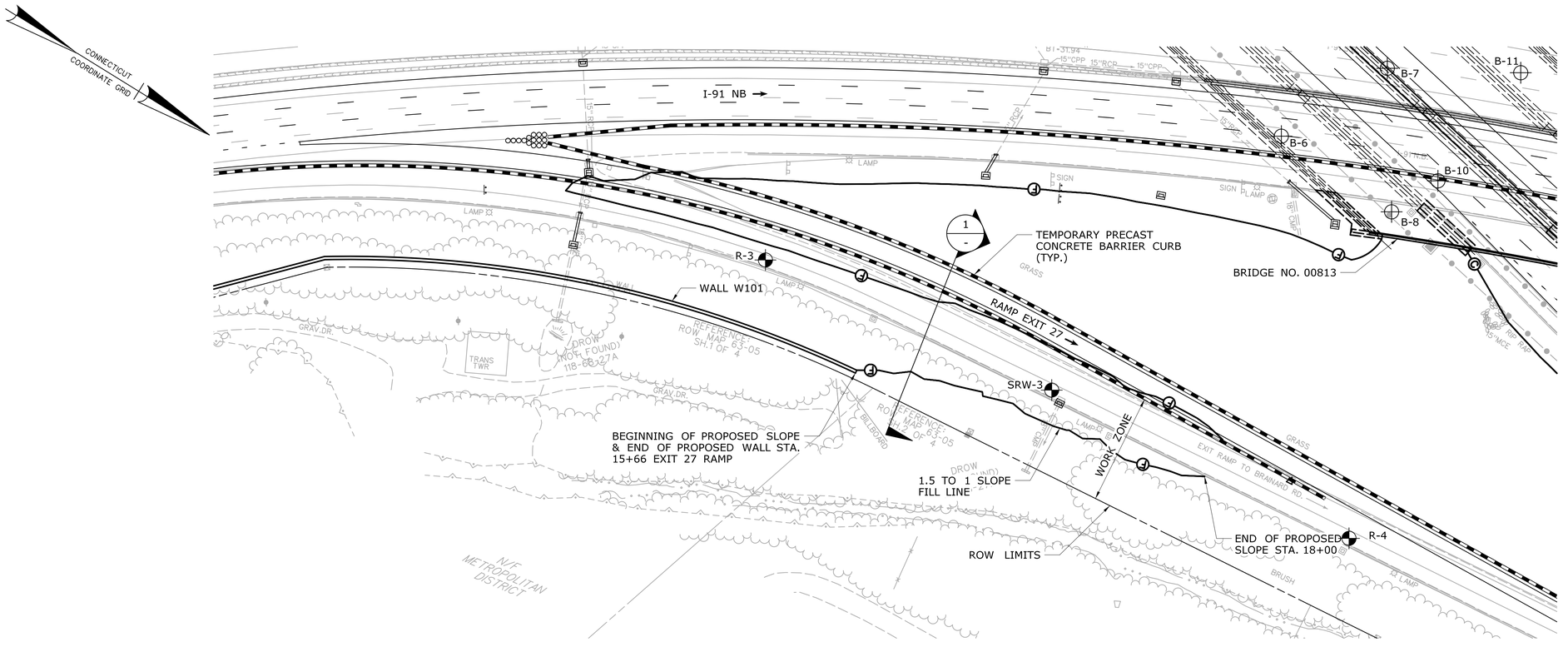
TOWN: **CITY OF HARTFORD**

DRAWING TITLE: **PLAN & SECTION**

PROJECT NO. **63-703**

DRAWING NO.

SHEET NO.



STAGE 1C - EXIT 27

1. SHIFT EXIT 27 TRAFFIC TO THE RIGHT, MAINTAINING 1 LANE OF TRAFFIC
2. WIDEN EXIT 27 TO THE LEFT

STAGE 2 - EXIT 27

1. SHIFT I-91 NB AND EXIT 27 TO THE LEFT, MAINTAINING 3 LANES AND 1 LANE OF TRAFFIC RESPECTIVELY
2. CONSTRUCT REINFORCED SLOPE

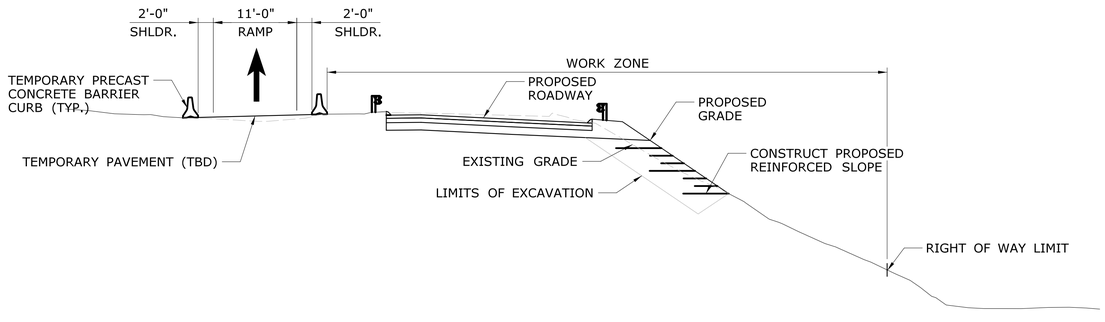
STAGE 3 - EXIT 27

1. SHIFT I-91 NB AND EXIT 27 TO THE RIGHT

LEGEND	
HISTORIC BORING	⊕
PROPOSED BORING	◪

STAGE 2

SCALE: 1" = 40'



1 / - STAGE 2 - EXIT 27

SCALE: 1" = 10'

PROPOSED SLOPE NO. 2 EAST OF EXIT 27

PRELIMINARY DESIGN REVIEW

REV.	DATE	REVISION DESCRIPTION	SHEET NO.

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Plotted Date: 6/22/2016

DESIGNER/DRAFTER: JLS
CHECKED BY: BLB
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\SB_MSH_SLOPE_S_02_StagIng.dgn

SIGNATURE/ BLOCK:

PROJECT TITLE:
RELOCATION OF I-91 NB INTERCHANGE 29 AND WIDENING OF I-91 NB AND ROUTE 15 NB TO I-84 EB

TOWN: **CITY OF HARTFORD**

DRAWING TITLE: **STAGE CONSTRUCTION**

PROJECT NO. **63-703**

DRAWING NO.

SHEET NO.

3.0 SLOPE NO. 3

3.1 Description

This section discusses the soil/structure types studied for Slope No. 3, located east of the I-91 NB and Exit 28 off ramp deceleration lane which carries traffic from I-91 NB to Route 5/15 SB, located approximately between Sta. 123+88 and 126+50. It also describes the existing site, provides three alternates for the proposed slope, and presents CME's recommendations for the proposed slope/structure type.

Based upon the evaluation of the proposed slope, CME recommends Alternate 1, which consists of a reinforced slope and an embankment wall.

The area to the east at the location of widening is wetlands/drainage. The widening along the deceleration lane of up to 17' requires a steepened slope to eliminate any fill slopes beyond the wetland limits for a majority of the length but an embankment wall is required where a 1.5:1 slope would also encroach on these wetlands. The proposed alternates presented in this report were evaluated based on: construction duration, construction cost, existing conditions, and future maintenance concerns. All estimates are based on ConnDOT's estimating guidelines.

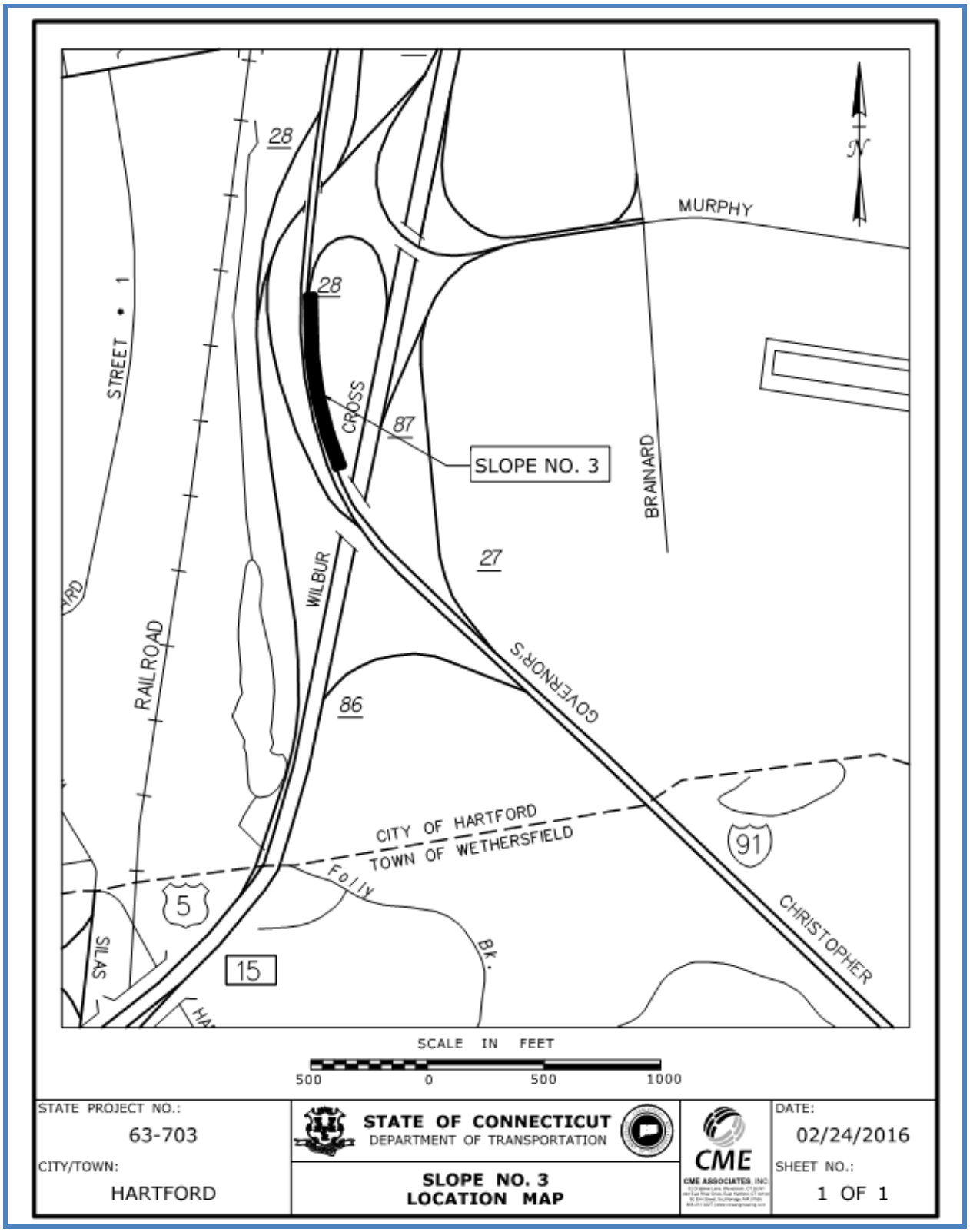
Highway Geometrics

The proposed roadway at Slope No. 3, I-91 NB, is on a horizontal curve with a 2800' radius. I-91 NB is located within a -1.0% back tangent for a 200' long sag vertical curve with a forward tangent of +0.62%. Exit Ramp 28 begins on a horizontal curve with a radius of 550' which transitions to a horizontal curve with a radius of 135'. The vertical profile consists of two vertical curves. The first is a 150' long crest vertical curve with a -0.5% back tangent and a -5.50% forward tangent. The second curve is a 200' long sag vertical curve with a -5.50% back tangent and a 1.00% forward tangent.

Traffic

According to the most recent ConnDOT Traffic Log, the 2014 Average Daily Traffic (ADT) is 117,500 vehicles per day for I-91 NB and SB traffic. The Average Daily Traffic (ADT) on the exit 28 ramp is 3,500 vehicles per day.

3.2 Location Map



3.3 Field Observations

Geotechnical Information

Previous subsurface explorations located near Slope No. 3 include test borings B-4 to B-13 which were drilled for Bridge No. 00813, I-91 over Route 5/15. Recent borings include R-5 and R-6 which are shown on the enclosed plan sheets in Section 3.10. The following conditions were encountered:

Existing Borings

Thickness Range (ft.)	Stratum	Generalized Description
0 to 10	Sand and Silt	Gray and grey-brown, coarse to fine sand, some silt, some clay, trace of roots. Standard Penetration Test N-Values ranged from about 3 to 27 blows per foot (bpf).
20 to 30	Sand	Gray and grey-brown, coarse to fine sand, trace of coarse silt, trace of fine gravel. SPT N-Values typically range from 54 to 58 bpf
10 to 20	Varved Clay	Soft, layered grey-brown and red-brown, silty clay and clayey silt, trace of medium to fine sand. SPT N-Values range from 2 to 16 bpf.
5 to 20	Glacial Till	Red-brown, coarse to fine sand, trace of fine silt and little fine gravel with subordinate coarse to fine gravel, clay, and occasional cobbles and boulders. SPT N-Values typically exceed 50 bpf.
	Bedrock	Not described

Recent Borings

Thickness Range (ft.)	Stratum	Generalized Description
20	Fill	Medium dense to dense, brown, coarse to fine SAND, little to trace medium to fine gravel, little to trace silt
Greater than 4 to Greater than 28	Alluvium	Medium dense to dense, brown to gray coarse to fine SAND, some to trace silt
	Groundwater	Not observed in the borings

Based on conditions encountered in the previous and recent borings, the subsurface conditions appear suitable to provide support to the proposed slope regrading. Preliminary review of the data suggests that settlement due to the increase in stress from the addition of fill to support the I-91 NB Exit 28 off ramp lane will be tolerable (less than about 1 inch) and will occur within a short period of time following fill placement. Further evaluation of subsurface conditions and settlement will be conducted following completion of the proposed subsurface exploration and laboratory testing program which are currently underway. The need for lightweight fill will be evaluated, if necessary.

Property

Considering the width of the existing right-of-way, permanent easements are not anticipated. Noise impacts to commercial and private property owners in the immediate vicinity surrounding the bridge are anticipated to be minimal and the noise level is not anticipated to exceed ambient noise generated by current highway traffic.

Cultural Resources

Developed commercial areas are present to the northeast of the bridge. Brainard Airport is approximately 0.5 miles to the northeast of the bridge and is located between the proposed reinforced slope and the Connecticut River. To the west approximately 0.1 miles, The Providence & Worcester Railroad provides freight service on the Wethersfield Secondary.

Environmental Resources

The Connecticut River is located approximately 0.9 miles east of the bridge with access at Charter Oak Landing approximately 1.5 miles to the north and Wethersfield Cove is approximately 0.6 miles to the south.

3.4 Design Criteria

Slopes will be designed in accordance with the FHWA publication *Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines* and Connecticut Department of Transportation Geotechnical Engineering Manual.

3.5 Seismic Considerations

Slope structures are resistant to dynamic forces from a seismic event due to their flexibility. In viewing a reinforced embankment similar to a retaining wall, a seismic design is not required according to the ConnDOT Bridge Manual Section 4.4.

3.6 Slope/Structure Type Alternates

Based on the preliminary design layout for the interchange, the proposed slope will begin at the end of the proposed embankment wall at Sta. 125+00 and end at 126+50 where a 2:1 slope is adequate. The embankment wall will begin at the end of Bridge No. 00813 northwest wingwall at Sta. 123+88 and end at 125+00, see Figure 3.1 below. Two slope types combined with a wall have been studied as well as a retaining structure for the full length. Each alternate will prevent impacts to wetlands.

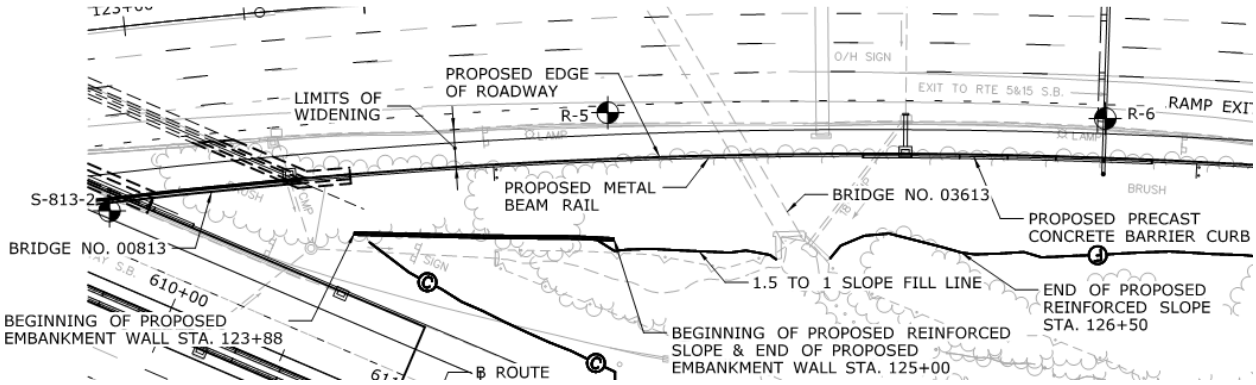


Figure 3.1 – Plan View

Slopes will be evaluated for global stability under both static and seismic conditions, as well as for anticipated settlement.

The constructability was investigated as part of this study and a general sequence is outlined. The slope can be constructed during Stage 2 of the overall project.

Cost Considerations

Section 3.10 contains an itemized cost estimate for all of the alternatives including the percentages used for the additional costs. The table below provides a summary of the total costs.

Proposed Alternates	Cost of Structure Only	Additional Costs	Rounded Total Cost
1 – Reinforced Slope	$ 375,000	$ 370,000	$745,000
2 – Stone Stabilization	$ 333,000	$ 336,000	$669,000
3 – Retaining Wall	$ 511,000	$ 481,000	$992,000

Additional Costs – Breakdown*	Alternate 1	Alternate 2	Alternate 3
Minor Items (10% of Structure Cost)	$ 38,000	$ 34,000	$ 52,000
Clearing and Grubbing	$ 5,000	$ 5,000	$ 5,000
Maintenance and Protection of Traffic	$ 27,000	$ 27,000	$ 27,000
Mobilization	$ 21,000	$ 19,000	$ 29,000
Construction Staking	$ 5,000	$ 5,000	$ 5,000
Incidentals and Contingencies	$ 143,000	$ 128,000	$ 189,000
Escalation to Midpoint Construction Year	$ 131,000	$ 118,000	$ 174,000
Total:	$ 370,000	$ 336,000	$ 481,000

Alternate 1 – Reinforced Slope

This alternate consists of an embankment wall which transitions to a reinforced slope.

The retaining wall is located at the base of the slope backfilled with pervious structure backfill. The wall begins at the end of Bridge No. 00813 northwest wingwall at Sta. 123+88 and ends at 125+00. This wall is an embankment wall with an embankment slope of 2:1, see Figure 3.2.

A proprietary wall is chosen over a cast-in-place wall based on ConnDOT Bridge Design Manual criterial. Where a wall height less than 8’ (measured from front slope to back slope) an embankment wall is preferred. Maximum wall height is 6.8’. An embankment wall is defined by the Bridge Design Manual as a proprietary wall system and supports an embankment.

This alternate also a reinforced slope from Sta. 125+00 to 126+50. The reinforced slope includes placement of uniaxial geogrid reinforcement layers to help strengthen the proposed fill slope areas and provide a required factor of safety. The maximum slope height is 22.5’. Slope heights are found where existing grade and proposed 1.5:1 slopes intersect. See Figure 3.3.

The preliminary evaluation indicates that slopes with heights up to 20’ tall will require a primary geogrid reinforcing length of 6’, while a slope between 20’ and 40’ tall will require a geogrid length of 12’, spaced at 3’ intervals over the height of the slope. In addition to primary reinforcing, assume additional secondary reinforcing made up of shorter lengths of uniaxial geogrid to limit shallow, surficial failures. This reinforcing is generally places at 1’ intervals between the primary reinforcing with a length of 3’ to 5’. It is assumed that slopes steeper than 2:1 will require reinforcing. Actual geogrid lengths are dependent on final slope geometry.

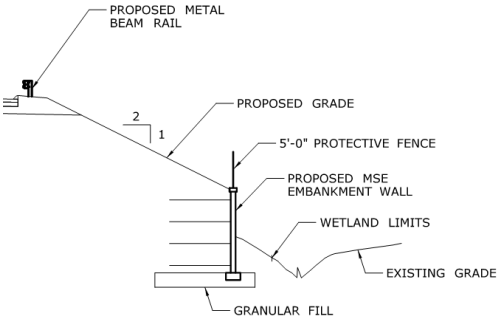


Figure 3.2 – Embankment Wall Portion (South End)

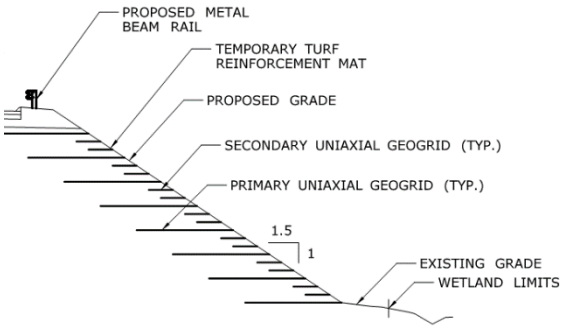


Figure 3.3 – Reinforced Slope Portion (North End)

The following are the advantages and disadvantages of a reinforced slope:

Advantages Alternate 1	Disadvantages Alternate 1
+ More desirable aesthetics than Alternate 2	– Cost is more than Alternate 2

Alternate 2 – Stone Stabilization

This alternate consists of an embankment wall which transitions to a steepened stone stabilized slope. The retaining wall is the same at Alternate 1. Typical CTDOT steepened slopes are protected with crush stone with only a 1 foot blanket of crushed stone placed on 6" granular fill base. Preliminary slope stability evaluations based on the historical borings suggest that additional stone is necessary. Additional evaluations will be conducted once the subsurface exploration program and results of laboratory testing are complete.

The stabilized a steepened slope is from Sta. 125+00 to 126+50. The steepened slope is stabilized with use of CTDOT No. 4 (2 inch minus) stone. Based on preliminary evaluation, slopes less than 20' high will require a toe thickness of 5' (measured horizontally) at the toe. Slopes 20' to 40' will require a slope toe stone thickness of approximately 13'. Stone geometry is dependent on final slope geometry. See Figure 3.4 below.

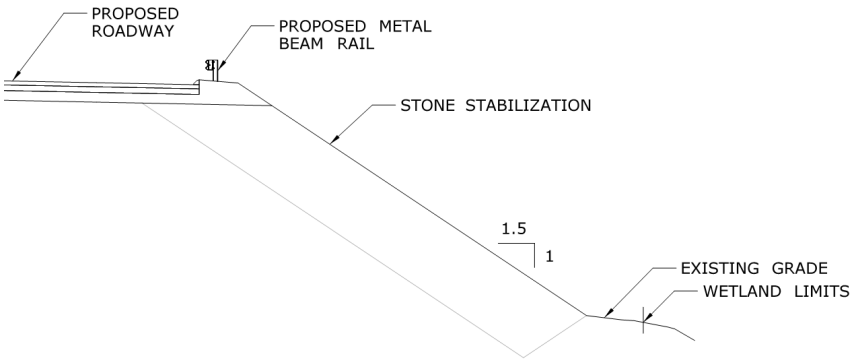


Figure 3.4 – Stone Stabilization

The following are the advantages and disadvantages of a slope stabilization:

Advantages Alternate 2	Disadvantages Alternate 2
+ Cost is less than other alternates	– Undesirable impact on aesthetics

Alternate 3 – Retaining Wall

This alternate consists of a retaining wall located at the base of the slope backfilled with pervious structure backfill. The wall begins at the end of Bridge No. 00813 northwest wingwall at Sta. 123+88. This wall is an embankment wall with an embankment slope of 2:1. See Figure 3.2 above.

A proprietary wall is chosen over a cast-in-place wall based on ConnDOT Bridge Design Manual criterial. Where a wall height less than 8' (measured from front slope to back slope) an embankment wall is preferred. Maximum wall height is 8.5' (average height is 6.5'). An embankment wall is defined by the Bridge Design Manual as a proprietary wall system and supports an embankment.

The following are the advantages and disadvantages of a retaining wall:

Advantages Alternate 3	Disadvantages Alternate 3
+ No slope greater than 2:1 will be required	– Cost is greater than other alternates
+	– Impact to traffic is greater due to delivery of precast materials

3.7 Recommendations for Construction

Although Alternate 2 is less expensive than Alternate 1, Alternate 2 has an undesirable impact on aesthetics based on the CTDOT Highway Design Manual Section 10-2.02 and the use of crushed stone treatment should be minimized. Therefore CME recommends Alternate 1 as the preferred alternative for the proposed slope. During the Final Design Phase Bridge No. 03613 will be analyzed with a load rating due to an increase of fill on the existing culvert.

3.8 Utility and Drainage Impacts

Modifications required to Bridge No. 03613, a drainage box culvert below I-91, are not included in this type study. The recommended rehabilitation to this culvert is to vertically extend the wingwall and headwall to accommodate the widening of I-91 NB. Currently there is one drainage catch basins proposed along on the shoulder in the limits of Slope No. 3. AASHTO requires design modifications for catch basins within the limits of reinforcement which includes one of the follow:

- Assume reinforcements layers are severed in location of catch basin and design the surrounding layers to carry the additional load.
- Place a structural frame around catch basin.
- May be possible to splay the layers around catch basin if soil reinforcement consist of discrete strips.

3.9 Construction Sequence and Maintenance & Protection of Traffic

The construction of the proposed slope is part of a larger interchange reconstruction project. Full construction staging plans are developed. Based on work to date and staging plans submitted in the PD submittal, the overall sequence of construction is as follows:

Stages 1B & 1C

1. Close Exit 28 Ramp

Stage 2

1. Shift I-91 NB traffic to the left, maintaining 3 lanes of traffic. Exist 28 remains closed.
2. Widen I-91 NB to the right and construct reinforced slope.

Stage 3

1. Open Exit 28 Ramp.

3.10 Backup Data

Cost Comparisons

Proposed Plans

Stage Construction Plans

CME	COMPUTATION BY: JLS	DATE: 2/25/16	SHEET: 1 OF: 1
	CHECKED BY: TEG	DATE: 2/26/16	CME PROJECT NO.
	CLIENT: ConnDOT Charter Oak Bridge Project		CLIENT PROJECT NO.: 063-0703

ITEM
Slope No. 3 - Alternate 1 - Soil Reinforcement

Alternate 1: Soil Reinforcement

1. Excavate for reinforced slopes
2. Install reinforced slopes

STRUCTURE ITEMS

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
0203000	Structure Excavation - Earth (Complete)	CY	2,245	$29.00	$66,000
0213100	Granular Fill	CY	110	$45.80	$6,000
0216000	Pervious Structure Backfill	CY	1,658	$52.00	$87,000
0506017	Retaining Wall	SF	1,305	$100.00	$131,000
0712010	Reinforced Soil Slope	SF	2,580	$24.00	$62,000
0714050	Temporary Earth Retaining System	SF	660	$15.00	$10,000
0913952	Protective Fence (5' High)	LF	115	$106.20	$13,000
				Structure Total:	$375,000
				STRUCTURE PLUS ROADWAY SUBTOTAL 1:	$375,000

MINOR ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Minor Items (10% of Subtotal 1)	LS	1	$37,500.00	$38,000
			SUBTOTAL 2:	$38,000

LUMP SUM ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Clearing and Grubbing (1.0% of Subtotal 1 and 2)	LS	1	$4,476.67	$5,000
M & P of Traffic (6.0% of Subtotal 1 and 2)	LS	1	$26,860.00	$27,000
Mobilization (5% of Subtotal 1 and 2)	LS	1	$20,650.00	$21,000
Construction Staking (1.0% of Subtotal 1 and 2)	LS	1	$4,476.67	$5,000
			SUBTOTAL 3:	$58,000

ENGINEERING PERCENTAGES		TOTAL
Incidentals (10% of Subtotal 1, 2, and 3)	10% INCIDENTALS	$48,000
Contingency (20% of Subtotal 1, 2, and 3)	20% CONTINGENCY	$95,000
	SUBTOTAL 4:	$143,000

ESCALATION TO YEAR OF CONSTRUCTION		TOTAL
5% INFLATION FOR 4.25 YEARS (from estimate date to midpoint of construction=Subtotal*0.05*4.25)	SUBTOTAL 6:	$131,000
	TOTAL	**$745,000**

CME	COMPUTATION BY: JLS	DATE: 2/25/16	SHEET: 1 OF: 1
	CHECKED BY: TEG	DATE: 2/26/16	CME PROJECT NO.
	CLIENT: ConnDOT Charter Oak Bridge Project		CLIENT PROJECT NO.: 063-0703

ITEM
Slope No. 3 - Alternate 2 - Stone Stabilization

Alternate 2: Stone Stabilization

1. Excavate for stone stabilization slope
2. Install stones

STRUCTURE ITEMS

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
0203000	Structure Excavation - Earth (Complete)	CY	2,100	$29.00	$61,000
0213100	Granular Fill	CY	110	$45.80	$6,000
0216000	Pervious Structure Backfill	CY	1,720	$52.00	$90,000
0506017	Retaining Wall	SF	1,305	$100.00	$131,000
0714050	Temporary Earth Retaining System	SF	660	$15.00	$10,000
0728031	No. 4 Crushed Stone	CF	13,305	$1.60	$22,000
0913952	Protective Fence (5' High)	LF	115	$106.20	$13,000
				Structure Total:	$333,000
				STRUCTURE PLUS ROADWAY SUBTOTAL 1:	$333,000

MINOR ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Minor Items (10% of Subtotal 1)	LS	1	$33,300.00	$34,000
			SUBTOTAL 2:	$34,000

LUMP SUM ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Clearing and Grubbing (1.0% of Subtotal 1 and 2)	LS	1	$4,476.67	$5,000
M & P of Traffic (6.0% of Subtotal 1 and 2)	LS	1	$26,860.00	$27,000
Mobilization (5% of Subtotal 1 and 2)	LS	1	$18,350.00	$19,000
Construction Staking (1.0% of Subtotal 1 and 2)	LS	1	$4,476.67	$5,000
			SUBTOTAL 3:	$56,000

ENGINEERING PERCENTAGES		TOTAL
Incidentals (10% of Subtotal 1, 2, and 3)	10% INCIDENTALS	$43,000
Contingency (20% of Subtotal 1, 2, and 3)	20% CONTINGENCY	$85,000
	SUBTOTAL 4:	$128,000

ESCALATION TO YEAR OF CONSTRUCTION		TOTAL
5% INFLATION FOR 4.25 YEARS (from estimate date to midpoint of construction=Subtotal*0.05*4.25)	SUBTOTAL 6:	$118,000
	TOTAL	**$669,000**

CME	COMPUTATION BY: JLS	DATE: 2/25/16	SHEET: 1	OF: 1
	CHECKED BY: TEG	DATE: 2/26/16	CME PROJECT NO.	
	CLIENT: ConnDOT Charter Oak Bridge Project		CLIENT PROJECT NO.: 063-0703	

ITEM
Slope No. 3 - Alternate 3 - Prefabricated Modular Wall

Alternate 3: Prefabricated Modular Wall

1. Excavate for new wall
2. Install Granular Fill
3. Install prefabricated modular wall
4. Backfill with Pervious Structure Fill
5. Install 5' Chain Link Fence

STRUCTURE ITEMS

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
0203000	Structure Excavation - Earth (Complete)	CY	1,030	$29.00	$30,000
0213100	Granular Fill	CY	300	$45.80	$14,000
0216000	Pervious Structure Backfill	CY	1,195	$52.00	$63,000
0506017	Retaining Wall	SF	2,820	$100.00	$282,000
0714050	Temporary Earth Retaining System	SF	2,820	$15.00	$43,000
0601000	Class "A" Concrete	CY	130	$606.60	$79,000
				Structure Total:	$511,000
				STRUCTURE PLUS ROADWAY SUBTOTAL 1:	$511,000

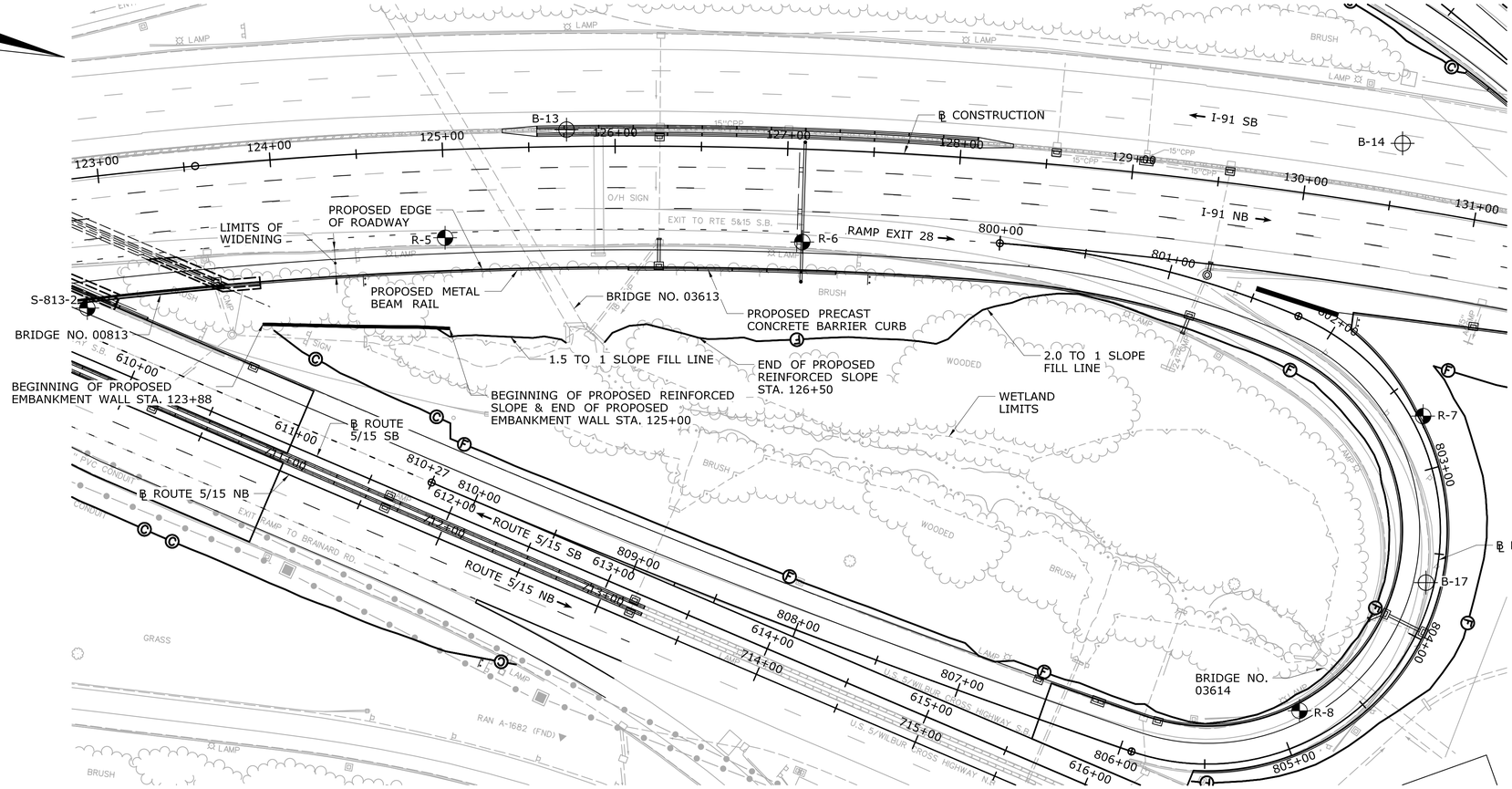
MINOR ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Minor Items (10% of Subtotal 1)	LS	1	$51,100.00	$52,000
			SUBTOTAL 2:	$52,000

LUMP SUM ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Clearing and Grubbing (1.0% of Subtotal 1 and 2)	LS	1	$4,476.67	$5,000
M & P of Traffic (6.0% of Subtotal 1 and 2)	LS	1	$26,860.00	$27,000
Mobilization (5% of Subtotal 1 and 2)	LS	1	$28,150.00	$29,000
Construction Staking (1.0% of Subtotal 1 and 2)	LS	1	$4,476.67	$5,000
			SUBTOTAL 3:	$66,000

ENGINEERING PERCENTAGES		TOTAL
Incidentals (10% of Subtotal 1, 2, and 3)	10% INCIDENTALS	$63,000
Contingency (20% of Subtotal 1, 2, and 3)	20% CONTINGENCY	$126,000
	SUBTOTAL 4:	$189,000

ESCALATION TO YEAR OF CONSTRUCTION		TOTAL
5% INFLATION FOR 4.25 YEARS (from estimate date to midpoint of construction=Subtotal*0.05*4.25)	SUBTOTAL 6:	$174,000
	TOTAL	**$992,000**

CONNECTICUT COORDINATE GRID



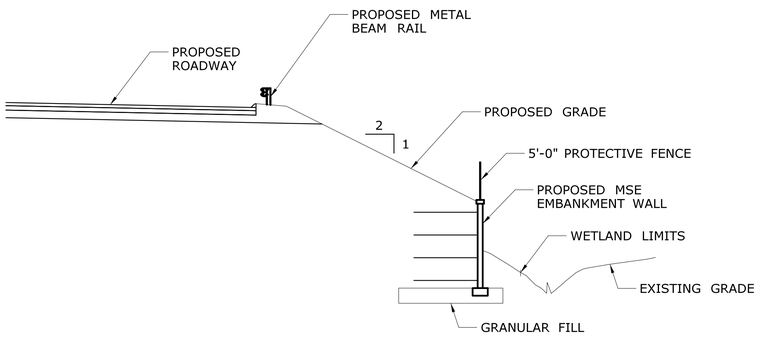
PLAN
SCALE: 1" = 40'

NOTES:

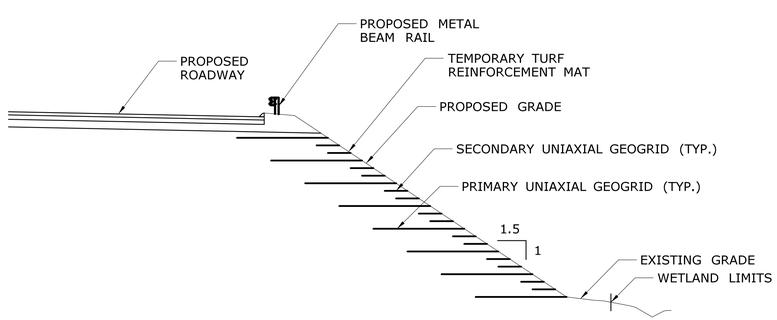
1. SLOPE LIMITS ARE APPROXIMATE
2. SLOPE TYPE SHOWN IN SECTION IS SCHEMATIC OF RECOMMENDED ALTERNATE

LEGEND

HISTORIC BORING	⊕
PROPOSED BORING	⊕



SECTION
(STA. 123+88 TO 125+00)
SCALE: 1" = 10'



SECTION
(STA. 125+00 TO 126+50
SCALE: 1" = 10'

PROPOSED SLOPE NO. 3 EAST OF I-91

PRELIMINARY DESIGN REVIEW

REV.	DATE	REVISION DESCRIPTION	SHEET NO.

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK, SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE CONDITIONS OF ACTUAL QUANTITIES OF WORK WHICH WILL BE REQUIRED.

Plotted Date: 6/22/2016

DESIGNER/DRAFTER: JLS
CHECKED BY: BLB
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\SB_MSH_SLOPE_S_03_Gen Plan.dgn

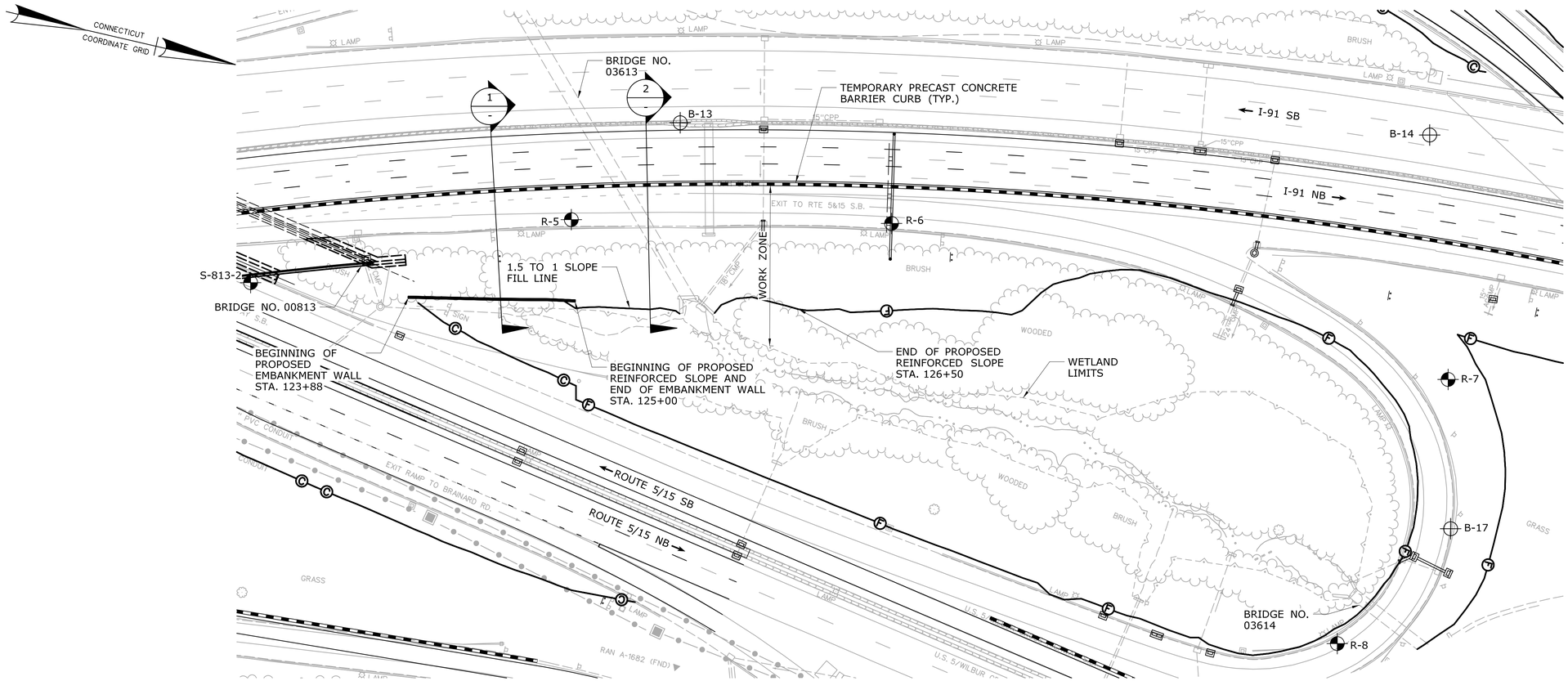
SIGNATURE/ BLOCK:

PROJECT TITLE:
RELOCATION OF I-91 NB INTERCHANGE 29 AND WIDENING OF I-91 NB AND ROUTE 15 NB TO I-84 EB

TOWN: **CITY OF HARTFORD**

DRAWING TITLE: **PLAN & SECTION**

PROJECT NO. **63-703**
DRAWING NO.
SHEET NO.



STAGE 2
SCALE: 1" = 40'

STAGE 1B & 1C - I-91 NB

1. CLOSE EXIT 28 RAMP

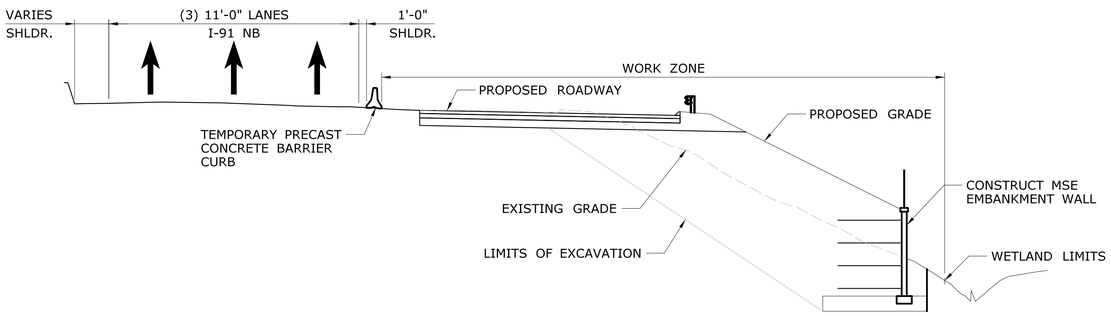
STAGE 2 - I-91 NB

1. SHIFT I-91 NB TRAFFIC TO THE LEFT, MAINTAINING 3 LANES OF TRAFFIC, EXIT 28 REMAINS CLOSED
2. WIDEN I-91 NB TO THE RIGHT AND CONSTRUCT REINFORCED SLOPE

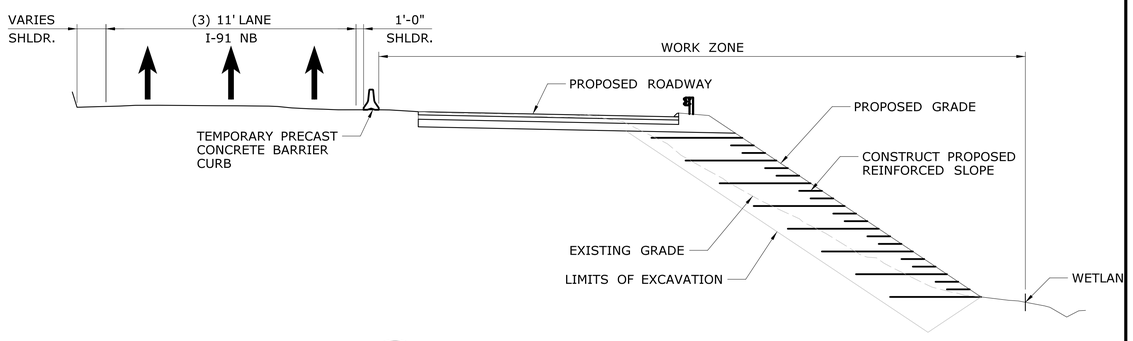
STAGE 3 - I-91 NB

1. OPEN EXIT 28 RAMP

LEGEND	
HISTORIC BORING	⊕
PROPOSED BORING	⊕



1 - **STAGE 2 - I-91 NB**
SCALE: 1" = 10'



2 - **STAGE 2 - I-91 NB**
SCALE: 1" = 10'

PROPOSED SLOPE NO. 3
EAST OF I-91

PRELIMINARY DESIGN REVIEW

REV.	DATE	REVISION DESCRIPTION	SHEET NO.

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK, SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE CONDITIONS OF ACTUAL QUANTITIES OF WORK WHICH WILL BE REQUIRED.

Plotted Date: 6/22/2016

DESIGNER/DRAFTER: JLS
CHECKED BY: BLB
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\SB_MSH_SLOPE_S_03_StagIng.dgn

SIGNATURE/ BLOCK:

PROJECT TITLE:
RELOCATION OF I-91 NB INTERCHANGE 29 AND WIDENING OF I-91 NB AND ROUTE 15 NB TO I-84 EB

TOWN: **CITY OF HARTFORD**
DRAWING TITLE: **STAGE CONSTRUCTION**

PROJECT NO. **63-703**
DRAWING NO.
SHEET NO.

4.0 SLOPE NO. 4

4.1 Description

This section discusses the soil/structure types studied for Slope No. 4, located east of the I-91 NB just south of the encapsulated landfill, located approximately from Sta. 141+29 to 144+58. This section also describes the existing site, provides three alternates for the proposed slope, and presents CME's recommendations for the proposed slope/structure type.

Based upon the evaluation of the proposed slope, CME recommends Alternate 1, which consists of a reinforced slope.

The area to the east at the location of widening is an access road to the encapsulated landfill. Widening I-91 up to 15.7' at this location requires a steepened slope at this location to limit fill slopes on the encapsulated landfill access road. The proposed alternates presented in this report were evaluated based on: construction duration, construction cost, existing conditions, and future maintenance concerns. All estimates are based on ConnDOT's estimating guidelines.

The slope will transition to a 2:1 slope at Airport Road where it meets a proposed northeast wingwall of Bridge No. 00480 required as part of the widening of a bridge.

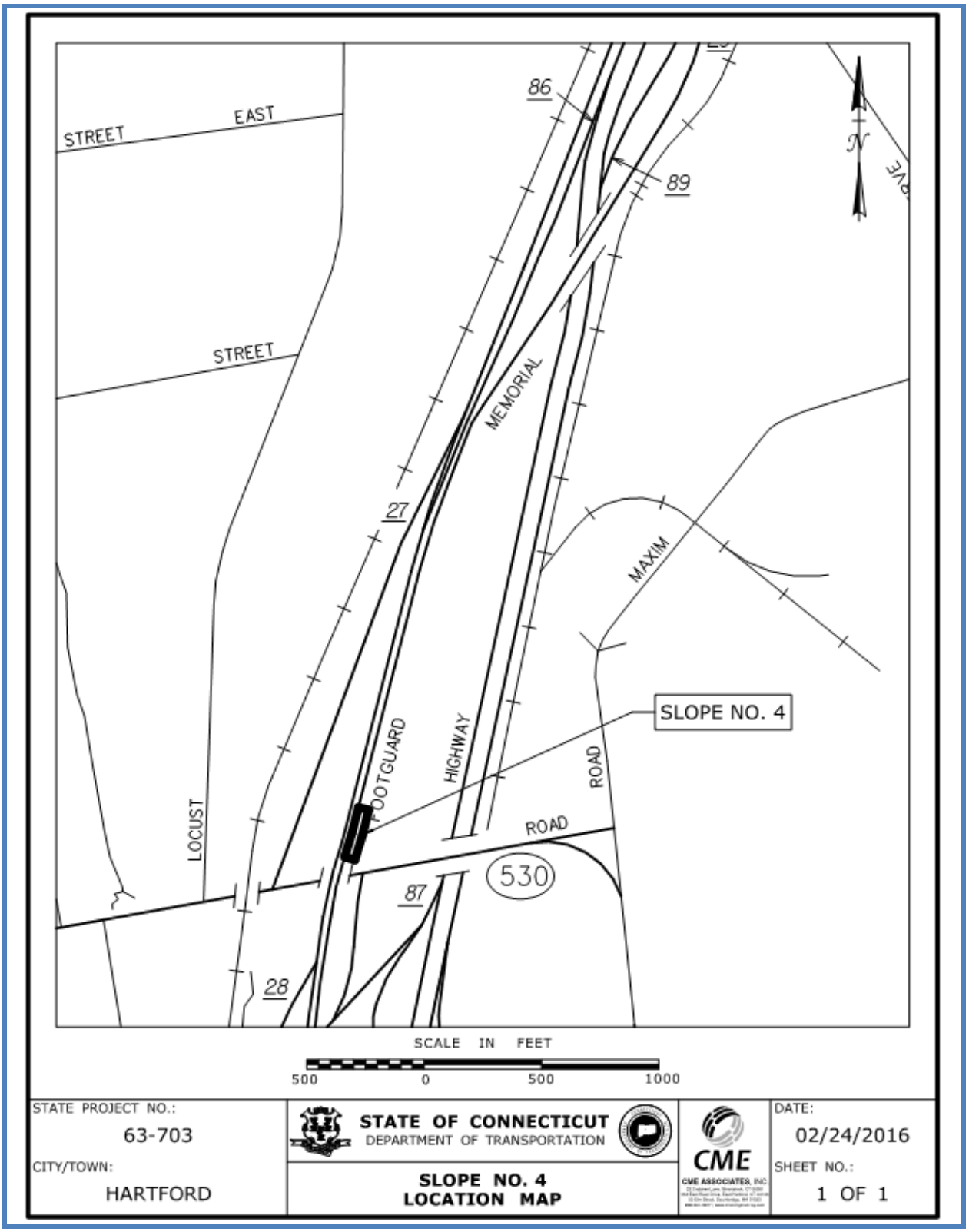
Highway Geometrics

The proposed roadway at Slope No. 4, I-91 NB, is on a horizontal tangent. The vertical alignment of I-91 in the area of the slope is on a -1.09% grade that is the back slope for a 500' sag vertical curve with a 2.55% forward tangent.

Traffic

According to the most recent ConnDOT Traffic Log, the 2014 Average Daily Traffic (ADT) on I-91 is 114,000 vehicles per day.

4.2 Location Map



4.3 Field Observations

Geotechnical Information

Widening to I-91 will be taking place to the east of the existing roadway. Previous subsurface explorations located near Slope No. 4 include test borings B-22 to B-25 which were drilled for Bridge No. 00480, I-91 over Airport Road. Recent borings include S-480-2 which is shown on the enclosed plan sheets in Section 4.10. The following conditions were encountered:

Existing Borings

Thickness Range (ft.)	Stratum	Generalized Description
10 to 20	Fill	Gray CLAY to SILT, little medium to fine sand, trace cinders. Standard Penetration Test N-Values ranged from about 3 to 38 blows per foot (bpf).
6 to 12	Sand	Gray, coarse to fine SAND, trace silt. SPT N-Values ranged from about 9 to 18 bpf.
6 to 20	Glacial Till	Red-brown, coarse to fine SAND, some clayey silt, some coarse to fine gravel. SPT N-Values were typically greater than 40 bpf.
	Bedrock	Red-brown fine sandy SILTSTONE, soft seams, some red sandy shale.
	Groundwater	Depth 0 to 4 feet

Recent Borings

Thickness Range (ft.)	Stratum	Generalized Description
14	Fill	Loose to medium dense, brown to red, coarse to fine SAND, little to trace coarse to fine gravel, little to trace silt, varying to gray SILT, some coarse to fine gravel, some coarse to fine sand, brick and wood.
15	Alluvium	Medium dense, gray fine SAND, some silt, trace fine gravel
5	Lacustrine Deposit	Soft, red CLAY, some fine sand
13	Glacial Till	Very dense, red CLAY, some coarse to fine sand, some coarse to fine gravel, varying to brown coarse to fine GRAVEL, some clayey silt, some coarse to fine sand
2	Weathered Bedrock	
	Bedrock	Red-brown ARKOSE
	Groundwater	10 feet below existing ground surface

Based on conditions encountered in the previous and recent borings, the subsurface conditions appear suitable to provide support to the proposed slope. Preliminary review of the data suggests that settlement due to the increase in stress from the addition of fill to support the I-91 NB widening will be tolerable and will occur within

a short period of time following fill placement. Further evaluation of subsurface conditions and settlement will be conducted following completion of the proposed subsurface exploration and laboratory testing program which is currently underway.

There will be a required transition area from the 1.5:1 slope to the proposed grade in front of wall W102, which is located at the end of the slope.

Property

Considering the width of the existing right-of-way, permanent easements are not anticipated. Noise impacts to commercial and private property owners in the immediate vicinity surrounding the bridge are anticipated to be minimal and the noise level is not anticipated to exceed ambient noise generated by current highway traffic.

Cultural Resources

Developed commercial areas are present to the east of the proposed wall. Brainard Airport is approximately 0.6 miles to the east. To the west approximately 400 feet, the Providence & Worcester Railroad provides freight service to the Wethersfield Secondary.

Environmental Resources

The Connecticut River is located approximately 1.0 mile east of the proposed slope with access at Charter Oak Landing approximately 0.9 miles to the north. Wethersfield Cove is approximately 0.9 miles to the south. There are also wetlands north of the wall approximately 115 feet and a drainage ditch approximately 23' east of the proposed toe of slope.

4.4 Design Criteria

Slopes will be designed in accordance with the FHWA publication *Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines* and Connecticut Department of Transportation Geotechnical Engineering Manual.

4.5 Seismic Considerations

Slope structures are resistant to dynamic forces from a seismic event due to their flexibility. In viewing a reinforced embankment similar to a retaining wall, a seismic design is not required according to the ConnDOT Bridge Manual Section 4.4.

4.6 Slope/Structure Type Alternates

Based on the preliminary design layout for the interchange, the proposed slope will begin at Bridge No. 00480 northeast wingwall at Sta. 141+29 and end at the beginning of Wall W102 at Sta. 144+58, see Figure 4.1 below. Two slope types have been studied as well as a retaining structure. Each alternate will prevent impacts to wetlands and minimize impacts to the landfill access road.

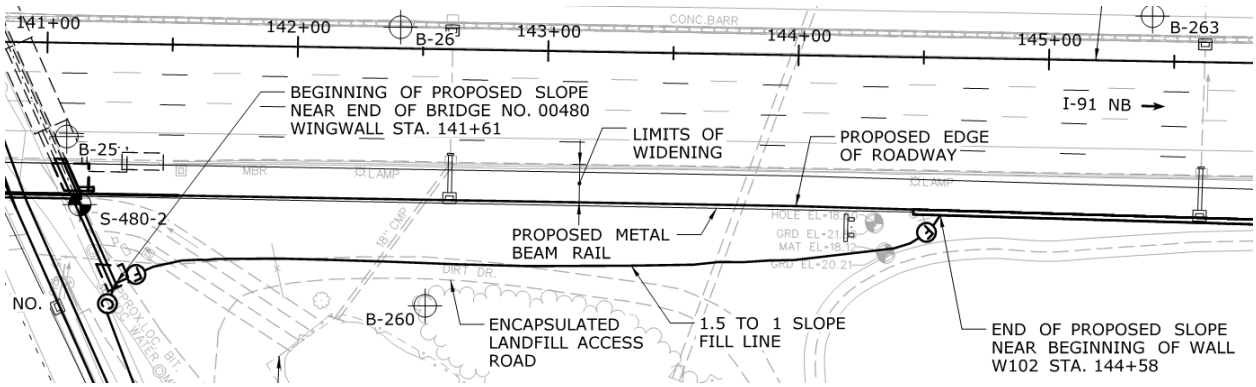


Figure 4.1 – Plan View

Slopes will be evaluated for global stability under both static and seismic conditions, as well as for anticipated settlement.

The constructability of was investigated as part of this study and a general sequence is outlined. The slope can be constructed during Stage 2 of the overall project.

Slope limits are preliminary and may change based on work proposed for Bridge No. 00480 and 06654 in the vicinity of this slope.

Cost Considerations

Section 4.10 contains an itemized cost estimate for all of the alternatives including the percentages used for the additional costs. The table below provides a summary of the total costs.

Proposed Alternates	Cost of Structure Only	Additional Costs	Rounded Total Cost
1 – Reinforced Slope	$ 105,000	$ 120,000	$225,000
2 – Stone Stabilization	$ 59,000	$ 81,000	$147,000
3 – Retaining Wall	$ 395,000	$ 357,000	$752,000

Additional Costs – Breakdown*	Alternate 1	Alternate 2	Alternate 3
Minor Items (10% of Structure Cost)	$ 11,000	$ 6,000	$ 40,000
Clearing and Grubbing	$ 3,000	$ 3,000	$ 3,000
Maintenance and Protection of Traffic	$ 13,000	$ 13,000	$ 13,000
Mobilization	$ 6,000	$ 4,000	$ 22,000
Construction Staking	$ 3,000	$ 3,000	$ 3,000
Incidentals and Contingencies	$ 44,000	$ 27,000	$ 144,000
Escalation to Midpoint Construction Year	$ 40,000	$ 25,000	$ 132,000
Total:	$ 120,000	$ 81,000	$ 357,000

Alternate 1 – Reinforced Slope

This alternate includes placement of uniaxial geogrid reinforcement layers to help strengthen the proposed fill slope areas and provide a required factor of safety. The maximum slope height is 14.5'. Slope heights are found where existing grade and proposed 1.5:1 slopes intersect.

The preliminary evaluation indicates that slopes with heights up to 20' tall will require a primary geogrid reinforcing length of 6', spaced at 3' intervals over the height of the slope. In addition to primary reinforcing,

assume additional secondary reinforcing made up of shorter lengths of uniaxial geogrid to limit shallow, surficial failures. This reinforcing is generally places at 1' intervals between the primary reinforcing with a length of 3' to 5'. It is assumed that slopes steeper than 2:1 will require reinforcing. Actual geogrid lengths are dependent on final slope geometry. See Figure 4.2 below.

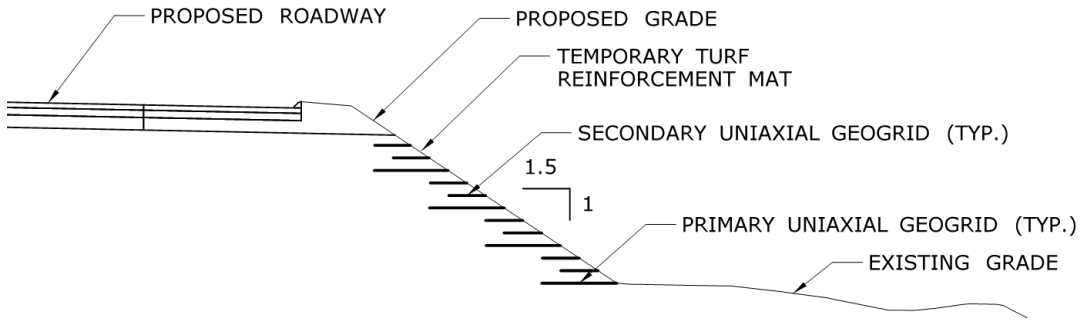


Figure 4.2 – Reinforced Slope

The following are the advantages and disadvantages of a reinforced slope:

Advantages Alternate 1	Disadvantages Alternate 1
+ More desirable aesthetics than Alternate 2	– Cost is more than Alternate 2
+ Cost is less than Alternate 3	– The slope will impact the existing landfill access roadway

Alternate 2 – Stone Stabilization

This alternate consists of stabilizing a steepened slope. Typical CTDOT steepened slopes are protected with crush stone with only a 1 foot blanket of crushed stone placed on 6" granular fill base. Preliminary slope stability evaluations based on the historical borings suggest that additional stone is necessary. Additional evaluations will be conducted once the subsurface exploration program and results of laboratory testing are complete.

The steepened slope is stabilized with use of CTDOT No. 4 (2 inch minus) stone. Based on preliminary evaluation, slopes less than 20' high will require a toe thickness of 5' (measured horizontally) at the toe. Stone geometry is dependent on final slope geometry. See Figure 4.3 below.

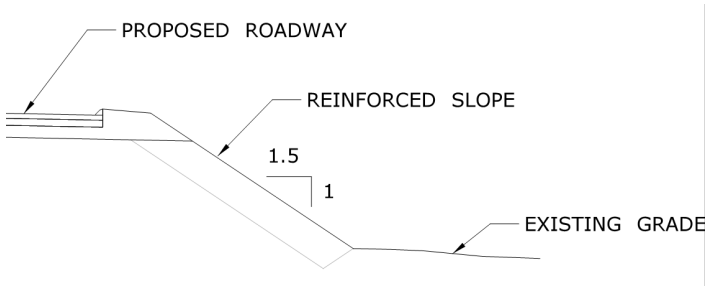


Figure 4.3 – Stone Stabilization

The following are the advantages and disadvantages of a slope stabilization:

Advantages Alternate 2	Disadvantages Alternate 2
+ Cost is less than other alternates	– Undesirable impact on aesthetics
+	– The slope will impact the existing landfill access roadway

Alternate 3 – Retaining Wall

This alternate consists of a retaining wall located adjacent to the edge of roadway, see Figure 4.4 below. The wall begins at the end of Bridge No. 00480 northeast wingwall at Sta. 141+29. The slope behind the wall will match existing and can eliminate impacts to the encapsulated landfill access road.

A cast-in-place wall is chosen over a proprietary wall based on ConnDOT Bridge Design Manual criteria. Where a wall height less than 8' (measured from front slope to back slope) an embankment wall is preferred. The maximum wall height is 6.5' at this location. An embankment wall is undesirable at this location due to the entombed landfill just to the north. Stated in the Bridge Design manual, a cast-in-place wall shall be used for locations where embankment wall are not appropriate.

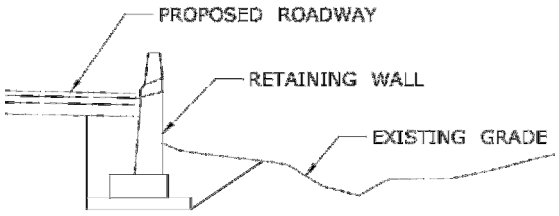


Figure 4.4 – Retaining Wall

The following are the advantages and disadvantages of a retaining wall:

Advantages Alternate 3	Disadvantages Alternate 3
+ No impact to access road to encapsulated landfill	– Cost is greater than other alternates
+	– Longer construction duration due to forming on site

4.7 Recommendations for Construction

Although Alternate 2 is less expensive than Alternate 1, Alternate 2 has an undesirable impact on aesthetics based on the CTDOT Highway Design Manual Section 10-2.02 and the use of crushed stone treatment should be minimized. Therefore CME recommends Alternate 1 as the preferred alternative for the proposed slope.

4.8 Utility and Drainage Impacts

Drainage culvert, Bridge No. 06654, inlet is located east of proposed slope and the proposed embankment slope will be above a portion of the culvert. The additional fill on the two reinforced concrete pipes may need to be checked for capacity and settlement. There is an 18" corrugated metal pipe at an unknown elevation carrying runoff water from catch basins in the adjacent roadway to the wingwall of Bridge No. 06654. AASHTO requires design modifications for catch basins within the limits of reinforcement which includes one of the follow:

- Assume reinforcements layers are severed in location of catch basin and design the surrounding layers to carry the additional load.
- Place a structural frame around catch basin.
- May be possible to splay the layers around catch basin if soil reinforcement consist of discrete strips.

There is also a 36" reinforced concrete pipe running below I-91 and the proposed slope that empties into the stream north of the culvert inlet.

4.9 Construction Sequence and Maintenance & Protection of Traffic

The construction of the proposed slope is part of a larger interchange reconstruction project. Full construction staging plans are developed. Based on work to date and staging plans submitted in the PD submittal, the overall sequence of construction is as follows:

Stage 2

1. Shift I-91 NB traffic to the left, maintaining 3 lanes of traffic.
2. Widen I-91 NB to the right and construct reinforced slope.

Stage 3

1. Shift I-91 NB traffic to the right maintaining three lanes of traffic.

4.10 Backup Data

Cost Comparisons

Proposed Plans

Stage Construction Plans

CME	COMPUTATION BY: JLS	DATE: 2/26/16	SHEET: 1	OF: 1
	CHECKED BY: TEG	DATE: 3/3/16	CME PROJECT NO.:	
	CLIENT: ConnDOT Charter Oak Bridge Project		CLIENT PROJECT NO.: 063-0703	

ITEM
Slope No. 4 - Alternate 1 - Soil Reinforcement

Alternate 1: Soil Reinforcement

1. Excavate for reinforced slopes
2. Install reinforced slopes

STRUCTURE ITEMS

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
0203000	Structure Excavation - Earth (Complete)	CY	280	$29.00	$9,000
0216000	Pervious Structure Backfill	CY	205	$52.00	$11,000
0712010	Reinforced Soil Slope	SF	3,520	$24.00	$85,000
				Structure Total:	$105,000
				STRUCTURE PLUS ROADWAY SUBTOTAL 1:	$105,000

MINOR ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Minor Items (10% of Subtotal 1)	LS	1	$10,500.00	$11,000
			SUBTOTAL 2:	$11,000

LUMP SUM ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Clearing and Grubbing (1.0% of Subtotal 1 and 2)	LS	1	$2,053.33	$3,000
M & P of Traffic (6.0% of Subtotal 1 and 2)	LS	1	$12,320.00	$13,000
Mobilization (5% of Subtotal 1 and 2)	LS	1	$5,800.00	$6,000
Construction Staking (1.0% of Subtotal 1 and 2)	LS	1	$2,053.33	$3,000
			SUBTOTAL 3:	$25,000

ENGINEERING PERCENTAGES		TOTAL
Incidentals (10% of Subtotal 1, 2, and 3)	10% INCIDENTALS	$15,000
Contingency (20% of Subtotal 1, 2, and 3)	20% CONTINGENCY	$29,000
	SUBTOTAL 4:	$44,000

ESCALATION TO YEAR OF CONSTRUCTION		TOTAL
5% INFLATION FOR 4.25 YEARS (from estimate date to midpoint of construction=Subtotal*0.05*4.25)	SUBTOTAL 6:	$40,000
	TOTAL	**$225,000**

CME	COMPUTATION BY: JLS	DATE: 2/25/16	SHEET: 1	OF: 1
	CHECKED BY: TEG	DATE: 3/3/16	CME PROJECT NO.:	
	CLIENT: ConnDOT Charter Oak Bridge Project		CLIENT PROJECT NO.: 063-0703	

ITEM
Slope No. 4 - Alternate 2 - Stone Stabilization

Alternate 2: Stone Stabilization

1. Excavate for stone stabilization slope
2. Install stones

STRUCTURE ITEMS

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
0203000	Structure Excavation - Earth (Complete)	CY	85	$29.00	$3,000
0216000	Pervious Structure Backfill	CY	470	$52.00	$25,000
0728031	No. 4 Crushed Stone	CF	19,101	$1.60	$31,000
				Structure Total:	$59,000
				STRUCTURE PLUS ROADWAY SUBTOTAL 1:	$59,000

MINOR ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Minor Items (10% of Subtotal 1)	LS	1	$5,900.00	$6,000
			SUBTOTAL 2:	$6,000

LUMP SUM ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Clearing and Grubbing (1.0% of Subtotal 1 and 2)	LS	1	$2,053.33	$3,000
M & P of Traffic (6.0% of Subtotal 1 and 2)	LS	1	$12,320.00	$13,000
Mobilization (5% of Subtotal 1 and 2)	LS	1	$3,250.00	$4,000
Construction Staking (1.0% of Subtotal 1 and 2)	LS	1	$2,053.33	$3,000
			SUBTOTAL 3:	$23,000

ENGINEERING PERCENTAGES		TOTAL
Incidentals (10% of Subtotal 1, 2, and 3)	10% INCIDENTALS	$9,000
Contingency (20% of Subtotal 1, 2, and 3)	20% CONTINGENCY	$18,000
	SUBTOTAL 4:	$27,000

ESCALATION TO YEAR OF CONSTRUCTION		TOTAL
5% INFLATION FOR 4.25 YEARS (from estimate date to midpoint of construction=Subtotal*0.05*4.25)	SUBTOTAL 6:	$25,000
	TOTAL	**$140,000**

CME	COMPUTATION BY: JLS	DATE: 2/26/16	SHEET: 1 OF: 1
	CHECKED BY: TEG	DATE: 3/3/16	CME PROJECT NO.
	CLIENT: ConnDOT Charter Oak Bridge Project		CLIENT PROJECT NO.: 063-0703

ITEM
Slope No. 4 - Alternate 3 - Retaining Wall

Alternate 3: Retaining Wall

1. Excavate for new wall
2. Install Granular Fill
3. Cast footing and walls
4. Backfill with Pervious Structure Fill

STRUCTURE ITEMS

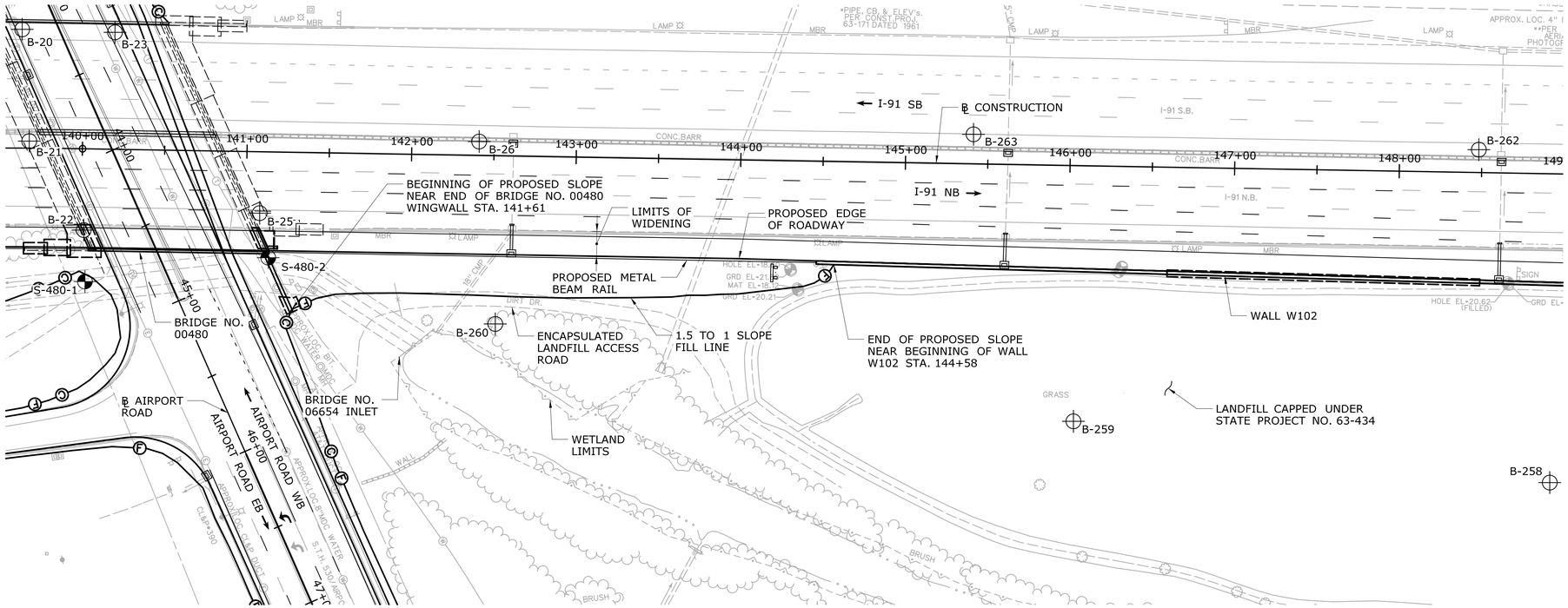
ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
0203000	Structure Excavation - Earth (Complete)	CY	1,085	$29.00	$32,000
0213100	Granular Fill	CY	200	$45.80	$10,000
0216000	Pervious Structure Backfill	CY	720	$52.00	$38,000
0714050	Temporary Earth Retaining System	SF	3,380	$15.00	$51,000
0601000	Class "A" Concrete	CY	435	$606.60	$264,000
				Structure Total:	$395,000
				STRUCTURE PLUS ROADWAY SUBTOTAL 1:	$395,000

MINOR ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Minor Items (10% of Subtotal 1)	LS	1	$39,500.00	$40,000
			SUBTOTAL 2:	$40,000

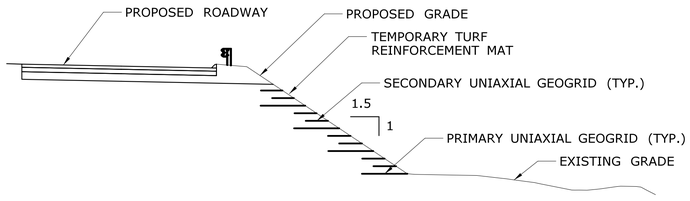
LUMP SUM ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Clearing and Grubbing (1.0% of Subtotal 1 and 2)	LS	1	$2,053.33	$3,000
M & P of Traffic (6.0% of Subtotal 1 and 2)	LS	1	$12,320.00	$13,000
Mobilization (5% of Subtotal 1 and 2)	LS	1	$21,750.00	$22,000
Construction Staking (1.0% of Subtotal 1 and 2)	LS	1	$2,053.33	$3,000
			SUBTOTAL 3:	$41,000

ENGINEERING PERCENTAGES		TOTAL
Incidentals (10% of Subtotal 1, 2, and 3)	10% INCIDENTALS	$48,000
Contingency (20% of Subtotal 1, 2, and 3)	20% CONTINGENCY	$96,000
	SUBTOTAL 4:	$144,000

ESCALATION TO YEAR OF CONSTRUCTION		TOTAL
5% INFLATION FOR 4.25 YEARS (from estimate date to midpoint of construction=Subtotal*0.05*4.25)	SUBTOTAL 6:	$132,000
	TOTAL	**$752,000**



PLAN
SCALE: 1" = 40'



SECTION
SCALE: 1" = 10'

NOTES:

1. SLOPE LIMITS ARE APPROXIMATE
2. SLOPE TYPE SHOWN IN SECTION IS SCHEMATIC OF RECOMMENDED ALTERNATE

LEGEND

HISTORIC BORING	⊕
PROPOSED BORING	⊕

PROPOSED SLOPE NO. 4 EAST OF I-91

PRELIMINARY DESIGN REVIEW

REV.	DATE	REVISION DESCRIPTION	SHEET NO.

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK, SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE CONDITIONS OF ACTUAL QUANTITIES OF WORK WHICH WILL BE REQUIRED.

Plotted Date: 6/22/2016

DESIGNER/DRAFTER: JLS
CHECKED BY: BLB
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\SB_MSH_SLOPE_S_04_Gen Plan.dgn

SIGNATURE/ BLOCK:

PROJECT TITLE:
RELOCATION OF I-91 NB INTERCHANGE 29 AND WIDENING OF I-91 NB AND ROUTE 15 NB TO I-84 EB

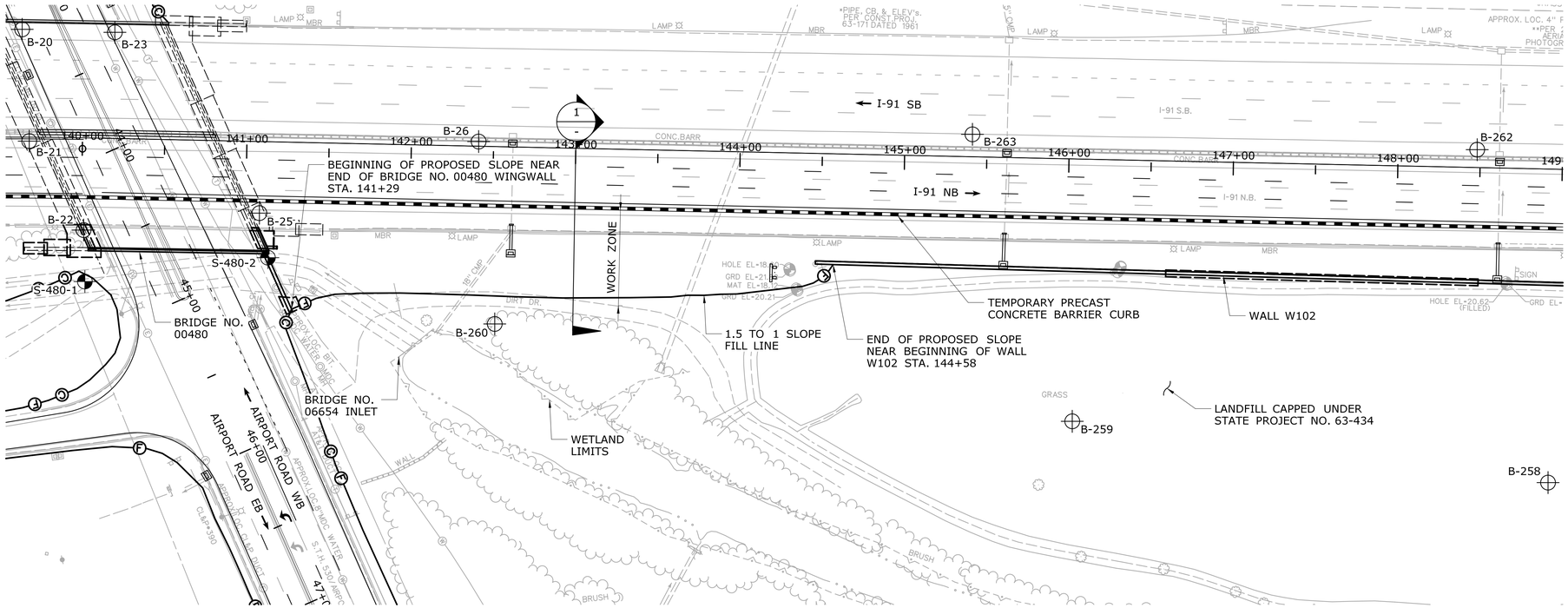
TOWN: **CITY OF HARTFORD**

DRAWING TITLE: **PLAN & SECTION**

PROJECT NO. **63-703**

DRAWING NO.

SHEET NO.



STAGE 2 - I-91 NB

1. SHIFT I-91 NB TRAFFIC TO THE LEFT, MAINTAINING 3 LANES OF TRAFFIC
2. WIDEN I-91 NB TRAFFIC TO THE RIGHT AND CONSTRUCT REINFORCED SLOPE

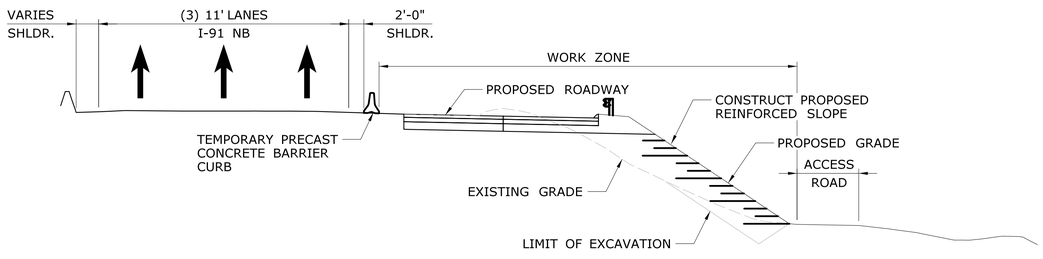
STAGE 3 - I-91 NB

1. SHIFT I-91 NB TO THE RIGHT AND CONSTRUCT REINFORCED SLOPE

LEGEND	
HISTORIC BORING	⊕
PROPOSED BORING	⊕

STAGE 2

SCALE: 1" = 40'



1 - STAGE 2 - I-91 NB

SCALE: 1" = 10'

PROPOSED SLOPE NO. 4
EAST OF I-91

PRELIMINARY DESIGN REVIEW

REV.	DATE	REVISION DESCRIPTION	SHEET NO.

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK, SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE CONDITIONS OF ACTUAL QUANTITIES OF WORK WHICH WILL BE REQUIRED.

Plotted Date: 6/22/2016

DESIGNER/DRAFTER: JLS
CHECKED BY: BLB
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\SB_MSH_SLOPE_S_04_StagIng.dgn

SIGNATURE/ BLOCK:

PROJECT TITLE:
RELOCATION OF I-91 NB INTERCHANGE 29 AND WIDENING OF I-91 NB AND ROUTE 15 NB TO I-84 EB

TOWN: **CITY OF HARTFORD**

DRAWING TITLE: **STAGE CONSTRUCTION**

PROJECT NO. **63-703**

DRAWING NO.

SHEET NO.

5.0 SLOPE NO. 5

5.1 Description

This section discusses the slope/structure types studied for Slope No. 5, located east of the I-91 NB at the proposed Exit 29 diverge, located approximately from baseline construction Sta. 153+50 to 159+07 and then from I-91 NB baseline Sta. 300+00 to 304+67. This section describes the existing site, provides three alternates for the proposed slope, and presents CME's recommendations for the proposed slope/structure type.

Based upon the evaluation of the proposed slope, CME recommends Alternate 1, which consists of a reinforced slope.

The area to the east at the location of widening is wetlands. The widening along I-91 NB of up to 24' requires a steepened slope at this location to eliminate any impacts to wetlands. The slope/structure proposed alternates presented in this report were evaluated based on: construction duration, construction cost, existing conditions, and future maintenance concerns. All estimates are based on ConnDOT's estimating guidelines.

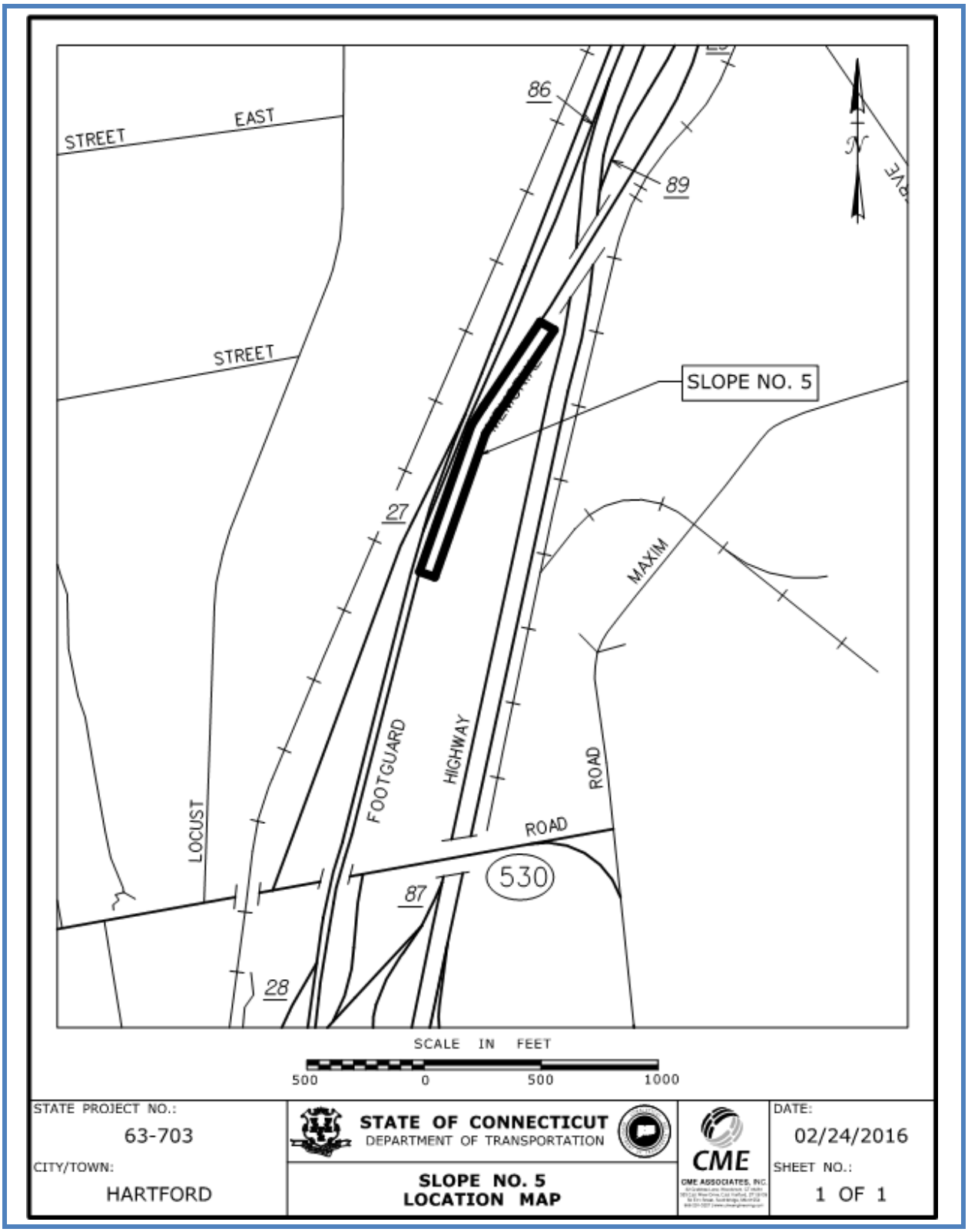
Highway Geometrics

Within the limits of Slope No. 5 there are two baselines. The first baseline is the construction baseline which is located along I-91 NB from the beginning of the project and then continues over the proposed bridge at the diverge and then along Route 5/15 NB. The second baseline is a baseline along I-91 NB which begins along I-91 NB at the diverge and continues over Bridge No. 05922. Sta. 300+00 of the I-91 baseline is equivalent to Sta. 159+07 of the construction baseline and is offset 24' right. The horizontal alignment adjacent to the slope begins on tangent which transitions to a horizontal curve with a 3600' radius to Sta. 159+07.39 where the baseline changes. At Sta. 300+00 a horizontal curve with a 3636.5' radius begins and continues beyond the limits of the proposed slope. Existing I-91 NB which is the same as proposed, is located on two vertical curves. The first vertical curve is a 400' long sag curve with a -0.527% back tangent and a +2.882% forward tangent and the second is a 1450' long crest curve with a +2.882% back tangent and a -2.888% forward tangent.

Traffic

According to the most recent ConnDOT Traffic Log, the 2014 Average Daily Traffic (ADT) is 114,000 vehicles per day for I-91 NB and SB traffic.

5.2 Location Map



5.3 Field Observations

Geotechnical Information

Widening to I-91 will be taking place to the east of the existing roadway. Previous subsurface explorations located near Slope No. 5 were drilled in the general area and are considered applicable, including B158 to B162, and B184 to B187. Recent borings include SRW-4, SRW-5, SRW-6 and RW-11 which are shown on the enclosed plan sheets in Section 5.10. The following conditions were encountered:

Thickness Range (ft.)	Stratum	Generalized Description
0.5 to 14	Fill	Very loose to medium dense SAND with subordinate amounts of silt and gravel, rock fragments, glass, brick, and debris. Standard Penetration Test (SPT N-Values typically ranged from 1 to 41 blows per foot (bpf)).
24 to 37.5	Alluvial Sand and Silt	Connecticut River floodplain and channel deposits of variable thickness consisting of an upper unit of loose to medium dense SILT, with subordinate amounts of fine sand and clay; and a lower unit of medium dense, medium to fine SAND, with subordinate amounts of silt, coarse sand and fine gravel. SPT N-values typically ranged from 1 to 37 bpf.
0 to 18	Varved Clay	Very soft to soft, varved red-brown CLAY and SILTY CLAY, in regular layers typically ¼ to ½ inch thick and up to 3 inches thick at some locations. Field and laboratory vanes are in the medium stiff to stiff range. The varved clay was typically between 0 (B185) and 14 feet thick (B159) south of the new bridge, 14 to 11 feet (B191) along the new bridge, and 11 to 40 feet (B2) north of the new bridge.
5 to 16	Glacial Till	Dense to very dense red-brown coarse to fine sandy SILT with subordinate coarse to fine gravel, clay, and occasional cobbles. SPT N-values ranged from 16 to more than 100 bpf (typically greater than 30 bpf).
	Bedrock	Moderately hard to hard, red-brown fine sandy SILTSTONE; ranges from moderately to extremely fractured with two primary joint attitudes: parallel to bedding, and steep to vertical. Joints generally smooth, planar, open. Top 1 to 3 feet was decomposed. The bedrock surface varies from about El. -43 near the proposed bridge substructures to about El. -61 near Abutment 1 of the Charter Oak Bridge.
	Groundwater	Groundwater in the general vicinity of the Charter Oak Bridge is reportedly between about El. 6 and El. 10. Groundwater levels are expected to fluctuate with variations in Connecticut River levels, season, precipitation, construction activity in the area and other factors.

Recent Borings

Thickness Range (ft.)	Stratum	Generalized Description
15 to 45	Fill	Loose to medium dense, brown to red, coarse to fine SAND, some to trace coarse to fine gravel, little to trace silt
Greater than 16 to 28	Alluvium	Medium dense, gray fine SAND, some silt, trace fine gravel, varying to gray fine SAND and SILT

30	Lacustrine Deposit	Very soft, brown Silty CLAY. Only encountered in boring RW-11
4	Glacial Till	Medium dense, brown coarse to fine SAND and SILT, some coarse to fine gravel
3	Weathered Bedrock	
	Bedrock	Red-brown, slightly fractured, medium strong, ARKOSE
	Groundwater	15 to 47 feet below existing ground surface

Based on conditions encountered in the previous and recent borings, the subsurface conditions appear suitable to provide support to the proposed slope. Preliminary review of the data suggests that settlement due to the increase in stress from the addition of fill to support the I-91 NB widening will be evaluated when laboratory test results are available. Further evaluation of subsurface conditions and settlement will be conducted following completion of the proposed subsurface exploration and laboratory testing program which are currently underway.

Property

Considering the width of the existing right-of-way, permanent easements are not anticipated. Noise impacts to commercial and private property owners in the immediate vicinity surrounding the bridge are anticipated to be minimal and the noise level is not anticipated to exceed ambient noise generated by current highway traffic.

Cultural Resources

Developed commercial areas exist to the east of the proposed slope. Brainard Airport is approximately 0.7 miles to the southeast. The Regional Market is located nearby to the northeast and the MDC wastewater treatment facility is located to the east. Bulkeley High School and Colt Park are located to the northwest. The Providence & Worcester Railroad provides freight service on the Wethersfield Secondary approximately 0.1 miles to the west. There are distribution rails approximately 0.1 miles to the east.

Environmental Resources

The Connecticut River is located approximately 0.7 miles northeast of the proposed slope with access at Charter Oak Landing approximately 0.7 miles to the north and Wethersfield Cove is approximately 1.0 miles to the south. Directly to the east of the proposed slope there is a marsh/wetland area.

5.4 Design Criteria

Slopes will be designed in accordance with the FHWA publication *Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines* and Connecticut Department of Transportation Geotechnical Engineering Manual.

5.5 Seismic Considerations

Slope structures are resistant to dynamic forces from a seismic event due to their flexibility. In viewing a reinforced embankment similar to a retaining wall, a seismic design is not required according to the ConnDOT Bridge Manual Section 4.4.

5.6 Slope/Structure Type Alternates

Based on the preliminary design layout for the interchange, the proposed slope will begin at Construction baseline Sta. 153+50 and will end at I-91 NB baseline Sta. 304+67, see Figure 5.1 below. Two slope types have been studied as well as a retaining structure. Each alternate will prevent impacts to wetlands.

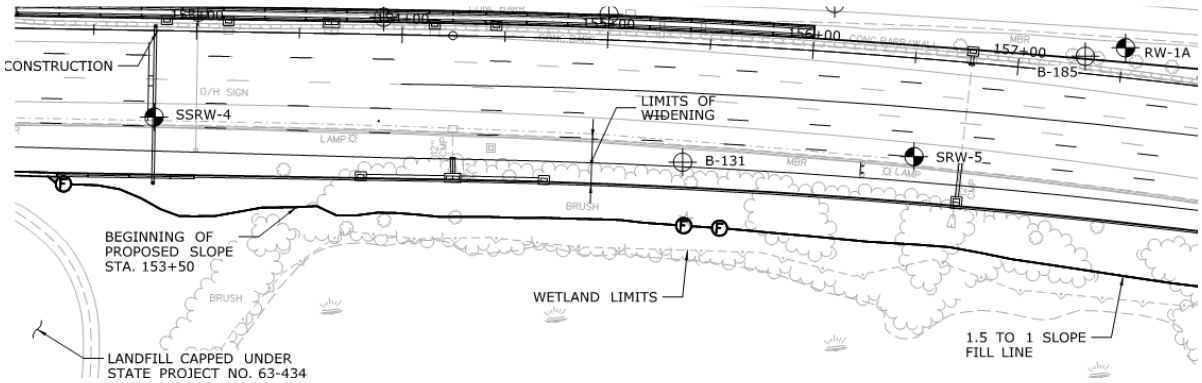


Figure 5.1 – Plan View (South End)

Slopes will be evaluated for global stability under both static and seismic conditions, as well as for anticipated settlement.

The constructability of was investigated as part of this study and a general sequence is outlined. The slope can be constructed during Stage 2.

Cost Considerations

Section 5.10 contains an itemized cost estimate for all of the alternatives including the percentages used for the additional costs. The table below provides a summary of the total costs.

Proposed Alternates	Cost of Structure Only	Additional Costs	Rounded Total Cost
1 – Reinforced Slope	$ 422,000	$ 456,000	$878,000
2 – Stone Stabilization	$ 171,000	$ 250,000	$421,000
3 – Retaining Wall	$ 1,590,000	$ 1,413,000	$3,003,000

Additional Costs – Breakdown*	Alternate 1	Alternate 2	Alternate 3
Minor Items (10% of Structure Cost)	$ 43,000	$ 18,000	$ 159,000
Clearing and Grubbing	$ 9,000	$ 9,000	$ 8,000
Maintenance and Protection of Traffic	$ 49,000	$ 49,000	$ 49,000
Mobilization	$ 24,000	$ 10,000	$ 88,000
Construction Staking	$ 9,000	$ 9,000	$ 8,000
Incidentals and Contingencies	$ 168,000	$ 81,000	$ 572,000
Escalation to Midpoint Construction Year	$ 154,000	$ 74,000	$ 527,000
Total:	$ 456,000	$ 250,000	$ 1,413,000

Alternate 1 – Reinforced Slope

This alternate includes placement of uniaxial geogrid reinforcement layers to help strengthen the proposed fill slope areas and provide a required factor of safety. The maximum slope height is approximately 21.3'. Slope heights are found where existing grade and proposed 1.5:1 slopes intersect.

The preliminary evaluation indicates that slopes with heights up to 20' tall will require a primary geogrid reinforcing length of 6', while a slope between 20' and 40' tall will require a geogrid length of 12', spaced at 3' intervals over the height of the slope. In addition to primary reinforcing, assume additional secondary reinforcing made up of shorter lengths of uniaxial geogrid to limit shallow, surficial failures. This reinforcing is generally places at 1' intervals between the primary reinforcing with a length of 3' to 5'. It is assumed that slopes steeper than 2:1 will require reinforcing. Actual geogrid lengths are dependent on final slope geometry.

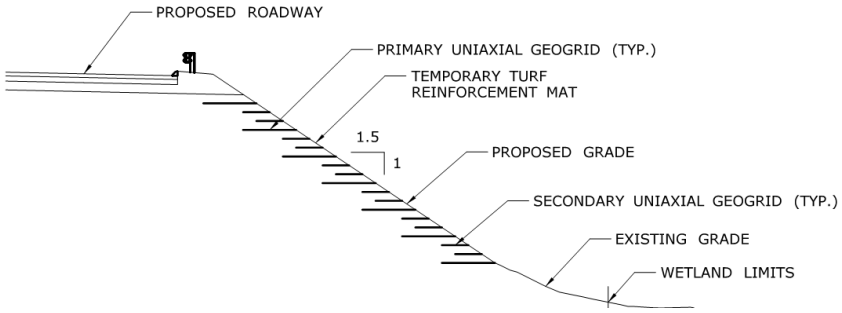


Figure 5.2 – Reinforced Slope

The following are the advantages and disadvantages of a reinforced slope:

Advantages Alternate 1	Disadvantages Alternate 1
+ More desirable aesthetics than Alternate 2	– Cost is more than Alternate 2
+ Cost is less than Alternate 3	–

Alternate 2 – Stone Stabilization

This alternate consists of stabilizing a steepened slope. Typical CTDOT steepened slopes are protected with crush stone with only a 1 foot blanket of crushed stone placed on 6" granular fill base. Preliminary slope stability evaluations based on the historical borings suggest that additional stone is necessary. Additional evaluations will be conducted once the subsurface exploration program and results of laboratory testing are complete.

The steepened slope is stabilized with use of CTDOT No. 4 (2 inch minus) stone. Based on preliminary evaluation, slopes less than 20' high will require a toe thickness of 5' (measured horizontally) at the toe. Slopes 20' to 40' will require a slope toe stone thickness of approximately 13'. Stone geometry is dependent on final slope geometry. See Figure 5.3 below.

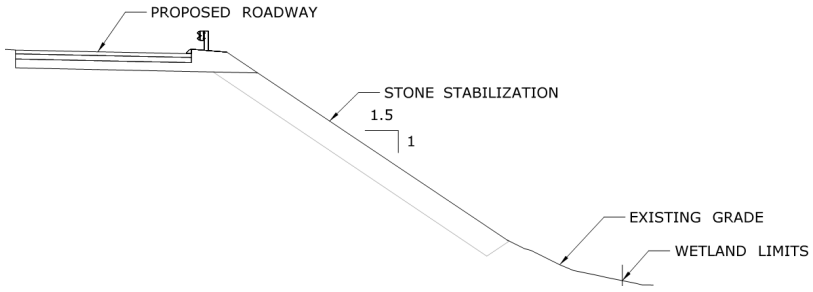


Figure 5.3 – Stone Stabilization

The following are the advantages and disadvantages of a slope stabilization:

Advantages Alternate 2	Disadvantages Alternate 2
+ Cost is less than other alternates	– Undesirable impact on aesthetics

Alternate 3 – Retaining Wall

This alternate consists of a retaining wall located adjacent to the edge of roadway.

A proprietary wall is chosen over a cast-in-place wall based on ConnDOT Bridge Design Manual criteria. Where a wall height less than 8' (measured from front slope to back slope) an embankment wall is preferred. Maximum wall height is 5.8'. An embankment wall is defined by the Bridge Design Manual as a proprietary wall system and supports an embankment. See Figure 5.4 below.

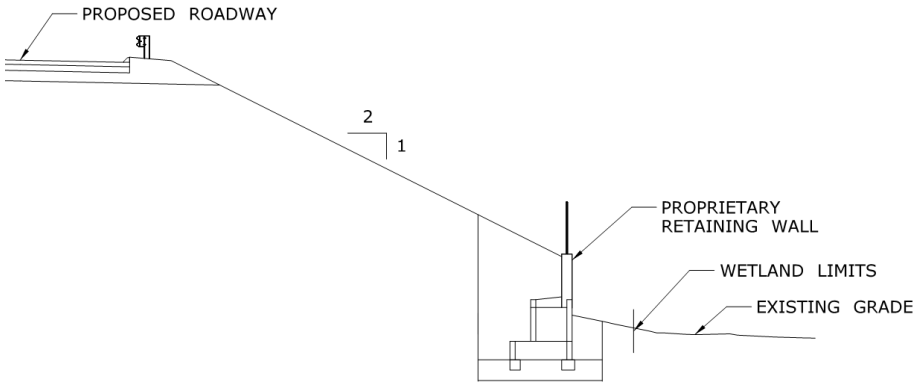


Figure 5.4 – Retaining Wall

The following are the advantages and disadvantages of a retaining wall:

Advantages Alternate 3	Disadvantages Alternate 3
+	– Cost is greater than other alternates
+	– Impact to traffic is greater due to delivery of precast materials

5.7 Recommendations for Construction

Although Alternate 2 is less expensive than Alternate 1, Alternate 2 has an undesirable impact on aesthetics based on the CTDOT Highway Design Manual Section 10-2.02 and the use of this treatment should be minimized. Therefore CME recommends Alternate 1 as the preferred alternative for the proposed slope.

5.8 Utility and Drainage Impacts

There are two 12" corrugated metal pipes and a 24" reinforced concrete pipe, each at an unknown elevations carrying runoff water from catch basins in the adjacent roadway. The pipes may need to be relocated or extended. Currently there is one drainage catch basins proposed along on the shoulders in the limits of Slope No. 4. AASHTO requires design modifications for catch basins within the limits of reinforcement which includes one of the follow:

- Assume reinforcements layers are severed in location of catch basin and design the surrounding layers to carry the additional load.
- Place a structural frame around catch basin.
- May be possible to splay the layers around catch basin if soil reinforcement consist of discrete strips.

5.9 Construction Sequence and Maintenance & Protection of Traffic

The construction of the proposed slope is part of a larger interchange reconstruction project. Full construction staging plans are developed. Based on work to date and staging plans submitted in the PD submittal, the overall sequence of construction is as follows:

Stage 2

1. Shift I-91 NB traffic to the left, maintaining 3 lanes of traffic.
2. Widen I-91 NB to the right and construct reinforced slope.

Stage 3

1. Shift I-91 traffic to the right maintaining 3 lanes of traffic.

5.10 Backup Data

Cost Comparisons

Proposed Plans

Stage Construction Plans

CME	COMPUTATION BY: JLS	DATE: 2/29/16	SHEET: 1 OF: 1
	CHECKED BY: TEG	DATE: 3/3/16	CME PROJECT NO.
	CLIENT: ConnDOT Charter Oak Bridge Project		CLIENT PROJECT NO.: 063-0703
ITEM: Slope No. 5 - Alternate 1 - Soil Reinforcement			

Alternate 1: Soil Reinforcement

1. Excavate for reinforced slopes
2. Install reinforced slopes

STRUCTURE ITEMS

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
0203000	Structure Excavation - Earth (Complete)	CY	2,245	$29.00	$66,000
0216000	Pervious Structure Backfill	CY	120	$52.00	$7,000
0712010	Reinforced Soil Slope	SF	14,530	$24.00	$349,000
				Structure Total:	$422,000
				STRUCTURE PLUS ROADWAY SUBTOTAL 1:	$422,000

MINOR ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Minor Items (10% of Subtotal 1)	LS	1	$42,200.00	$43,000
			SUBTOTAL 2:	$43,000

LUMP SUM ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Clearing and Grubbing (1.0% of Subtotal 1 and 2)	LS	1	$8,010.00	$9,000
M & P of Traffic (6.0% of Subtotal 1 and 2)	LS	1	$48,060.00	$49,000
Mobilization (5% of Subtotal 1 and 2)	LS	1	$23,250.00	$24,000
Construction Staking (1.0% of Subtotal 1 and 2)	LS	1	$8,010.00	$9,000
			SUBTOTAL 3:	$91,000

ENGINEERING PERCENTAGES		TOTAL
Incidentals (10% of Subtotal 1, 2, and 3)	10% INCIDENTALS	$56,000
Contingency (20% of Subtotal 1, 2, and 3)	20% CONTINGENCY	$112,000
	SUBTOTAL 4:	$168,000

ESCALATION TO YEAR OF CONSTRUCTION		TOTAL
5% INFLATION FOR 4.25 YEARS (from estimate date to midpoint of construction=Subtotal*0.05*4.25)	SUBTOTAL 6:	$154,000
	TOTAL	**$878,000**

CME	COMPUTATION BY: JLS	DATE: 2/29/16	SHEET: 1 OF: 1
	CHECKED BY: TEG	DATE: 3/3/16	CME PROJECT NO.
	CLIENT: ConnDOT Charter Oak Bridge Project		CLIENT PROJECT NO.: 063-0703

ITEM
Slope No. 5 - Alternate 2 - Stone Stabilization

Alternate 2: Stone Stabilization

1. Excavate for stone stabilization slope
2. Install stones

STRUCTURE ITEMS

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
0203000	Structure Excavation - Earth (Complete)	CY	895	$29.00	$26,000
0216000	Pervious Structure Backfill	CY	575	$52.00	$30,000
0728031	No. 4 Crushed Stone	CF	71,466	$1.60	$115,000
				Structure Total:	$171,000
				STRUCTURE PLUS ROADWAY SUBTOTAL 1:	$171,000

MINOR ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Minor Items (10% of Subtotal 1)	LS	1	$17,100.00	$18,000
			SUBTOTAL 2:	$18,000

LUMP SUM ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Clearing and Grubbing (1.0% of Subtotal 1 and 2)	LS	1	$8,010.00	$9,000
M & P of Traffic (6.0% of Subtotal 1 and 2)	LS	1	$48,060.00	$49,000
Mobilization (5% of Subtotal 1 and 2)	LS	1	$9,450.00	$10,000
Construction Staking (1.0% of Subtotal 1 and 2)	LS	1	$8,010.00	$9,000
			SUBTOTAL 3:	$77,000

ENGINEERING PERCENTAGES		TOTAL
Incidentals (10% of Subtotal 1, 2, and 3)	10% INCIDENTALS	$27,000
Contingency (20% of Subtotal 1, 2, and 3)	20% CONTINGENCY	$54,000
	SUBTOTAL 4:	$81,000

ESCALATION TO YEAR OF CONSTRUCTION		TOTAL
5% INFLATION FOR 4.25 YEARS (from estimate date to midpoint of construction=Subtotal*0.05*4.25)	SUBTOTAL 6:	$74,000
	TOTAL	**$421,000**

CME	COMPUTATION BY: JLS	DATE: 2/29/16	SHEET: 1 OF: 1
	CHECKED BY: TEG	DATE: 3/3/16	CME PROJECT NO.
	CLIENT: ConnDOT Charter Oak Bridge Project		CLIENT PROJECT NO.: 063-0703

ITEM
Slope No. 5 - Alternate 3 - Retaining Wall

Alternate 3: Retaining Wall

1. Excavate for new wall
2. Install Granular Fill
3. Install prefabricated modular wall
4. Backfill with Pervious Structure Fill

STRUCTURE ITEMS

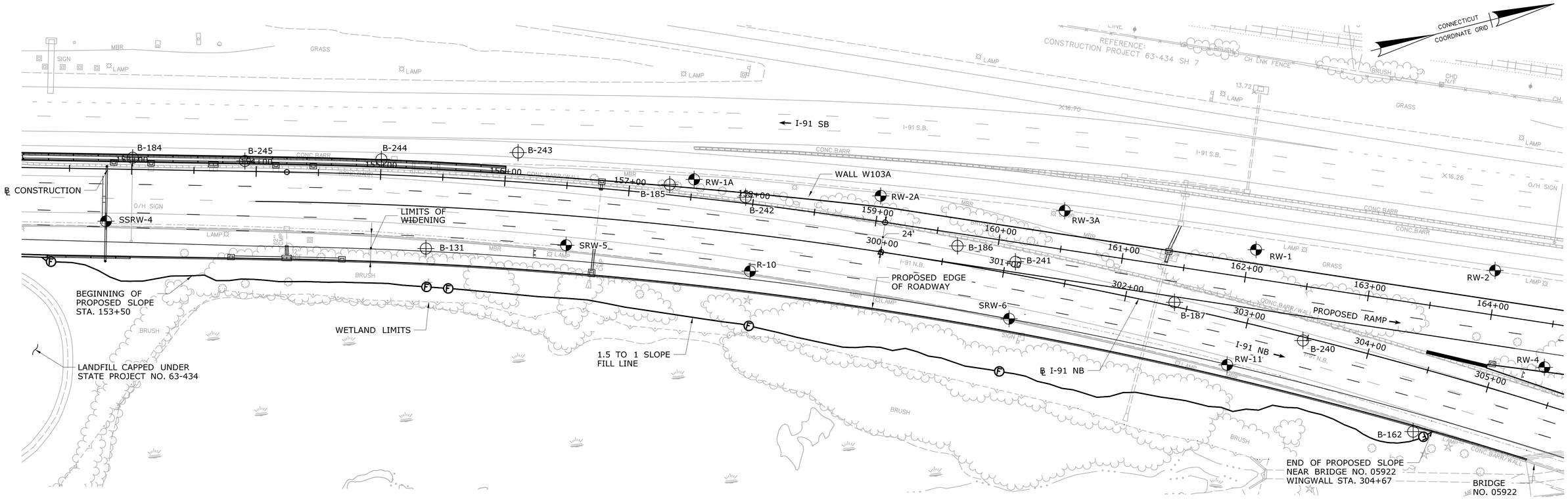
ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
0203000	Structure Excavation - Earth (Complete)	CY	3,605	$29.00	$105,000
0213100	Granular Fill	CY	900	$45.80	$42,000
0216000	Pervious Structure Backfill	CY	2,880	$52.00	$150,000
0506017	Retaining Wall	SF	7,375	$100.00	$738,000
0714050	Temporary Earth Retaining System	SF	16,500	$15.00	$248,000
0601000	Class "A" Concrete	CY	505	$606.60	$307,000
				Structure Total:	$1,590,000
				STRUCTURE PLUS ROADWAY SUBTOTAL 1:	$1,590,000

MINOR ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Minor Items (10% of Subtotal 1)	LS	1	$159,000.00	$159,000
			SUBTOTAL 2:	$159,000

LUMP SUM ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Clearing and Grubbing (1.0% of Subtotal 1 and 2)	LS	1	$8,010.00	$9,000
M & P of Traffic (6.0% of Subtotal 1 and 2)	LS	1	$48,060.00	$49,000
Mobilization (5% of Subtotal 1 and 2)	LS	1	$87,450.00	$88,000
Construction Staking (1.0% of Subtotal 1 and 2)	LS	1	$8,010.00	$9,000
			SUBTOTAL 3:	$155,000

ENGINEERING PERCENTAGES		TOTAL
Incidentals (10% of Subtotal 1, 2, and 3)	10% INCIDENTALS	$191,000
Contingency (20% of Subtotal 1, 2, and 3)	20% CONTINGENCY	$381,000
	SUBTOTAL 4:	$572,000

ESCALATION TO YEAR OF CONSTRUCTION		TOTAL
5% INFLATION FOR 4.25 YEARS (from estimate date to midpoint of construction=Subtotal*0.05*4.25)	SUBTOTAL 6:	$527,000
	TOTAL	**$3,003,000**

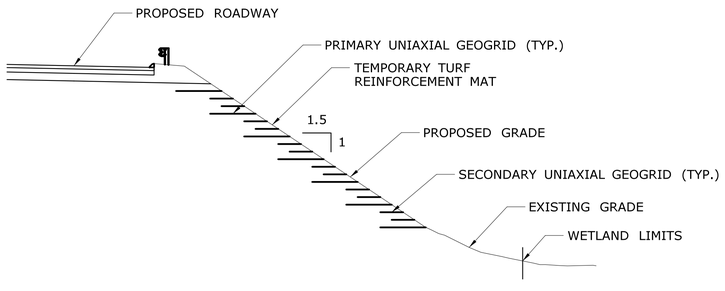


PLAN
SCALE: 1" = 40'

LEGEND	
HISTORIC BORING	⊕
PROPOSED BORING	◆

NOTES:

1. SLOPE LIMITS ARE APPROXIMATE
2. SLOPE TYPE SHOWN IN SECTION IS SCHEMATIC OF RECOMMENDED ALTERNATE



SECTION
SCALE: 1" = 10'

PROPOSED SLOPE NO. 5 EAST OF I-91

PRELIMINARY DESIGN REVIEW

REV.	DATE	REVISION DESCRIPTION	SHEET NO.

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK, SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE CONDITIONS OF ACTUAL QUANTITIES OF WORK WHICH WILL BE REQUIRED.

Plotted Date: 6/22/2016

DESIGNER/DRAFTER: JLS
CHECKED BY: BLB
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\SB_MSH_SLOPE_S_05_Gen Plan.dgn

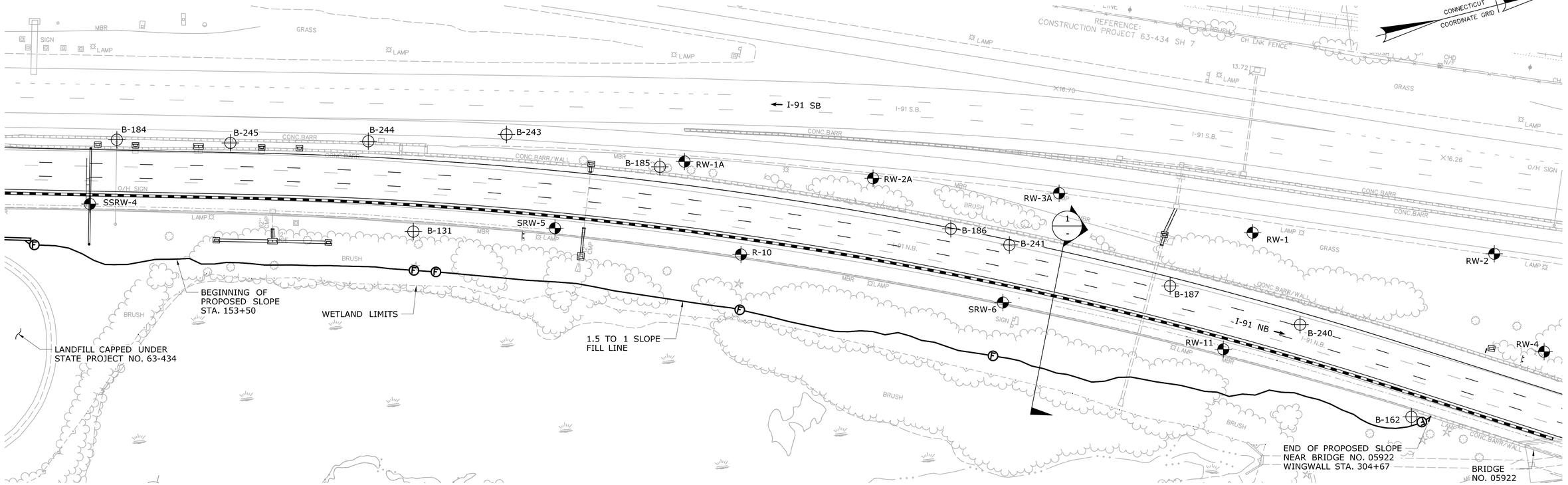
SIGNATURE/ BLOCK:

PROJECT TITLE:
RELOCATION OF I-91 NB INTERCHANGE 29 AND WIDENING OF I-91 NB AND ROUTE 15 NB TO I-84 EB

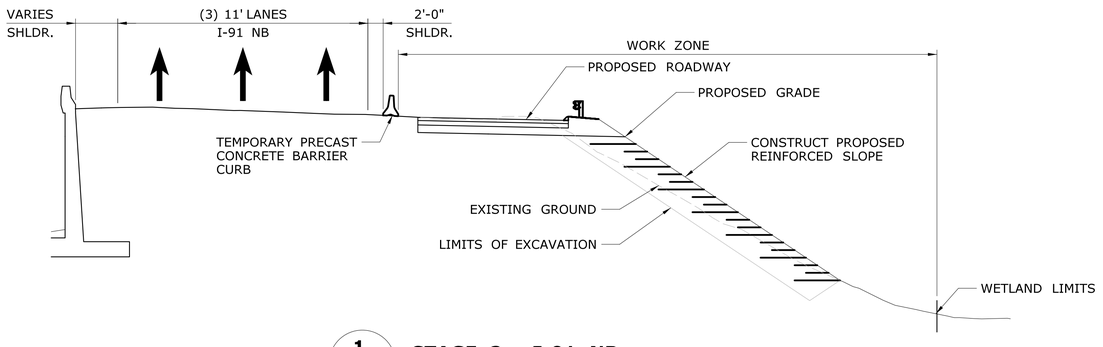
TOWN: **CITY OF HARTFORD**

DRAWING TITLE: **PLAN & SECTION**

PROJECT NO. **63-703**
DRAWING NO.
SHEET NO.



STAGE 2
SCALE: 1" = 40'



1 - STAGE 2 - I-91 NB
SCALE: 1" = 10'

LEGEND	
HISTORIC BORING	⊕
PROPOSED BORING	◕

STAGE 2 - I-91 NB
1. SHIFT I-91 NB TRAFFIC TO THE LEFT, MAINTAINING 3 LANES OF TRAFFIC
2. WIDEN I-91 NB TRAFFIC TO THE RIGHT AND CONSTRUCT REINFORCED SLOPE

STAGE 3 - I-91 NB
1. SHIFT I-91 NB TO THE RIGHT, MAINTAINING 3 LANES OF TRAFFIC

PROPOSED SLOPE NO. 5 EAST OF I-91

PRELIMINARY DESIGN REVIEW

REV.	DATE	REVISION DESCRIPTION	SHEET NO.

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DESIGNER/DRAFTER: JLS
CHECKED BY: BLB
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\SB_MSH_SLOPE_S_05_StagIng.dgn

SIGNATURE/ BLOCK:

PROJECT TITLE:
RELOCATION OF I-91 NB INTERCHANGE 29 AND WIDENING OF I-91 NB AND ROUTE 15 NB TO I-84 EB

TOWN: **CITY OF HARTFORD**

DRAWING TITLE: **PLAN & SECTION**

PROJECT NO. **63-703**
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