SCI-823-0.00

PID No. 19415

S.R. 823 OVER WEBSTER STREET (S.R. 140)

STRUCTURE TYPE STUDY SUBMITTAL

Prepared for:
OHIO DEPARTMENT OF TRANSPORTATION
DISTRICT 9
650 EASTERN AVE.
CHILLICOTHE, OHIO 45601

MAY 12, 2006

Prepared by:

TranSystems®

STRUCTURAL ENGINEERING

MAY 16 2006

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AD	☐	SS	☐	JS	☐	FILE	☐

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BRIDGE TYPE STUDY NARRATIVE

1. Introduction

TranSystems Corporation is providing engineering services to the Ohio Department of Transportation for the design of new left and right overpass structures that will carry the proposed S.R. 823 bypass over existing Webster Street (SR 140). As requested by the Scope of Services, a Bridge Type Study report is to be submitted before any plan development. The purpose of this report is to investigate various span arrangements and superstructure and substructure types in order to determine the most appropriate and economical structure type that will meet the project requirements. An initial Bridge Type Study report dated 7/15/2005 was submitted to the Department and comments, dated 9/9/2005, were in turn received by TranSystems. However, since these dates, the entire project has experienced a change in profile – the original project profile presented in the Preferred Alternative Verification Report (PAVR) submitted July 2005 has been altered and the revised profile has been approved by the Department. The revised profile raises the elevations of proposed S.R. 823 over Webster Street (SR 140) from the elevations specified in the July 2005 PAVR. This follow-up Bridge Type Study presents the results of these changes as well as alternative bridge types that are investigated in accordance with the 9/9/2005 ODOT comments. As a result, three (3) alternatives for construction of the proposed S.R. 823 Mainline over Webster Street are evaluated in this study and are designated as Alternatives 1-3. Each of these alternatives is evaluated with regard to estimated construction cost, projected maintenance costs, horizontal and vertical clearances, constructability and maintenance of traffic. Discussion of these alternatives is presented later in this report.

2. Design Criteria

The proposed structure will be designed according to the most current version of the Ohio Department of Transportation Bridge Design Manual and the 2002 AASHTO Standard Specifications for Highway Bridges, 17th Edition. Horizontal clearances (clear zone width and horizontal sight distance) are based on the Ohio Department of Transportation Location and Design Manual, Volume One – Roadway Design.

3. Subsurface Conditions and Foundation Recommendation

DLZ Ohio, Inc. performed the subsurface exploration for the proposed bridge and prepared the Preliminary Bridge Foundation Recommendations which were presented in Section 3 and Appendix E of the original 7/15/2005 Structure Type Study report. Updated boring logs for the four test borings (TR-43, ? TR-44 and TR-45) and preliminary MSE wall evaluations – performed by DLZ Ohio, Inc. – accompany this modified/updated Structure Type Study Report. Note that DLZ recommends spread footings or drilled shafts as foundation types for the proposed abutments. Driven H-piles are not recommended due to the depth of overburden/fill that needs to be placed on the existing rock cuts – the resulting depth of fill would provide insufficient lateral stability for driven H-piles. ? The preliminary evaluations reveal that MSE walls can be used at the rear and forward abutment locations. At the rear abutment DLZ anticipates that the MSE wall will be founded on rock. DLZ recommends additional exploration to more accurately determine rock elevations. At the forward abutment DLZ recommends the naturally occurring soils beneath the proposed MSE walls be overexcavated to top of rock and replaced with compacted, granular fill or constructing the MSE wall in stages. MSE wall global stability safety factors are in excess of 1.5 therefore spread footings are acceptable at this location. Refer to the preliminary MSE wall evaluation report for more details and information.

4. Roadway

The purpose of this project is to construct a new bypass state route around the town of Portsmouth, Ohio. The proposed alignment will carry two lanes of traffic, 15 plus miles in either direction, from an interchange with US 52 just east of Portsmouth to another interchange with US 23, located north of Portsmouth in Valley Township.

Both the left and right structures are similar and will consist of a 16'-0" travel lane with 6'-0" median shoulders and 8'-0" outside shoulders. A 1" opening centered about the centerline of construction and survey SR 823 will be positioned between the left and right bridges. A 4'-9" tall inside median barrier with a width of 1'-5 ½" and a 1'-6" wide outside straight faced deflector parapet (standard drawing SBR-1-99) yield a deck width of 32'-11 ½" out-to-out. This horizontal bridge layout maintains consistency with the proposed, and ODOT accepted roadway geometry and prevents alteration of the outside roadway edges. Horizontal and vertical sight distances, in accordance with the design standards, have been provided over the bridge for all alternatives considered.

Vertical and Horizontal Design – Since the proposed vertical alignment for all overpass structures on this project was dictated by the overall design of the new bypass profile, vertical clearance was not a critical design issue for each alternative proposed herein. For this report, more than 17'-0" of preferred vertical clearance could be provided for each structure's alternatives considered. In accordance with the ODOT L&D manual, Volume 1, for the twin structures at Webster Street, a minimum horizontal clear zone width of 26'-0" from edge of traveled way to face of obstruction is required. If the clear zone is less than 26', a barrier will be required with the proper offset behind it.

Webster Street will be widened to the horizontal and vertical alignment shown in the plans. The cross section will be three lanes wide and superelevated under the structure. Guardrail along an existing ditch will remain in the proposed design.

Pavement Drainage - The collection of storm water runoff will be addressed off of the bridge, thus scuppers will not be required. The type of drainage system will be investigated as part of the preliminary design.

Utilities - No utilities will be placed on the bridge. However, lighting and ITS conduits will be provided as necessary. An existing waterline runs parallel to SR 140 approximately at the existing north edge of pavement. A gas line also runs parallel to SR 140 on the north side, approximately 15'-0" off the existing edge of pavement. The gas line is approximately 10'-0" in front of the nearest MSE wall and under the proposed pavement. There is an existing aerial electric line also on the north side of SR 140 that will need to be relocated. There are no other utilities known at this point in time.

Maintenance of Traffic - While the new bridges are under construction, traffic will be maintained on existing Webster Street. It is anticipated that there will be limited closures during construction for beam setting.

5. Proposed Structure Configurations

Alignment & Profile: The proposed mainline horizontal geometry is tangent along entire length of both the left and right structures. The cross section has a crown at the profile grade line with a break at the median shoulder in accordance with the BDM. The proposed mainline profile grade line is located on the inside edge of pavement for both bridges and is in a 1600' sag vertical curve, PVI= 66+50, El. 583.33, G1 = -0.5% and G2 = 5.0%. The horizontal and vertical geometry for all alternatives considered are the same. Embankment slopes will be a maximum of 2:1 in order to minimize right-of-way impacts.

The proposed alignment of SR 140 is tangent below the structures. East and west of the structures there are horizontal curves to the right and therefore the cross section of SR 140 is superelevated at 2%. The proposed profile grade for SR 140 is in a 300' vertical curve, PVI= 11+00, El. 556.68, G1 = 0.42% and G2 = 3.12%.

Structure Types: As per the Scope of Services, we investigated several bridge types and alternatives as part of this type study. Considering the preferred and minimum clearances required for Webster Street and the position of the large ditch at the rear abutment, single span structures were selected as the most economical. The different alternatives discussed below present span arrangements at the minimum and preferred clearances.

A preliminary bridge construction cost has been prepared for the three (3) Alternatives (See Appendix A). The unit prices were based on ODOT's Summary of Contracts Awarded Year 2004 inflated 3.5% each year to the 2008 sale date, unless different unit prices were recommended by ODOT in September 2005. This estimate will be used as a comparison between alternatives and as a guide to select the most economical structure. Maintenance costs such as painting, overlays and re-decking were included for each Alternative.

The structure types that were considered are outlined in the Structure Type Alternative Table below:

BRIDGE TYPE ALTERNATIVE TABLE			
Structure Type Alternative	**1**	**2**	**3**
Superstructure Type Description	Prestressed Concrete Girders 72" Modified AASHTO Type 4 beams	58"web, steel plate girders A709 Grade 50W	Prestressed Concrete Girders 72" Modified AASHTO Type 4 beams
Proposed Beam Spacing	3 Spaces @ 8'-8"	3 Spaces @ 8'-8"	4 Spaces @ 6'-10 1/2"
No. of Spans	1 (114.5')	1 (113.5')	1 (130'-0")
Abutment Type	Semi-integral Type abutments on MSE wall supported embankments (Semi-Integral)	Semi-integral Type abutments on MSE wall supported embankments (Semi-Integral)	Semi-integral Type abutments on MSE wall supported embankments (Semi-Integral)
No. of Piers	0	0	0
Pier Type	None	None	None
Substructure Orientation	21°35'48" RF	21°35'48" RF	21°35'48" RF
Approximate Bridge Limits	116.65'	115.65'	132.15'
Approximate Structure Depth **Slab** **Haunch** **Beam** **Total**	 8.5" 2" 72.0" 82.5" (6.875')	 8.5" 2" 58.0" 68.5" (5.708')	 8.5" 2" 72.0" 82.5" (6.875')

Alternatives Discussion:

Alternative 1

This alternative is comprised of a single span structure with span a length of 114'-6". The abutments are oriented with a 21°35'48" right forward skew. Embankment slopes are supported by MSE walls approximately 20'-25' in height at both abutments. The forward MSE wall is placed at the minimum clearance using a Type D barrier in front of the wall. The Type D barrier was placed at the edge of a 10'-0" paved shoulder that meets the requirements for the rural shoulder criteria at SR 140 (refer to ODOT Location and Design Manual Volume 1). The MSE wall at the rear abutment was set to avoid impacting the flow in the existing ditch. Constructing a culvert through the MSE embankment is not preferred as noted in ODOT's recent documentation on MSE walls. In addition to this preference the proposed culvert (approx. 60") would significantly impact the soil reinforcement.

? The abutments will be semi-integral type supported on spread footings. The details of the abutments will follow ODOT Standard Construction drawings. Spread footing width was estimated from preliminary design reactions and using 4ksf as the allowable bearing pressure per BDM section 204.6.2.1. Drilled shaft foundations were considered but eliminated as an option due to the high construction costs. Driven piles were not recommended by the geotechnical engineer, as previously noted.

The preliminary design of this alternative consists of 4 - 72" AASHTO Type 4 Modified prestressed beams, spaced at 8'-8" with 3'-5 3/4" overhangs. The design loading applied was HS-25 with Alternate Military Loading and a future wearing surface of 60 psf. Details of the beams will follow ODOT standard construction drawings using standard 7000psi (final) concrete. Both the left and right bridge width will be 30'-0" from toe to toe of parapets with an overall bridge deck width of 33'-11 1/2". Deck thickness, including a 1" monolithic wearing surface, is 8 1/2".

The initial bridge construction cost for Alternative 1 is estimated to be $1,870,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $412,000, resulting in a total estimated ownership cost of $2,282,000 in year 2008 dollars.

Alternative 2

Alternative 2 is similar to Alternative 1 except that the superstructures the left and right structures consist of 4 - 58" web Grade 50W plate girders, spaced at 8'-8" with 3'-5 3/4" overhangs. The design loading applied was HS-25 (Case I fatigue) with Alternate Military Loading and a future wearing surface of 60 psf. Both the left and right bridge width will be 30'-0" from toe to toe of parapets with an overall bridge deck width of 33'-11 1/2". Deck thickness, including a 1" monolithic wearing surface, is 8 1/2".

The initial bridge construction cost for Alternative 2 is estimated to be $1,650,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $777,000, resulting in a total estimated ownership cost of $2,427,000 in year 2008 dollars.

Alternative 3

This alternative is similar to the previous span arrangement but provides for the preferred clear zone clearance at the forward abutment yielding a span a length of 130'-0". The abutments are again oriented with a 21°35'48" right forward skew. Embankment slopes are supported by MSE walls approximately 20'-25' in height at both abutments. The forward MSE wall is set at the clear zone for SR 140 of 26'-0". The

MSE wall at the rear abutment was set to avoid impacting the flow in the existing ditch, similar to Alternative 1.

The abutments will be semi-integral type supported on spread footings. The details of the abutments will follow ODOT Standard Construction drawings. Spread footing width was estimated from preliminary design reactions and used 4ksf as the allowable bearing pressure per BDM section 204.6.2.1. Drilled shaft foundations were considered but eliminated as an option due to the high construction costs. Driven piles were not recommended by the geotechnical engineer, as previously noted.

The preliminary design of this alternative consists of are 5 - 72" AASHTO Type 4 Modified prestressed beams, spaced at 6'-10 1/2" with 2'-8 3/4" overhangs. The design loading applied was HS-25 with Alternate Military Loading and a future wearing surface of 60 psf. Details of the beams will follow ODOT standard construction drawings using standard 7000psi (final) concrete. Both the left and right bridge width will be 30'-0" from toe to toe of parapets with an overall bridge deck width of 33'-11 1/2". Deck thickness, including a 1" monolithic wearing surface, is 8 1/2".

The initial bridge construction cost for Alternative 3 is estimated to be $2,080,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $476,000, resulting in a total estimated ownership cost of $2,556,000 in year 2008 dollars.

6. Recommendations:

Based upon the above information and discussions, we recommend **Structure Type Alternative 1**, which consists of single span 72" Type 4 Modified prestressed beams with semi-integral abutments on MSE wall supported embankments for both the left and right structures. (See Appendix B for the Site Plan and Structure Details).

Our recommendation for Alternative 1 is based on the following items:

a. This Alternative appears to be economical when considering the construction costs.

b. Lowest life cycle costs.

c. Lowest total ownership costs.

APPENDIX A

Cost Comparison Summary

TranSystems

SCI-823-0.00 - PORTSMOUTH BYPASS

S.R. 823 over Webster Street (S.R. 140) L&R

STRUCTURE TYPE STUDY

By: PJP Date: 5/8/2006
Checked: JRC Date: 5/12/2006

ALTERNATIVE COST SUMMARY

Alternative No.	Span Arrangement No. Spans	Span Arrangement Lengths	Total Span Length (ft.)	Framing Alternative	Proposed Stringer Section	Subtotal Superstructure Cost	Subtotal Substructure Cost	Structure Incidental Cost (16%)	Structure Contingency Cost (20%)	Total Alternative Const. Cost	Life Cycle Maintenance Cost	Total Relative Ownership Cost
1	1	114'-6"	114.50	4 Prestressed Concrete Girders /per BRIDGE	AASHTO Type 4 Modified (72")	**$668,000**	**$678,000**	**$215,400**	**$312,300**	**$1,870,000**	**$412,000**	**$2,282,000**
2	1	113'-6"	113.50	4 Steel Girders /per BRIDGE	58" Web Grade 50W	**$583,000**	**$600,000**	**$189,300**	**$274,500**	**$1,650,000**	**$777,000**	**$2,427,000**
3	1	130'-0"	130.00	5 Prestressed Concrete Girders /per BRIDGE	AASHTO Type 4 Modified (72")	**$816,000**	**$678,000**	**$239,000**	**$346,600**	**$2,080,000**	**$476,000**	**$2,556,000**

NOTES:

1. Structure incidental cost allowance includes provision for structure excavation, porous backfill, sealing of concrete surfaces, bearings, and crushed aggregate slope protection costs.
2. Estimated construction cost does not include existing structure removal (if any), which should be quantified seperately, if required.

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S.R. 823 over Webster Street (S.R. 140) L&R

STRUCTURE TYPE STUDY - PRESTRESSED CONCRETE GIRDER ALTERNATIVE 1 - SUPERSTRUCTURE

By: PJP Date: 5/8/2006
Checked: JRC Date: 5/12/2006

SUPERSTRUCTURE

Alternative No.	Span Arrangement No. Spans	Lengths	Total Span Length (ft.)	Deck Length (ft.)	Deck Volume (cu. yd.)	Deck Concrete Cost	Deck Reinforcing Cost	Approach Slab Cost	Approach Roadway Cost	Framing Alternative	Proposed Girder Section	Prestressed Concrete Cost	Subtotal Superstructure Cost
1	1	114'-6"	114.50	116.50	300	$179,900	$75,200	$72,600	$19,400	4 Prestressed Concrete Girders /per BRIDGE	AASHTO Type 4 Modified (72")	$321,000	**$668,000**

COST SUPPORT CALCULATIONS

Deck Cross-Sectional Area:

Parapets:

	No.	Individual Area (sq. ft.)	Parapet Area (sq. ft.)
Parapets	1	4.77	4.77
Parapets	1	4.26	4.26

Slab:

	T (ft.)	W (ft.)	Slab Area	Haunch & Overhang Area	Total Concrete Area (sq. ft.)
Left Bridge	0.71	33.00	23.4	2.3	34.7
Right Bridge	0.71	33.00	23.4	2.3	34.7

Note: Deck width is out to out
10% of deck area allowed for haunches and overhangs.

QC/QA Concrete, Class QSC2
Unit Cost ($/cu. yd):

	Year 2004	Annual Escalation	Year 2008
Deck	$491.00	3.5%	$563.00
Parapets	$615.00	3.5%	$706.00
Weighted Average =			$600.00

Based on parapet and slab percentages
of total concrete area

Epoxy Coated Reinforcing Steel
Unit Cost ($/lb):
Assume 285 lbs of reinforcing steel per cubic yard of deck concrete

	Year 2004	Annual Escalation	Year 2008
Deck Reinforcing	$0.77	3.5%	$0.88

Prestressed Concrete Girders
Unit Costs:

	Year 2005		Annual Escalation	Year 2008		No. Required	
AASHTO Type IV Beams							
Pier Diaphragms	$1,800	ea.	3.5%	$2,070	ea.	0	$0
Abutment Diaphragms	$1,200	ea.	3.5%	$1,380	ea.	0	$0
Intermediate Diaphragms	$905	ea.	3.5%	$1,040	ea.	18	$18,720
Modified Type 4 I-Beams (72")	$300	per ft.	3.5%	$330	ea.	916	$302,280
							$321,000

Construction Complexity Factor
Percent of Superstructure = 0% Due to Deck forming, Screed and Varying Girder Spaces

Reinforced Concrete Approach Slabs (T=17")
Unit Cost ($/sq. yd.):
Length = 30 ft. Width = 66 ft
Area = 440 sq. yd.

	Year 2004	Annual Escalation	Year 2008
Approach Slabs	$144.00	3.5%	$165.00

Expansion Joints
Unit Costs ($/Lin.Ft.):

	Cost Ratio	Year 2004	Annual Escalation	Year 2008
Strip Seal Expansion Joints	1.00	$250.00	3.5%	$318.07

Approach Roadway

			Year 2005	Annual Escalation	Year 2008
Embankment fill	2,675.00	cu.yd.	$4.00	3.5%	$4.43
Roadway incl. base	155.00	sq.yd.	$26.00	3.5%	$28.83
Barrier (single faced)	31	ft.	$50.00	3.5%	$55.44
Barrier (dble faced)	15.5	ft.	$80.00	3.5%	$88.70

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S.R. 823 over Webster Street (S.R. 140) L&R

STRUCTURE TYPE STUDY - PRESTRESSED CONCRETE GIRDER ALTERNATIVE 1 - SUBSTRUCTURE

By: PJP
Checked: JRC

Date: 5/8/2006
Date: 5/12/2006

SUBSTRUCTURE

Alternative No.	Span Arrangement No. Spans	Span Arrangement Lengths	Framing Alternative	Proposed Stringer Section	Pier Concrete Cost	Pier Reinforcing Cost	Abutment Concrete Cost	Abutment Reinforcing Cost	Pile Foundation Cost	MSE Wall Cost	Additional Crane Cost	Subtotal Substructure Cost
1	1	114'-6"	4 Steel Girders /per BRIDGE	AASHTO Type 4 Modified (72")	$0	$0	$151,200	$24,800	$0	$426,600	$75,000	**$678,000**

COST SUPPORT CALCULATIONS

Pier QC/QA Concrete, Class QSC1 Cost: (Spread Footing)

Component	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Cap	0	$421.00	3.5%	$483.00	$0
Stem	0	$421.00	3.5%	$483.00	$0
Footings	0	$421.00	3.5%	$483.00	$0
Total	0				$0

Pier QC/QA Concrete, Class QSC1 Cost: (Drilled Shaft)

Component	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Cap	0	$421.00	3.5%	$483.00	$0
Columns	0	$421.00	3.5%	$483.00	$0
Footings	0	$421.00	3.5%	$483.00	$0
Total					$0

Abutment QC/QA Concrete, Class QSC1 Cost:

Component	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Abutment	272	$421.00	3.5%	$483.00	$131,400
Wingwalls	41	$421.00	3.5%	$483.00	$19,800

Note: 15% of abutment volume allowed for wingwalls.

Epoxy Coated Reinforcing Steel
Unit Cost ($/lb):
Assume 125 lbs of reinforcing steel per cubic yard of pier concrete.
Assume 90 lbs of reinforcing steel per cubic yard of abutment concrete.

	Year 2004	Annual Escalation	Year 2008
Pier	$0.77	3.5%	$0.88
Abutment	$0.77	3.5%	$0.88

MSE Abutment Unit Cost ($/sq. ft.):

	Total Area (sq. ft.)	Year 2005 Unit Cost	Annual Escalation	Year 2008
Alt. 1	7,700	$50.00	3.5%	$55.40

Pile Foundation Unit Cost ($/ft.): *HP 12X53 Piles, Furnished & Driven*

Number of Piles		Total Pile Length
0	SEE QUANTITY CALCULATIONS	0

Pile Foundation Unit Cost ($/ft.):

	Year 2004 Unit Cost	Annual Escalation	Year 2008
Furnished	$20.15	3.5%	$23.10
Driven	$9.24	3.5%	$10.60
Total			$33.70

Shaft Foundation Unit Cost ($/ft.): 36" Drilled Shaft

	Number of Shafts		Total Shaft Length
Alt. 1	0	SEE QUANTITY CALCULATIONS	0

Shaft Foundation Unit Cost ($/ft.):

Unit Cost	Escalation	2008
$125.00	4.5%	$149.00

Cost of Shafts: $ -

Temporary Shoring and Support Unit Costs ($/sq. ft.):

	Temp. Shoring Area (sq. ft.)	Temp. Girder Support (lump sum)
Alt. 1	0	$ -

	Year 2004 Unit Cost	Annual Escalation	Year 2008
Temporary Shoring	$22.50	3.5%	$25.80
Cofferdam	$32.00	3.5%	$36.70

Additional Crane Cost

$ 75,000

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S.R. 823 over Webster Street (S.R. 140) L&R
STRUCTURE TYPE STUDY - PRESTRESSED CONCRETE GIRDER ALTERNATIVE 1 - QUANTITY CALCULATIONS

By: PJP
Checked: JRC

Date: 5/8/2006
Date: 5/12/2006

Pier Quantities

Pier Location	Length	Cap				Stem					Footing					Total Volume
		Width	*Depth*	*Area*	*Volume*	*Width*	*Height*	*Length*		*Volume*	*Width*	*Depth*	*Length*		*Volume*	
Pier 1 (Spr Ftg)	0	0	0	0.00	0	0	0	0.00		0	0	0	0.00		0	0
Pier 2																
Pier 3																0
Pier 4																0
Pier 5																0
Pier 6																0
Pier 7																0
Total (Cu.Ft.)					**0**					**0**					**0**	**0**
Total (Cu.Yd.)					**0**					**0**					**0**	**0**
			Qty x 2 (L/R)		**0**					**0**					**0**	**0**

Pile Quantities

Location	Load/girder (Kips)	# Girders	Total Girder Load	Subst Wt (kips)	Pile Cap.(Kips)	No. Piles	Increase Factor	Total Piles	Top Elev.	Bot Elev.	Pile Length	Total Pile Length (Feet)
Rear Abut.	0	0	0	0	140	0	1	*0*	575.3	550.0	25.0	*0*
Pier 1	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 2	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 3	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 4	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 5	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 6	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 7	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Fwd. Abut.	0	0	0	0	140	0	1	*0*	576.1	550	30.0	*0*
Total								**0**				**0**
							Qty x 2 (L/R)	**0**				**0**

Abutment Quantities

Abut Location	Length (feet)	Backwall				Beam Seat					Footing					Total Volume
		Width	*Depth*	*Area*	*Volume*	*Width*	*Height*	*Area*		*Volume*	*Width*	*Depth*	*Area*	*# Footi*	*Volume*	
Rear Abut	35.5	3	6.75	20.25	719	3	1.5	4.50		160	9	3	27	1	959	1837
Fwd. Abut	35.5	3	6.75	20.25	719	3	1.5	4.50		160	9	3	27	1	959	1837
Total (Cu.Ft.)					**1438**					**320**					**1917**	**3674**
Total (Cu.Yd.)					**53**					**12**					**71**	**136**
			Qty x 2 (L/R)		**106**					**24**					**142**	**272**

36" Drilled Shafts

Location	Load/girder (Kips)	# Girders	Total Load	Subst Wt (kips)	Pile Cap.(Kips)	No. Piles	Increase Factor	Total Shafts	Top Elev.	Bot Elev.	Pile Length	Total Shaft Length (Feet)
Rear Abut.	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Pier 1	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Pier 2	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Pier 3	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Pier 4	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Pier 5	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Pier 6	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Pier 7	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Fwd. Abut.	0	10	0	0	0	0	1	*0*	0	0	0.0	*0*
Total								**0**				**0**

MSE Abutment Wall Quantities

Abut Location		Wall			
		Height	*Length*	*Area*	*Volume*
Rear Abut		27	90	2430	
RA Wing (L)		19	77	1463	
RA Wing (R)		16	40	640	
Fwd Abut		22	92	2024	
FA Wing (L)		13.5	40	540	
FA Wing (R)		13.5	40	540	
Total (Sq.Ft.)				**7700**	

Superstructure P/S Concrete Quantities

Location	Type of girder	# Girders	Span Length	Total	Spacing Int. diaphragm	No. of Int in span	Number of Int Diap. 1 location	Total No. in Span
Span 1	MOD TYPE 4 72	8	114.5	916	28.63	6	3	18
Span 2		0	0.0	0	0.00			0
Span 3		0	0.0	0	0.00			0
Span 4		0	0.0	0	0.00			0
Span 5		0	0.0	0	0.00			0
Span 6		0	0.0	0	0.00			0
Span 7		0	0.0	0	0.00			0
Span 8		0	0.0	0	0.00			0
Span 9		0	0.0	0	**Total**			18
Total	**MOD TYPE 4 72**	**8**		**880**				

SCI-823-0.00 - PORTSMOUTH BYPASS
S.R. 823 over Webster Street (S.R. 140) L&R
STRUCTURE TYPE STUDY - STEEL PLATE GIRDER ALTERNATIVE 2 - SUPERSTRUCTURE

By: PJP
Checked: JRC

Date: 5/8/2006
Date: 5/12/2006

SUPERSTRUCTURE

Alternative No.	Span Arrangement No. Spans	Span Arrangement Lengths	Total Span Length (ft.)	Deck Length (ft.)	Deck Volume (cu. yd.)	Deck Concrete Cost	Deck Reinforcing Cost	Approach Slab Cost	Approach Roadway Cost	Framing Alternative	Proposed Stringer Section	Structural Steel Weight (pounds)	Structural Steel Cost	Subtotal Superstructure Cost
2	1	113'-6"	113.50	115.50	297	$178,300	$74,500	$72,600	$19,400	4 Steel Girders /per BRIDGE	58" Web Grade 50W	204288	$237,823	**$583,000**

COST SUPPORT CALCULATIONS

Deck Cross-Sectional Area:

Parapets:

	No.	Individual Area (sq. ft.)	Parapet Area (sq. ft.)
Parapets	1	4.77	4.77
Parapets	1	4.26	4.26

Slab:

	T (ft.)	W (ft.)	Slab Area	Haunch & Overhang Area	Total Concrete Area (sq. ft.)
Left Bridge	0.71	33.00	23.4	2.3	34.7
Right Bridge	0.71	33.00	23.4	2.3	34.7

Note: Deck width is out to out
10% of deck area allowed for haunches and overhangs.

QC/QA Concrete, Class QSC2
Unit Cost ($/cu. yd):

	Year 2004	Annual Escalation	Year 2008
Deck	$491.00	3.5%	$563.00
Parapets	$615.00	3.5%	$706.00
Weighted Average =			$600.00

Based on parapet and slab percentages
of total concrete area

Epoxy Coated Reinforcing Steel
Unit Cost ($/lb):
Assume 285 lbs of reinforcing steel per cubic yard of deck concrete

	Year 2004	Annual Escalation	Year 2008
Deck Reinforcing	$0.77	3.5%	$0.88

Structural Steel
Unit Costs ($/lb.):

	Cost Ratio	Year 2005	Annual Escalation	Year 2008	
Rolled Beams - Grade 50	n/a	$0.74	3.5%	$0.85	
Level 4 Plate Girders - Grade 50W	n/a	$1.05	3.5%	$1.16	Straight Girders
Level 5 Plate Girders - Grade 50W	n/a	$1.20	3.5%	$1.38	Curved Girders

Construction Complexity Factor
Percent of Superstructure = 0% Due to Deck forming, Screed and Varying Girder Spaces

Reinforced Concrete Approach Slabs (T=17")
Unit Cost ($/sq. yd.):
Length = 30 ft.
Area = 440 sq. yd.
Width = 66 ft

	Year 2004	Annual Escalation	Year 2008
Approach Slabs	$144.00	3.5%	$165.00

Expansion Joints
Unit Costs ($/Lin.Ft.):

	Cost Ratio	Year 2003	Annual Escalation	Year 2008
Strip Seal Expansion Joints	1.00	$250.00	3.5%	$318.07

Approach Roadway

		Year 2005	Annual Escalation	Year 2008
Embankment fill	2,675.00 cu.yd.	$4.00	3.5%	$4.43
Roadway incl. base	155.00 sq.yd.	$26.00	3.5%	$28.83
Barrier (single faced)	31 ft.	$50.00	3.5%	$55.44
Barrier (dble faced)	15.5 ft.	$80.00	3.5%	$88.70

SCI-823-0.00 - PORTSMOUTH BYPASS

S.R. 823 over Webster Street (S.R. 140) L&R

STRUCTURE TYPE STUDY - STEEL PLATE GIRDER ALTERNATIVE 2 - SUBSTRUCTURE

By: PJP
Checked: JRC

Date: 5/8/2006
Date: 5/12/2006

SUBSTRUCTURE

Alternative No.	Span Arrangement		Framing Alternative	Proposed Stringer Section	Pier Concrete Cost	Pier Reinforcing Cost	Abutment Concrete Cost	Abutment Reinforcing Cost	Pile Foundation Cost	MSE Wall Cost	Additional Crane Cost	Subtotal Substructure Cost
	No. Spans	Lengths										
2	1	113'-6"	4 Steel Girders /per BRIDGE	58" Web Grade 50W	$0	$0	$134,300	$22,000	$0	$443,200	$0	**$600,000**

COST SUPPORT CALCULATIONS

Pier QC/QA Concrete, Class QSC1 Cost: (Spread Footing)

Component	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Alt 1 Total Cost
Cap	0	$421.00	3.5%	$483.00	$0
Stem	0	$421.00	3.5%	$483.00	$0
Footings	0	$421.00	3.5%	$483.00	$0
Total	0				$0

Pier QC/QA Concrete, Class QSC1 Cost: (Drilled Shaft)

Component	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Alt 1 Total Cost
Cap	0	$421.00	3.5%	$483.00	$0
Columns	0	$421.00	3.5%	$483.00	$0
Footings	0	$421.00	3.5%	$483.00	$0
Total					$0

Abutment QC/QA Concrete, Class QSC1 Cost:

Component	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Abutment	242	$421.00	3.5%	$483.00	$116,900
Wingwalls	36	$421.00	3.5%	$483.00	$17,400

Note: 15% of abutment volume allowed for wingwalls.

Epoxy Coated Reinforcing Steel
Unit Cost ($/lb):

Assume 125 lbs of reinforcing steel per cubic yard of pier concrete.
Assume 90 lbs of reinforcing steel per cubic yard of abutment concrete.

	Year 2004	Annual Escalation	Year 2008
Pier	$0.77	3.5%	$0.88
Abutment	$0.77	3.5%	$0.88

MSE Abutment Unit Cost ($/sq. ft.):

	Total Area (sq. ft.)	Year 2005 Unit Cost	Annual Escalation	Year 2008
Alt. 2	8,000	$50.00	3.5%	$55.40

Pile Foundation Unit Cost ($/ft.): *HP 12X53 Piles, Furnished & Driven*

Number of Piles		Total Pile Length
0	SEE QUANTITY CALCULATIONS	0

Pile Foundation Unit Cost ($/ft.):

	Year 2004 Unit Cost	Annual Escalation	Year 2008
Furnished	$20.15	3.5%	$23.10
Driven	$9.24	3.5%	$10.60
Total			$33.70

Shaft Foundation Unit Cost ($/ft.): 36" Drilled Shaft

	Number of Shafts		Total Shaft Length
Alt. 2	0	SEE QUANTITY CALCULATIONS	0

Shaft Foundation Unit Cost ($/ft.):

Unit Cost	Escalation	2008
$125.00	4.5%	$149.00

Cost of Shafts: $ -

Temporary Shoring and Support Unit Costs ($/sq. ft.):

	Temp. Shoring Area (sq. ft.)	Temp. Girder Support (lump sum)
Alt. 2	0	$ -

	Year 2004 Unit Cost	Annual Escalation	Year 2008
Temporary Shoring	$22.50	3.5%	$25.80
Cofferdam	$32.00	3.5%	$36.70

Additional Crane Cost

$ -

SCI-823-0.00 - PORTSMOUTH BYPASS

S.R. 823 over Webster Street (S.R. 140) L&R

STRUCTURE TYPE STUDY - STEEL PLATE GIRDER ALTERNATIVE 2 - QUANTITY CALCULATIONS

By: PJP
Checked: JRC

Date: 5/8/2006
Date: 5/12/2006

Pier Quantities

Pier Location	Length	Cap				Stem					Footing					Total Volume
		Width	*Depth*	*Area*	*Volume*	*Width*	*Height*	*Length*		*Volume*	*Width*	*Depth*	*Length*		*Volume*	
Pier 1 (Spr Ftg)	0	0	0	0.00	0	0	0	0.00		0	0	0	0.00		0	0
Pier 2																0
Pier 3																0
Pier 4																0
Pier 5																0
Pier 6																0
Pier 7																0
Total (Cu.Ft.)					0					0					0	0
Total (Cu.Yd.)					0					0					0	0
		Qty x 2 (L/R)			**0**					**0**					**0**	**0**

Pile Quantities

Location	Load/girder (Kips)	# Girders	Total Girder Load	Subst Wt (kips)	Pile Cap.(Kips	No. Piles	Increase Factor	Total Piles	Top Elev.	Bot Elev.	Pile Length	Total Pile Length (Feet)
Rear Abut.	0	0	0	0	140	0	1	*0*	576.5	550.0	30.0	*0*
Pier 1	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 2	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 3	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 4	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 5	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 6	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 7	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Fwd. Abut.	0	0	0	0	140	0	1	*0*	577.3	550	30.0	*0*
Total								**0**				**0**
							Qty x 2 (L/R)	**0**				**0**

Abutment Quantities

Abut Location	Length (feet)	Backwall				Beam Seat					Footing					Total Volume
		Width	*Depth*	*Area*	*Volume*	*Width*	*Height*	*Area*		*Volume*	*Width*	*Depth*	*Area*	*# Footin*	*Volume*	
Rear Abut	35.5	3	5.833	17.50	621	3	1.5	4.50		160	8	3	24	1	852	1633
Fwd. Abut	35.5	3	5.833	17.50	621	3	1.5	4.50		160	8	3	24	1	852	1633
Total (Cu.Ft.)					**1242**					**320**					**1704**	**3266**
Total (Cu.Yd.)					**46**					**12**					**63**	**121**
		Qty x 2 (L/R)			**92**					**24**					**126**	**242**

36" Drilled Shafts

Location	Load/girder (Kips)	# Girders	Total Load	Subst Wt (kips)	Pile Cap.(Kips	No. Piles	Increase Factor	Total Shafts	Top Elev.	Bot Elev.	Pile Length	Total Shaft Length (Feet)
Rear Abut.	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Pier 1	0	0	0	0	0	0	1	*0*	0	0	2.0	*0*
Pier 2	0	0	0	0	0	0	1	*0*	0	0	2.0	*0*
Pier 3	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Pier 4	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Pier 5	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Pier 6	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Pier 7	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Fwd. Abut.	0	10	0	0	0	0	1	*0*	0	0	0.0	*0*
Total								**0**				**0**

MSE Abutment Wall Quantities

Abut Location		Wall			
		Height	*Length*	*Area*	*Volume*
Rear Abut		28	90	2520	
RA Wing (L)		19	77	1463	
RA Wing (R)		16	44	704	
Fwd Abut		23	92	2116	
FA Wing (L)		14	42	588	
FA Wing (R)		14	42	588	
Total (Sq.Ft.)				**8000**	

Note: MSE wall area from CAD.

Superstructure Steel Quantities

Location	Wt.of girder (lb)/ft	# Girders	Span Length	Total Weight
Span 1	224	8	114	204288
Span 2	0	0	0	0
Span 3	0	0	0	0
Span 4	0	0	0	0
Span 5	0	0	0	0
Span 6	0	0	0	0
Span 7	0	0	0	0
Span 8	0	0	0	0
Total				204288

SCI-823-0.00 - PORTSMOUTH BYPASS

S.R. 823 over Webster Street (S.R. 140) L&R

STRUCTURE TYPE STUDY - PRESTRESSED CONCRETE GIRDER ALTERNATIVE 4 - SUPERSTRUCTURE

By: PJP
Checked: JRC

Date: 5/8/2006
Date: 5/12/2006

SUPERSTRUCTURE

Alternative No.	Span Arrangement No. Spans	Lengths	Total Span Length (ft.)	Deck Length (ft.)	Deck Volume (cu. yd.)	Deck Concrete Cost	Deck Reinforcing Cost	Approach Slab Cost	Framing Alternative	Proposed Girder Section	Prestressed Concrete Cost	Subtotal Superstructure Cost
3	1	130'-0"	130.00	132.00	340	$203,800	$85,200	$72,600	5 Prestressed Concrete Girders /per BRIDGE	AASHTO Type 4 Modified (72")	$453,960	**$816,000**

COST SUPPORT CALCULATIONS

Deck Cross-Sectional Area:

Parapets:

	No.	Individual Area (sq. ft.)	Parapet Area (sq. ft.)
Parapets	1	4.77	4.77
Parapets	1	4.26	4.26

Slab:

	T (ft.)	W (ft.)	Slab Area	Haunch & Overhang Area	Total Concrete Area (sq. ft.)
Left Bridge	0.71	33.00	23.4	2.3	34.7
Right Bridge	0.71	33.00	23.4	2.3	34.7

Note: Deck width is out to out
10% of deck area allowed for haunches and overhangs.

QC/QA Concrete, Class QSC2
Unit Cost ($/cu. yd):

	Year 2004	Annual Escalation	Year 2008
Deck	$491.00	3.5%	$563.00
Parapets	$615.00	3.5%	$706.00
Weighted Average =			$600.00

Based on parapet and slab percentages
of total concrete area

Epoxy Coated Reinforcing Steel
Unit Cost ($/lb):
Assume 285 lbs of reinforcing steel per cubic yard of deck concrete

	Year 2004	Annual Escalation	Year 2008
Deck Reinforcing	$0.77	3.5%	$0.88

Prestressed Concrete Girders
Unit Costs:

	Year 2005		Annual Escalation	Year 2008		No. Required	
AASHTO Type IV Beams							
Pier Diaphragms	$1,800	ea.	3.5%	$2,070	ea.	0	$0
Abutment Diaphragms	$1,200	ea.	3.5%	$1,380	ea.	0	$0
Intermediate Diaphragms	$905	ea.	3.5%	$1,040	ea.	24	$24,960
Modified Type 4 I-Beams (72")	$300	per ft.	3.5%	$330	ea.	1300	$429,000
							$453,960

Reinforced Concrete Approach Slabs (T=17")
Unit Cost ($/sq. yd.):

Length = 30 ft.
Width = 66 ft
Area = 440 sq. yd.

	Year 2004	Annual Escalation	Year 2008
Approach Slabs	$144.00	3.5%	$165.00

Expansion Joints
Unit Costs ($/Lin.Ft.):

	Cost Ratio	Year 2005	Annual Escalation	Year 2008
Strip Seal Expansion Joints	1.00	$250.00	3.5%	$277.18

Strip Seal Expansion Joints Length 0 ft.

SCI-823-0.00 - PORTSMOUTH BYPASS

S.R. 823 over Webster Street (S.R. 140) L&R

STRUCTURE TYPE STUDY - PRESTRESSED CONCRETE GIRDER ALTERNATIVE 4 - SUBSTRUCTURE

By: PJP
Checked: JRC

Date: 5/8/2006
Date: 5/12/2006

SUBSTRUCTURE

Alternative No.	Span Arrangement No. Spans	Span Arrangement Lengths	Framing Alternative	Proposed Stringer Section	Pier Concrete Cost	Pier Reinforcing Cost	Abutment Concrete Cost	Abutment Reinforcing Cost	Pile Foundation Cost	MSE Wall Cost	Additional Crane Cost	Subtotal Substructure Cost
3	1	130'-0"	5 Prestressed Concrete Girders /per BRIDGE	AASHTO Type 4 Modified (72")	$0	$0	$151,100	$24,800	$0	$426,600	$75,000	**$678,000**

COST SUPPORT CALCULATIONS

Pier QC/QA Concrete, Class QSC1 Cost: (Spread Footing)

Component	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Cap	0	$421.00	3.5%	$483.00	$0
Stem	0	$421.00	3.5%	$483.00	$0
Footings	0	$421.00	3.5%	$483.00	$0
Total	0				$0

Pier QC/QA Concrete, Class QSC1 Cost: (Drilled Shaft)

Component	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Cap	0	$421.00	3.5%	$483.00	$0
Columns	0	$421.00	3.5%	$483.00	$0
Footings	0	$421.00	3.5%	$483.00	$0
Total					$0

Abutment QC/QA Concrete, Class QSC1 Cost:

Component	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Abutment	272	$421.00	3.5%	$483.00	$131,400
Wingwalls	41	$421.00	3.5%	$483.00	$19,700

Note: 15% of abutment volume allowed for wingwalls.

Epoxy Coated Reinforcing Steel
Unit Cost ($/lb):

Assume 125 lbs of reinforcing steel per cubic yard of pier concrete.
Assume 90 lbs of reinforcing steel per cubic yard of abutment concrete.

	Year 2004	Annual Escalation	Year 2008
Pier	$0.77	3.5%	$0.88
Abutment	$0.77	3.5%	$0.88

MSE Abutment Unit Cost ($/sq. ft.):

	Total Area (sq. ft.)	Year 2005 Unit Cost	Annual Escalation	Year 2008
Alt. 3	7,700	$50.00	3.5%	$55.40

Pile Foundation Unit Cost ($/ft.): *HP 12X53 Piles, Furnished & Driven*

Number of Piles		Total Pile Length
0	SEE QUANTITY CALCULATIONS	0

Pile Foundation Unit Cost ($/ft.):	Year 2004 Unit Cost	Annual Escalation	Year 2008
Furnished	$20.15	3.5%	$23.10
Driven	$9.24	3.5%	$10.60
Total			$33.70

Shaft Foundation Unit Cost ($/ft.): 36" Drilled Shaft

Number of Shafts		Total Shaft Length
0	SEE QUANTITY CALCULATIONS	0

Shaft Foundation Unit Cost ($/ft.):

Unit Cost	Escalation	2008
$125.00	4.5%	$149.00

Cost of Shafts: $ -

Temporary Shoring and Support
Unit Costs ($/sq. ft.):

	Temp. Shoring Area (sq. ft.)	Temp. Girder Support (lump sum)
Alt. 3	0	$ -

	Year 2004 Unit Cost	Annual Escalation	Year 2008
Temporary Shoring	$22.50	3.5%	$25.80
Cofferdam	$32.00	3.5%	$36.70

Additional Crane Cost

$ 75,000

SCI-823-0.00 - PORTSMOUTH BYPASS
S.R. 823 over Webster Street (S.R. 140) L&R
STRUCTURE TYPE STUDY - PRESTRESSED CONCRETE GIRDER ALTERNATIVE 4 - QUANTITY CALCULATIONS

By: PJP
Checked: JRC

Date: 5/8/2006
Date: 5/12/2006

Pier Quantities

Pier Location	Length	Cap				Stem					Footing					Total Volume
		Width	*Depth*	*Area*	*Volume*	*Width*	*Height*	*Length*		*Volume*	*Width*	*Depth*	*Length*		*Volume*	
Pier 1	0	0	0	0.00	0	0	0	0.00		0	0	0	0.00		0	0
Pier 2																0
Pier 3																0
Pier 4																0
Pier 5																0
Pier 6																0
Pier 7																0
Total (Cu.Ft.)					**0**					**0**					**0**	**0**
Total (Cu.Yd.)					**0**					**0**					**0**	**0**
			Qty x 2 (L/R)		**0**					**0**					**0**	**0**

Pile Quantities

Location	Load/girder (Kips)	# Girders	Total Girder Load	Subst Wt (kips)	Pile Cap.(Kips	No. Piles	Increase Factor	Total Piles	Top Elev.	Bot Elev.	Pile Length	Total Pile Length (Feet)
Rear Abut.	0	0	0	0	140	0	1	*0*	575.3	550.0	25.0	*0*
Pier 1	0	0	0	0	140	0	1	*0*	0	0	2.0	*0*
Pier 2	0	0	0	0	140	0	1	*0*	0	0	2.0	*0*
Pier 3	0	0	0	0	140	0	1	*0*	0	0	2.0	*0*
Pier 4	0	0	0	0	140	0	1	*0*	0	0	2.0	*0*
Pier 5	0	0	0	0	140	0	1	*0*	0	0	2.0	*0*
Pier 6	0	0	0	0	140	0	1	*0*	0	0	2.0	*0*
Pier 7	0	0	0	0	140	0	1	*0*	0	0	2.0	*0*
Fwd. Abut.	0	0	0	0	140	0	1	*0*	576.1	550	30.0	*0*
Total								**0**				**0**
							Qty x 2 (L/R)	**0**				**0**

Abutment Quantities

Abut Location	Length (feet)	Backwall				Beam Seat					Footing					Total Volume
		Width	*Depth*	*Area*	*Volume*	*Width*	*Height*	*Area*		*Volume*	*Width*	*Depth*	*Area*	*# Footi*	*Volume*	
Rear Abut	35.5	3	6.75	20.25	719	3	1.5	4.50		160	9	3	27	1	959	1837
Fwd. Abut	35.5	3	6.75	20.25	719	3	1.5	4.50		160	9	3	27	1	959	1837
Total (Cu.Ft.)					**1438**					**320**					**1917**	**3674**
Total (Cu.Yd.)					**53**					**12**					**71**	**136**
			Qty x 2 (L/R)		**106**					**24**					**142**	**272**

36" Drilled Shafts

Location	Load/girder (Kips)	# Girders	Total Load	Subst Wt (kips)	Pile Cap.(Kips	No. Piles	Increase Factor	Total Shafts	Top Elev.	Bot Elev.	Pile Length	Total Shaft Length (Feet)
Rear Abut.	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Pier 1	0	0	0	0	0	0	1	*0*	0	0	2.0	*0*
Pier 2	0	0	0	0	0	0	1	*0*	0	0	2.0	*0*
Pier 3	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Pier 4	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Pier 5	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Pier 6	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Pier 7	0	0	0	0	0	0	1	*0*	0	0	0.0	*0*
Fwd. Abut.	0	10	0	0	0	0	1	*0*	0	0	0.0	*0*
Total								**0**				**0**

MSE Abutment Wall Quantities

Abut Location		Wall			
		Height	*Length*	*Area*	*Volume*
Rear Abut		27	90	2430	
RA Wing (L)		19	77	1463	
RA Wing (R)		16	40	640	
Fwd Abut		22	92	2024	
FA Wing (L)		13.5	40	540	
FA Wing (R)		13.5	40	540	
Total (Sq.Ft.)				**7700**	

Superstructure P/S Concrete Quantities

Location	Type of girder	# Girders	Span Length (ft.)	Total Length (ft.)	Spacing Int. diaphragm	No. of Int in span	Number of Int Diap. 1 location	Total No. in Span
Span 1	MOD TYPE 4 72	10	130.0	1300	32.50	8	3	24
Span 2		0	0.0	0	0.00			0
Span 3		0	0.0	0	0.00			0
Span 4		0	0.0	0	0.00			0
Span 5		0	0.0	0	0.00			0
Span 6		0	0.0	0	0.00			0
Span 7		0	0.0	0	0.00			0
Span 8		0	0.0	0	0.00			0
Span 9		0	0.0	0	**Total**			24
Total	**MOD TYPE 4 72**	**8**		**1300**				

SCI-823-0.00 - PORTSMOUTH BYPASS
S.R. 823 over Webster Street (S.R. 140) L&R
STRUCTURE TYPE STUDY - LIFE CYCLE COSTS

By: PJP
Checked: JRC

Date: 5/8/2006
Date: 5/12/2006

LIFE CYCLE MAINTENANCE COST

				Structural Steel Painting *			Superstructure Sealing			Approach Pavement Resurfacing		
Alt. No.	Span Arrangement No. Spans	Lengths	Framing Alternative	Cost Per Cycle	Number of Maintenance Cycles	Total Life Cycle Cost	Cost Per Cycle	Number of Maintenance Cycles	Total Life Cycle Cost	Cost Per Cycle	Number of Maintenance Cycles	Total Life Cycle Cost
1	1	114.50	4 Prestressed Concrete Girders /per BRIDGE	$0	0	$0	$20,600	2	$41,200	$200	10	$2,000
2	1	113.50	4 Steel Girders /per BRIDGE	$204,800	2	$409,600	$0	0	$0	$200	10	$2,000
3	1	130.00	5 Prestressed Concrete Girders /per BRIDGE	$0	0	$0	$29,200	2	$58,400	$0	10	$0

				Bridge Deck Overlay (5)					Bridge Redecking (5)								
Alt. No.	Span Arrangement No. Spans	Lengths	Framing Alternative	Deck Demo & Chipping	Deck Overlay	Deck Joint Gland (2)	Number of Maintenance Cycles	Total Life Cycle Cost	Deck Concrete Cost (3)	Deck Reinforcing Cost (3)	Deck Joint Cost (2)	Deck Removal Cost	Number of Maintenance Cycles	Total Life Cycle Cost	Superstructure Life Cycle Maintenance Cost (1)	Total Initial Construction Cost	Total Relative Ownership Cost
1	1	114.5	4 Prestressed Concrete Girders /per BRIDGE	$22,900	$27,800	n/a	1	$50,700	$179,900	$75,200	n/a	$62,600	1	$317,700	**$412,000**	**$1,870,000**	**$2,282,000**
2	1	113.5	4 Steel Girders /per BRIDGE	$22,700	$27,500	n/a	1	$50,200	$178,300	$74,500	n/a	$62,000	1	$314,800	**$777,000**	**$1,650,000**	**$2,427,000**
3	1	130	5 Prestressed Concrete Girders /per BRIDGE	$26,000	$31,500	n/a	1	$57,500	$203,800	$85,200	n/a	$71,000	1	$360,000	**$476,000**	**$2,080,000**	**$2,556,000**

Structural Steel Painting:

Structural Steel Area:

	Web Depth (in.)	No. Stringers	Total Span Length (ft.)	Assumed Ave. Bot. Flange Width (in.)	Nominal Exposed Girder Area (sq. ft.)	Secondary Member Allowance	Total Exposed Steel Area (sq. ft.)
Alt. 2	58	8	113.50	18.00	12,863	20%	15,400

Painting Cost per sq. ft.:

	Year 2005	Annual Escalation	Year 2008
Prep.	$6.75	3.5%	$7.48
Prime	$1.75	3.5%	$1.94
Intermed.	$1.75	3.5%	$1.94
Finish	$1.75	3.5%	$1.94
Total	$12.00		$13.30

Superstructure Sealing:

PS Concrete I-Beam Area:

72" Modified AASHTO Type 4

	H	V	Diag.	No.	Total
Bot. Flange	26			1	26.00
		8		2	16.00
Lower Fillets	9	9	12.73	2	25.46
Web		46		2	92.00
Upper Fillets	3	3	4.24	2	8.49
	11	2	11.18	2	22.36
Top Flange		4		2	8.00
Total Exposed Perimeter					198.30 in.

66" Modified AASHTO Type 4

	H	V	Diag.	No.	Total
Bot. Flange	26			1	26.00
		8		2	16.00
Lower Fillets	9	9	12.73	2	25.46
Web		40		2	80.00
Upper Fillets	3	3	4.24	2	8.49
	11	2	11.18	2	22.36
Top Flange		4		2	8.00 in.
Total Exposed Perimeter					186.30

	No. Stringers	Total Span Length (ft.)	Nominal Exposed Beam Area (sq. ft.)	Secondary Member Allowance	Total Exposed Concrete Area (sq. yd.)
Alt. 1	8	114.50	15,137	10%	1,850
Alt. 3	10	130.00	21,483	10%	2,630

Sealing Cost per sq. yd.:

	Year 2004	Annual Escalation	Year 2008
Epoxy-Urethane Sealer	$9.68	3.5%	$11.11

Bridge Redecking:

Bridge Deck Joint Cost per foot:

	Year 2005	Annual Escalation	Year 2008
Structural Expansion Joint Including Elastomeric Strip Seal	$250.00	3.5%	$277.18

	Bridge Width	No. Joints
Alt. 1	70.00	0
Alt. 2	70.00	0
Alt. 3	70.00	0

Bridge Deck Removal Cost:

	Deck Area (3) (sq. ft.)	Year 2008	Deck Removal Cost
Alt. 1	7,557	$8.28	$62,600
Alt. 2	7,491	$8.28	$62,000
Alt. 3	8,580	$8.28	$71,000

Bridge Deck Overlay (Item 848):

Bridge Deck MSC Overlay Cost per sq. yd.:

	Year 2004	Annual Escalation	Year 2008
Micro Silica Modified Concrete Overlay Using Hydrodemolition (1.25" thick)	$25.58	3.5%	$29.35
Surface Preparation Using Hydrodemolition	$22.85	3.5%	$26.22
Hand Chipping	$37.07	3.5%	$42.54

Bridge Deck MSC Overlay Cost per cu. yd.:

Micro Silica Modified Concrete Overlay (Variable Thickness), Material Only	$144.00	3.5%	$165.24

	Deck Area (3) (sq. ft.)	Deck Area (sq. yd.)	Hand Chipping (sq. yd.)	Variable Thickness Repair (cu. yd.)
Alt. 1	7,557	840	21	19
Alt. 2	7,491	832	21	19
Alt. 3	8,580	953	24	22

Assume 25% of deck area requires removal to depth of 4.5" (3.25" additional removal).

Bridge Deck Joint Gland Replacement Cost per foot:

	Year 2005	Annual Escalation	Year 2008
Elastomeric Strip Seal Gland	$62.50	3.5%	$69.29

Assume gland replacement cost equals 25% of original deck joint construction cost.

NOTES:

1. Life cycle maintenance costs assume a 75 -year structure life, and are expressed in present value (2008 construction year) dollars.
2. Bridges are assumed to have semi-integral abutments, therefore no strip seal deck joints will be required except for Alt. 3.
3. See Superstructure Cost sheet.
4. See Alternative Cost Summary sheet.
5. Assume bridge deck overlay at Year 25 and bridge deck replacement at Year 50.
   Assume superstructures are painted or sealed on a 25-year recurrence interval.
   Assume complete bridge replacement at Year 75.
6. Life cycle maintenance cost differences are assumed to be predominately a function of superstructure maintenance costs. Consequently, substructure lifecycle maintenance costs are not included in this analysis.

Approach Pavement Resurfacing:

Resurface Perpetual Asphalt Pavement:
Resurfacing Units Costs:

	Year 2004	Annual Escalation	Year 2008
Pavement Planing, Asphalt Concrete, per sq. yd. (Item 254)	$0.98	3.5%	$1.12
Asphalt Concrete Surface Course, per cu. yd.	$72.00	3.5%	$82.62

Asphalt Resurfacing Costs:

	Approach Roadway Length (ft.) (4)	Approach Roadway Width (ft.)	Resurfacing Area (sq. yd.)	Wearing Course Thickness (in.)	Wearing Course Volume (cu. yd.)
Alt. 1	15.5	26.0	45	1.50	1.9
Alt. 2	15.5	26.0	45	1.50	1.9
Alt. 3	0.0	26.0	0	1.50	0.0

APPENDIX B

Preferred Alternative Site Plan and Details

TranSystems

APPENDIX C

Vertical Clearance Calculations

TranSystems

TranSystems

Made By PJP **Date** 05/10/06 **Job No.** P403030064
Checked By MTN **Date** 05/11/06 **Sheet No.**

VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 **Structure**
Description S.R. 823 OVER SR 140 **PID #** 19415

Alternative 1 - 4-72" Type 4 Modified Prestressed I-Beams, Single span ***Point Location:*** ***A***

Adjstment for Cross Slope

Comment	Grade		Offset (from PGL)	
Profile grade line to critical pt.:	-0.016	x	22	-0.352

Total Adjustment = **-0.35**

Superstructure Depth

Comment	Depth (in)	Depth (ft)
Deck Thickness:	8.5	0.71
Haunch:	2	0.17
Girder or Beam Depth:	72	6
	82.5	6.88

Total Superstructure Depth (ft) = **6.88**

Vertical Clearance at Critical Point

Station @ Critical Point = **62+29.36**
Offset Location @ Critical Point = **29.5' Lt.**
Profile Grade Elevation at Critical Point = 587.91
Adjustment for Cross Slopes to Beam CL = -0.35
Top of Deck Elevation @ Critical Point = **587.56**

Total Superstructure Depth = -6.88
Bottom of Beam Elevation @ Critical Point = **580.68**

Station @ Critical Point = **09+81.94**
Offset Location @ Critical Point = **18' Rt.**
Profile Grade Elevation at Critical Point = 556.23
Adjustment for Cross Slopes to EOP = 0.36
Top of Pavement @ Critical Point = **556.59**
Actual Vertical Clearance = ***24.09***
Preferred Vertical Clearance = *17.0*
Required Vertical Clearance = *16.5*

TranSystems

Made By PJP **Date** 05/10/06 **Job No.** P403030064
Checked By MTN **Date** 05/11/06 **Sheet No.**

VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 **Structure**
Description S.R. 823 OVER SR 140 **PID #** 19415

Alternative 1 - 4-72" Type 4 Modified Prestressed I-Beams, Single span ***Point Location:*** ***B***

Adjstment for Cross Slope

Comment	Grade		Offset (from PGL)		
Profile grade line to critical pt.:	-0.016	x	22	=	-0.35
			Total Adjustment	=	**-0.35**

Superstructure Depth

Comment	Depth (in)	Depth (ft)
Deck Thickness:	8.5	0.71
Haunch:	2	0.17
Girder or Beam Depth:	72	6
	82.5	6.88

Total Superstructure Depth (ft) = **6.88**

Vertical Clearance at Critical Point

Station @ Critical Point = **62+52.71**
Offset Location @ Critical Point = **29.5' Rt.**
Profile Grade Elevation at Critical Point = 588.11
Adjustment for Cross Slopes to Beam CL = -0.35
Top of Deck Elevation @ Critical Point = **587.76**

Total Superstructure Depth = -6.88
Bottom of Beam Elevation @ Critical Point = **580.88**

Station @ Critical Point = **10+45.40**
Offset Location @ Critical Point = **18' Rt.**
Profile Grade Elevation at Critical Point = 556.86
Adjustment for Cross Slopes to EOP = 0.36
Top of Pavement @ Critical Point = **557.22**
Actual Vertical Clearance = ***23.66***
Preferred Vertical Clearance = *17.0*
Required Vertical Clearance = *16.5*

TranSystems

Made By PJP Date 05/10/06 Job No. P403030064

Checked By MTN Date 05/11/06 Sheet No.

VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 Structure

Description S.R. 823 OVER SR 140 PID # 19415

Alternative 2 - 4-58" Web Plate Girders, Single span

Point Location: A

Adjstment for Cross Slope

Comment	Grade		Offset (from PGL)	
Profile grade line to critical pt.:	-0.016	x	22	-0.352

Total Adjustment = **-0.35**

Superstructure Depth

Comment	Depth (in)	Depth (ft)
Deck Thickness:	8.5	0.71
Haunch:	2	0.17
Girder or Beam Depth:	61	5.08
	71.5	5.96

Total Superstructure Depth (ft) = **5.96**

Vertical Clearance at Critical Point

Station @ Critical Point = **62+29.36**

Offset Location @ Critical Point = **29.5' Lt.**

Profile Grade Elevation at Critical Point = 587.91

Adjustment for Cross Slopes to Beam CL = -0.35

Top of Deck Elevation @ Critical Point = **587.56**

Total Superstructure Depth = -5.96

Bottom of Beam Elevation @ Critical Point = **581.60**

Station @ Critical Point = **09+81.94**

Offset Location @ Critical Point = **18' Rt.**

Profile Grade Elevation at Critical Point = 556.23

Adjustment for Cross Slopes to EOP = 0.36

Top of Pavement @ Critical Point = **556.59**

Actual Vertical Clearance = ***25.01***

Preferred Vertical Clearance = *17.0*

Required Vertical Clearance = *16.5*

TranSystems

Made By PJP **Date** 05/10/06 **Job No.** P403030064
Checked By MTN **Date** 05/11/06 **Sheet No.**

VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 **Structure**
Description S.R. 823 OVER SR 140 **PID #** 19415

Alternative 2 - 4-58" Web Plate Girders, Single span ***Point Location:*** ***B***

Adjstment for Cross Slope

Comment	Grade		Offset (from PGL)		
Profile grade line to critical pt.:	-0.016	x	22	=	-0.35
			Total Adjustment	=	**-0.35**

Superstructure Depth

Comment	Depth (in)	Depth (ft)
Deck Thickness:	8.5	0.71
Haunch:	2	0.17
Girder or Beam Depth:	61	5.08
	71.5	5.96

Total Superstructure Depth (ft) = **5.96**

Vertical Clearance at Critical Point

Station @ Critical Point = 62+52.71
Offset Location @ Critical Point = 29.5' Rt.
Profile Grade Elevation at Critical Point = 588.11
Adjustment for Cross Slopes to Beam CL = -0.35
Top of Deck Elevation @ Critical Point = 587.76

Total Superstructure Depth = -5.96
Bottom of Beam Elevation @ Critical Point = 581.80

Station @ Critical Point = 10+45.40
Offset Location @ Critical Point = 18' Rt.
Profile Grade Elevation at Critical Point = 556.86
Adjustment for Cross Slopes to EOP = 0.36
Top of Pavement @ Critical Point = 557.22
Actual Vertical Clearance = 24.58
Preferred Vertical Clearance = 17.0
Required Vertical Clearance = 16.5

TranSystems

Made By PJP **Date** 05/10/06 **Job No.** P403030064
Checked By MTN **Date** 05/11/06 **Sheet No.**

VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 **Structure**
Description S.R. 823 OVER SR 140 **PID #** 19415

Alternative 3 - 5-72" Type 4 Modified I-Beams, Single span **Point Location: *A***

Adjstment for Cross Slope

Comment	Grade		Offset	
Profile grade line to critical pt.:	-0.016	x	22.75	-0.364

Total Adjustment = **-0.36**

Superstructure Depth

Comment	Depth (in)	Depth (ft)
Deck Thickness:	8.5	0.71
Haunch:	2	0.17
Girder or Beam Depth:	72	6
	82.5	6.88

Total Superstructure Depth (ft) = **6.88**

Vertical Clearance at Critical Point

Station @ Critical Point = 62+29.06
Offset Location @ Critical Point = 30.25' Left
Profile Grade Elevation at Critical Point = 587.91
Adjustment for Cross Slopes to Beam CL = -0.36
Top of Deck Elevation @ Critical Point = 587.54

Total Superstructure Depth = -6.88
Bottom of Beam Elevation @ Critical Point = 580.66

Station @ Critical Point = 09+81.14
Offset Location @ Critical Point = 18' Rt.
Profile Grade Elevation at Critical Point = 556.22
Adjustment for Cross Slopes to EOP = 0.36
Top of Pavement @ Critical Point = 556.58
Actual Vertical Clearance = 24.08
Preferred Vertical Clearance = 17.0
Required Vertical Clearance = 16.5

TranSystems

Made By PJP **Date** 05/10/06 **Job No.** P403030064
Checked By MTN **Date** 05/11/06 **Sheet No.**

VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 **Structure**
Description S.R. 823 OVER SR 140 **PID #** 19415

Alternative 3 - 5-72" Type 4 Modified I-Beams, Single span — ***Point Location:*** ***B***

Adjstment for Cross Slope

Comment	Grade		Offset		
Profile grade line to critical pt.:	-0.016	x	22.75	=	-0.36
			Total Adjustment	=	**-0.36**

Superstructure Depth

Comment	Depth (in)	Depth (ft)
Deck Thickness:	8.5	0.71
Haunch:	2	0.17
Girder or Beam Depth:	72	6
	82.5	6.88

Total Superstructure Depth (ft) = **6.88**

Vertical Clearance at Critical Point

Station @ Critical Point = **62+53.01**

Offset Location @ Critical Point = **30.25' Rt.**

Profile Grade Elevation at Critical Point = 588.11

Adjustment for Cross Slopes to Beam CL = -0.36

Top of Deck Elevation @ Critical Point = **587.75**

Total Superstructure Depth = -6.88

Bottom of Beam Elevation @ Critical Point = **580.87**

Station @ Critical Point = **10+46.20**

Offset Location @ Critical Point = **18' Rt.**

Profile Grade Elevation at Critical Point = 556.87

Adjustment for Cross Slopes to EOP = 0.36

Top of Pavement @ Critical Point = **557.23**

Actual Vertical Clearance = ***23.64***

Preferred Vertical Clearance = *17.0*

Required Vertical Clearance = *16.5*

APPENDIX D

Preliminary Structure Site Plan

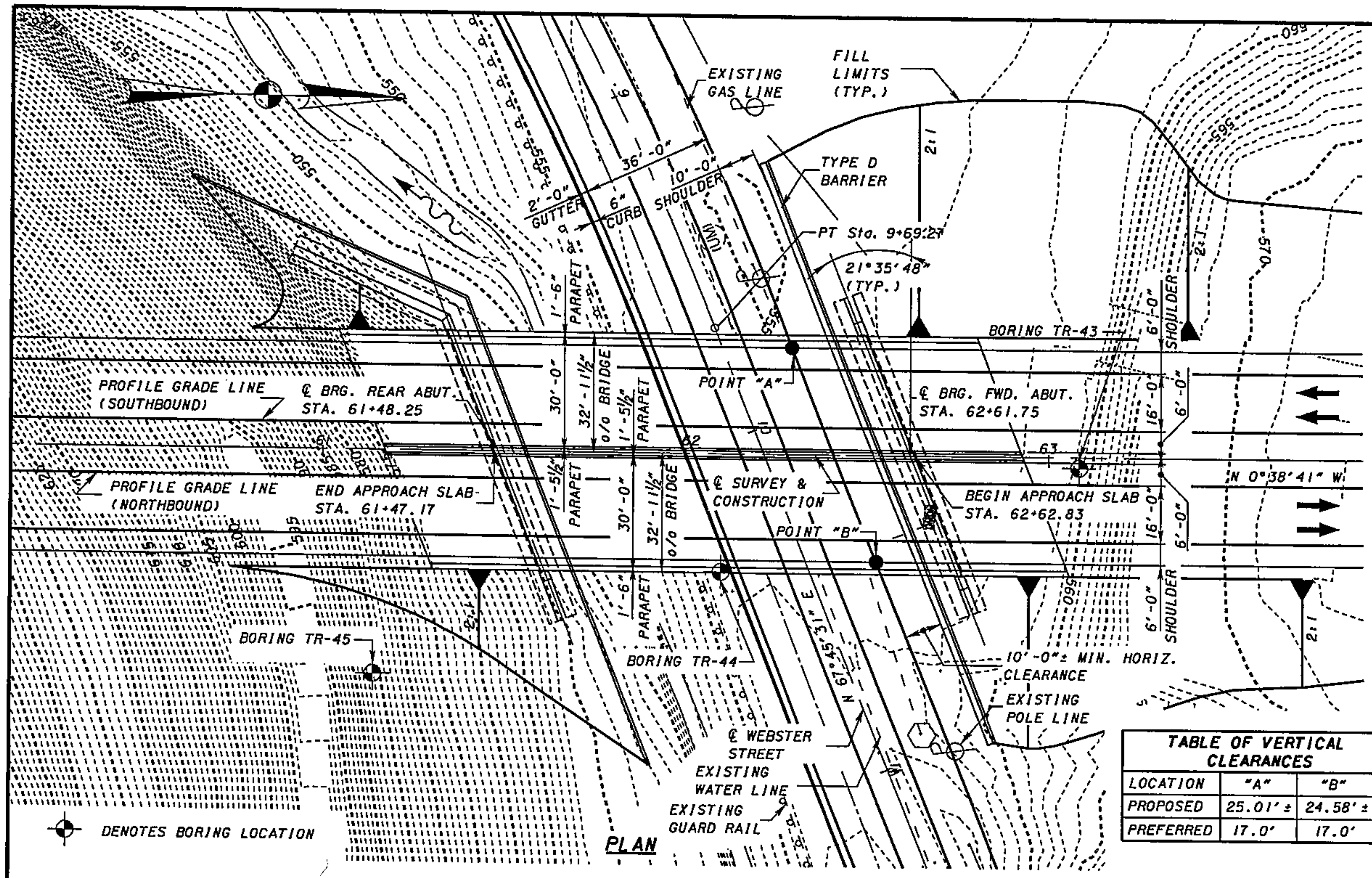
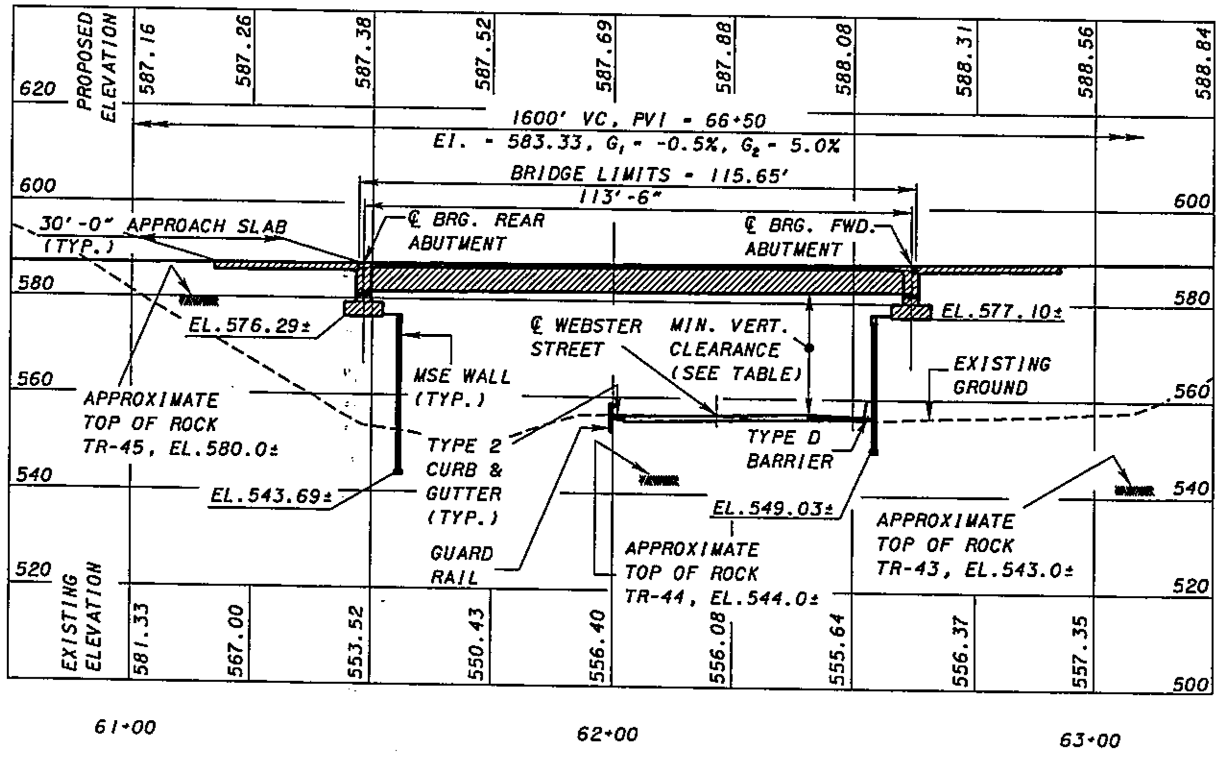
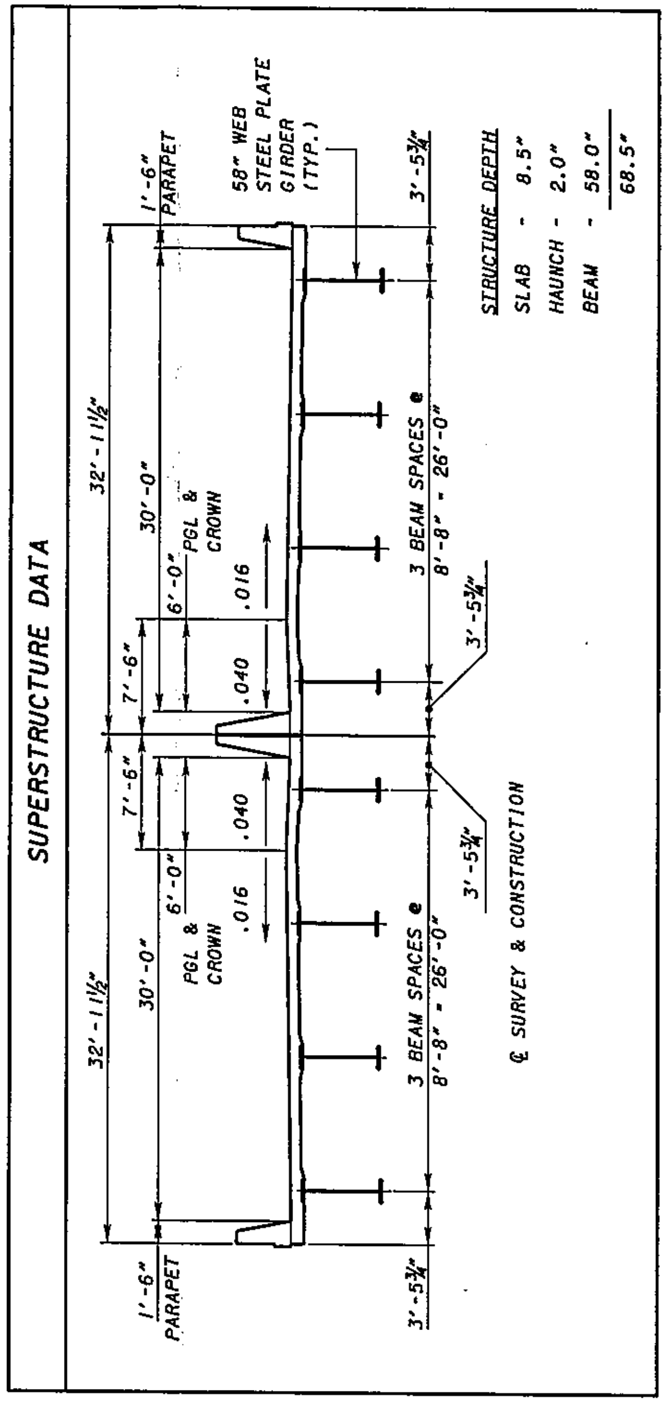


TABLE OF VERTICAL CLEARANCES		
LOCATION	"A"	"B"
PROPOSED	25.01'±	24.58'±
PREFERRED	17.0'	17.0'



ELEVATION ALONG PROFILE GRADE S.R. 823



PROPOSED STRUCTURE

TYPE: SINGLE SPAN 58" WEB STEEL PLATE GIRDER WITH COMPOSITE REINFORCED CONCRETE DECK SUPPORTED BY SEMI-INTEGRAL ABUTMENTS AND MSE WALLS.

SPANS: 113'-6" C/C BEARING

ROADWAY: 2 - 30'-0" T/T PARAPETS

LOADING: HS-25 AND ALTERNATE MILITARY LOADING, FWS-60 PSF

SKEW: 21°35'48" RF

CROWN: NORMAL, 0.016 FT/FT

ALIGNMENT: TANGENT

WEARING SURFACE: MONOLITHIC CONCRETE

APPROACH SLABS: AS-1-81 (30'-0" LONG)

LATITUDE:

LONGITUDE:

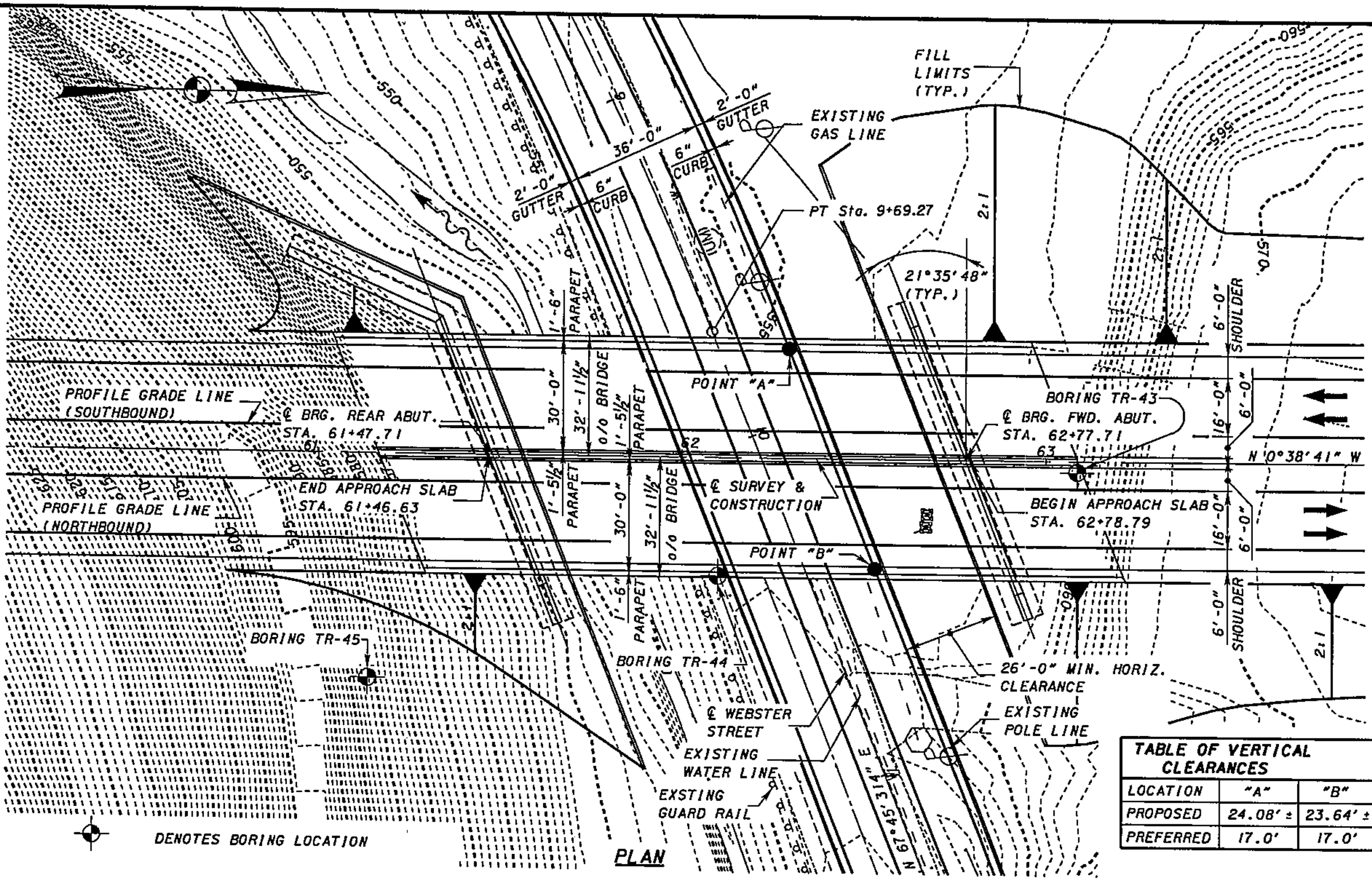
DESIGN AGENCY
TranSystems
720 EAST PETE ROSE WAY, SUITE 360, CINCINNATI, OHIO, 45202

DESIGNED	DRAWN	REVIEWED	DATE
PJP	CAS	JRC	05/12/06
CHECKED	REVISED	STRUCTURE FILE NUMBER	

SCIOTO COUNTY
STA. 61+47.17
STA. 62+62.83

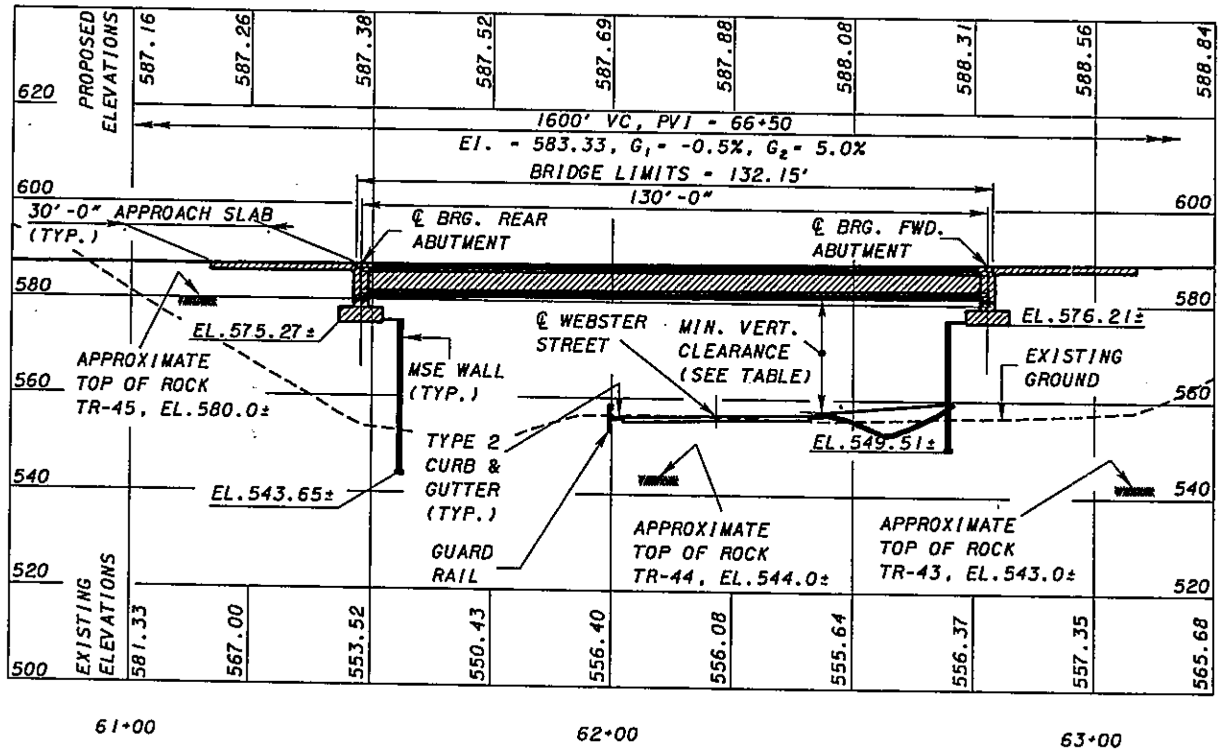
SITE PLAN - ALTERNATIVE 2
BRIDGE NO. SCI-823-XXXX
S.R. 823 OVER WEBSTER STREET

SCI-823-0.00
PID19415

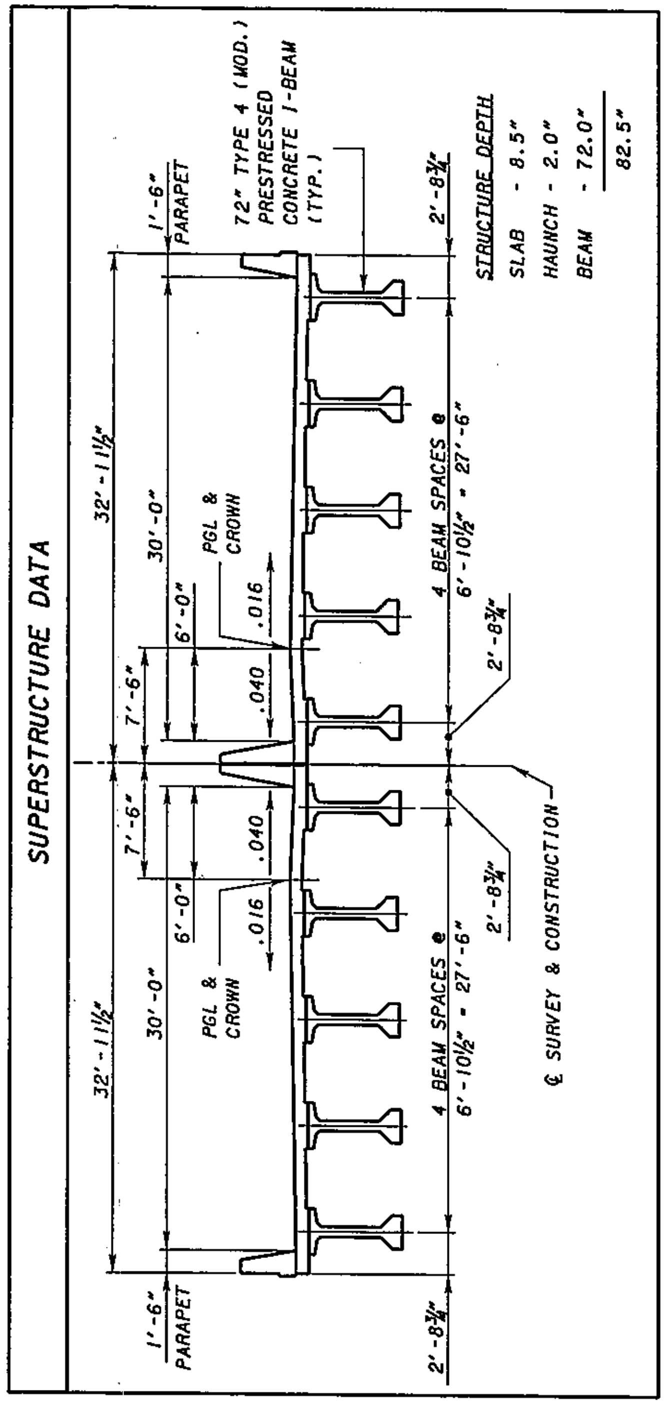


PLAN

TABLE OF VERTICAL CLEARANCES		
LOCATION	"A"	"B"
PROPOSED	24.08′ ±	23.64′ ±
PREFERRED	17.0′	17.0′



ELEVATION ALONG PROFILE GRADE S.R. 823



PROPOSED STRUCTURE

TYPE: SINGLE SPAN 72″ TYPE 4 (MOD.) PRESTRESSED CONCRETE I-BEAM WITH COMPSITE REINFORCED CONCRETE DECK SUPPORTED BY SEMI-INTEGRAL ABUTMENTS AND MSE WALLS.

SPANS: 130′-0″ C/C BEARING

ROADWAY: 2 - 30′-0″ T/T PARAPETS

LOADING: HS-25 AND ALTERNATE MILITARY LOADING, FWS-60 PSF

SKEW: 21°35′48″ RF

CROWN: NORMAL, 0.016 FT/FT

ALIGNMENT: TANGENT

WEARING SURFACE: MONOLITHIC CONCRETE

APPROACH SLABS: AS-1-81 (30′-0″ LONG)

LATITUDE:

LONGITUDE:

SITE PLAN - ALTERNATIVE 3
BRIDGE NO. SCI-823-XXXX
S.R. 823 OVER WEBSTER STREET

SCIOTO COUNTY
STA. 61+46.63
STA. 62+78.79

DESIGNED	DRAWN	REVIEWED	DATE
PJP	CAS	JRC	05/12/06
CHECKED	REVISED	STRUCTURE FILE NUMBER	

DESIGN AGENCY
TranSystems
720 EAST PETE ROSE WAY, SUITE 360, CINCINNATI, OHIO, 45202

SCI-823-0.00
PID19415

2 / 2

APPENDIX E

Preliminary Geotechnical Report
& Preliminary MSE Wall Evaluation

TranSystems

DLZ
ENGINEERS • ARCHITECTS • SCIENTISTS
PLANNERS • SURVEYORS

March 30, 2005

Mr. Greg Parsons, P.E.
Project Manager
TranSystems Corporation
5747 Perimeter Dr., Suite 240
Dublin, OH 43017

Re: **SCI-823-0.00 over Webster Street (S.R. 140)**
Preliminary Structural Foundation Recommendations
Project SCI-823-0.00
DLZ Job No.: 0121-3070.03

Dear Mr. Parsons:

This letter reports the findings of the subsurface exploration and preliminary foundation recommendations for the proposed structure for SCI-823-0.00 over Webster Street (S.R. 140). It is anticipated that the proposed structure will be a two-span elevated bridge. The existing grade at the proposed new bridge location is at approximate elevations 585 and 570 feet at the south and north abutments, respectively. It is anticipated that the SCI-823-0.00 mainline will be located in fill sections on either side of the proposed bridge. Approximately 5 feet and 20 feet of new fill are anticipated at the rear (south) and forward (north) abutments, respectively. It is anticipated that the center pier will be approximately 36 feet in height. A stream is located along the south side of Webster Street. Weathered bedrock is present in the stream bed. Old report

The findings and recommendations presented in this report should be considered preliminary. It is understood that the final number and locations of substructure units have not been determined yet. After the substructure unit locations have been established, the results of the borings should be reviewed to determine if additional exploration is needed to finalize the foundation recommendations for the new structure.

Field Exploration

A total of three borings, TR-43, TR-44 and TR-45, were drilled at the proposed structure between February 2 and 24, 2005. The borings were drilled to depths ranging from 25 to 35 feet. The borings were extended into bedrock, which was verified by rock coring. Boring logs and information concerning the drilling procedures are attached.

The boring locations were selected by TranSystems Corporation. Borings TR-43, TR-44 and TR-45 are located approximately at Stations 68+00, 67+00 and 66+00, respectively. Ground

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surface elevations at the boring locations and the boring locations were estimated from the established topographic mapping for the project and are presented on the attached Boring Logs.

Findings

The following text presents generalized subsurface conditions encountered by the borings. For more detailed information, please refer to the attached Boring Logs.

At the ground surface Borings TR-44 and TR-45 encountered 12 inches of asphalt pavement and 2 inches of topsoil, respectively. Beneath the asphalt pavement in Boring TR-44, 2 feet of silt (A-4b) was encountered overlying 2.5 feet of sandy silt (A-4a). Beneath the sandy silt in Boring TR-44 and at the surface of Boring TR-43, silt and clay (A-6a) was encountered to depths of 2.5 feet and 5.5 feet, respectively. Boring TR-43 encountered 6.1 feet of silty clay (A-6b) beneath the silt and clay (A-6a). Underlying the topsoil in Boring TR-45 and the residual soils in Borings TR-43 and TR-44, highly weathered to decomposed very soft sandstone was encountered ranging in thickness from 3 to 5 feet.

Bedrock was encountered between 5 and 15 feet below the ground surface, and generally consisted of a medium hard to hard sandstone that was slightly broken to intact. Recovery of the core samples ranged from 97 to 100%, and RQD values ranged from 73 to 100% with an average RQD of 87%.

Water seepage was not detected in any of the borings prior to coring operations. At the completion of drilling, water levels ranged from 2.0 to 6.7 feet. The final water levels include drilling water and likely are not representative of actual groundwater conditions. Groundwater levels may vary seasonably.

Conclusions and Recommendations

Based on the subsurface materials encountered in the borings, either spread footing or drilled shaft foundations are best suited for support of the proposed structure. Competent bedrock was encountered at a shallow depth at the pier and rear (south) abutment locations. Additional fill will be placed at the abutment locations, resulting in an estimated depth to bedrock of 35 feet below the proposed grade at the forward (north) abutment. Bedrock will be shallower at the rear (south) abutment, possibly only 10 to 15 feet with the new fill. If an alternative foundation type is required due to lateral or uplift loads, a pile-type foundation can be used. H-piles can be used if pre-bored sockets into bedrock are utilized.

If spread footings are used to support the abutments, it is anticipated that they will be bearing in new fill. However, the rear (south) abutment may be bearing in bedrock, depending on how much fill is placed. Spread footings bearing in embankment fill may be designed for an allowable bearing capacity of 3000 psf.

If spread footings are used to support the pier or the rear (south) abutment is bearing on bedrock, the footings should be embedded into the bedrock. Additionally, drilled shafts socketed into rock can also be used. The depth of the spread footing embedment or the sockets will need to be designed based upon actual loading conditions. The following table summarizes the site conditions and bearing capacity recommendations for foundations on rock.

Foundation Recommendations

Boring Number	Structural Element	Existing Ground Surface Elevation* (Feet)	Top of Competent Rock Elevation* (Feet)	Allowable Bearing Capacity
TR-43	Forward (North) Abutment	570	555	15 TSF
TR-44	Pier	555	544	15 TSF
TR-45	Rear (South) Abutment	585	580	15 TSF

*Existing ground surface elevation was estimated from the established topographic mapping.

Grain size analyses of the overburden in Boring TR-44 were performed for scour analysis since the proposed structure location is located along a stream. The following table presents the D_{50} and D_{85} for each respective soil type encountered in the boring. In addition, grain size data sheets are attached to this report.

Data for Scour Analysis

Boring Number	Existing Ground Surface Elevation* (Feet)	Sample Depth (Feet)	ODOT Classification	D_{50} (mm)	D_{85} (mm)
TR-44	555.0	1.0-2.5	A-4b	0.0145	0.0526
TR-44	555.0	3.5-5.0	A-4a	0.0576	7.75
TR-44	555.0	6.0-7.5	A-6a	0.0103	0.0478
TR-44	555.0	8.5-9.3	Weathered Rock	0.0168	0.0519

*Existing ground surface elevation was estimated from the established topographic mapping.

Closing

If you have any questions, please contact our office for clarification.

Sincerely,

DLZ OHIO, INC.

P. Paul Painter for
Edward R. Hood, P.E.
Geotechnical Engineer

Dorothy A. Adams
Dorothy A. Adams, P.E.
Senior Geotechnical Engineer

Attachments: General Information – Drilling Procedures and Logs of Borings
Legend – Boring Log Terminology
Site Plan
Boring Logs TR-43, TR-44, TR-45
Grain Size Analysis

cc: File

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GENERAL INFORMATION
DRILLING PROCEDURES AND LOGS OF BORINGS

Drilling and sampling were conducted in accordance with procedures generally recognized and accepted as standardized methods of investigation of subsurface conditions concerning geotechnical engineering considerations. Borings were drilled with either a truck-mounted or ATV-mounted drill rig.

Drive split-barrel sampling was performed in 1.5 foot increments at intervals not exceeding 5 feet. In the event the sampler encountered resistance to penetration of 6 inches or less after 50 blows of the drop hammer, the sampling increment was discontinued. Standard penetration data were recorded and one or more representative samples were preserved from each sampling increment.

In borings where rock was cored, NXM or NQ size diamond coring tools were used.

In the laboratory all samples were visually classified by a geotechnical engineer. Moisture contents of representative fine-grained soil samples were determined. A limited number of samples, considered representative of foundation materials present, were selected for performance of grain-size analyses and plasticity characteristics tests. The results of these tests are shown on the boring logs.

The boring logs included in the Appendix have been prepared on the basis of the field record of drilling and sampling, and the results of the laboratory examination and testing of samples. Stratification lines on the boring logs indicating changes in soil stratigraphy represent depths of changes approximated by the driller, by sampling effort and recovery, and by laboratory test results. Actual depths to changes may differ somewhat from the estimated depths, or transitions may occur gradually and not be sharply defined. The boring logs presented in this report therefore contain both factual and interpretative information and are not an exact copy of the field log.

Although it is considered that the borings have disclosed information generally representative of site conditions, it should be expected that between borings conditions may occur which are not precisely represented by any one of the borings. Soil deposition processes and natural geologic forces are such that soil and rock types and conditions may change in short vertical intervals and horizontal distances.

Soil/rock samples will be stored at our laboratory for a period of six months. After this period of time, they will be discarded, unless notified to the contrary by the client.

LEGEND – BORING LOG TERMINOLOGY

Explanation of each column, progressing from left to right

1. Depth (in feet) – refers to distance below the ground surface.

2. Elevation (in feet) – is referenced to mean sea level, unless otherwise noted.

3. Standard Penetration (N) – the number of blows required to drive a 2-inch O.D., 1-3/8 inch I.D., split-barrel sampler, using a 140-pound hammer with a 30-inch free fall. The blows are recorded in 6-inch drive increments. Standard penetration resistance is determined from the total number of blows required for one foot of penetration by summing the second and third 6-inch increments of an 18-inch drive.

   50/n – indicates number of blows (50) to drive a split-barrel sampler a certain number of inches (n) other than the normal 6-inch increment.

4. The length of the sampler drive is indicated graphically by horizontal lines across the "Standard Penetration" and "Recovery" columns.

5. Sample recovery from each drive is indicated numerically in the column headed "Recovery".

6. The drive sample location is designated by the heavy vertical bar in the "Sample No., Drive" column.

7. The length of hydraulically pressed "Undisturbed" samples is indicated graphically by horizontal lines across the "Press" column.

8. Sample numbers are designated consecutively, increasing in depth.

9. Soil Description

   a. The following terms are used to describe the relative compactness and consistency of soils:

Granular Soils – Compactness

Term	Blows/Foot Standard Penetration
Very Loose	0 – 4
Loose	4 – 10
Medium Dense	10 – 30
Dense	30 – 50
Very Dense	over 50

Cohesive Soils – Consistency

Term	Unconfined Compression tons/sq.ft.	Blows/Foot Standard Penetration	Hand Manipulation
Very Soft	less than 0.25	below 2	Easily penetrated by fist
Soft	0.25 – 0.50	2 – 4	Easily penetrated by thumb
Medium Stiff	0.50 – 1.0	4 – 8	Penetrated by thumb with moderate pressure
Stiff	1.0 – 2.0	8 – 15	Readily indented by thumb but not penetrated
Very Stiff	2.0 – 4.0	15 – 30	Readily indented by thumb nail
Hard	over 4.0	over 30	Indented with difficulty by thumb nail

   b. Color – If a soil is a uniform color throughout, the term is single, modified by such adjective as light and dark. If the predominant color is shaded by a secondary color, the secondary color precedes the primary color. If two major and distinct colors are swirled throughout the soil, the colors are modified by the term "mottled".

   c. Texture is based on the Ohio Department of Transportation Classification System. Soil particle size definitions are as follows:

Description		Size	Description		Size
Boulders		Larger than 8"	Sand	– Coarse	2.0 mm to 0.42 mm
Cobbles		8" to 3"		– Fine	0.42 mm to 0.074 mm
Gravel	– Coarse	3" to ¾"	Silt		0.074 mm to 0.005 mm
	– Fine	¾" to 2.0 mm	Clay		smaller than 0.005 mm

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d. The main soil component is listed first. The minor components are listed in order of decreasing percentage of particle size.

e. Modifiers to main soil descriptions are indicated as a percentage by weight of particle sizes.

trace	0 to 10%
little	10 to 20%
some	20 to 35%
"and"	35 to 50%

f. Moisture content of **cohesionless soils** (sands and gravels) is described as follows:

Term	Relative Moisture or Appearance
Dry	No moisture present
Damp	Internal moisture, but none to little surface moisture
Moist	Free water on surface
Wet	Voids filled with free water

g. The moisture content of **cohesive soils** (silts and clays) is expressed relative to plastic properties.

Term	Relative Moisture or Appearance
Dry	Powdery
Damp	Moisture content slightly below plastic limit
Moist	Moisture content above plastic limit but below liquid limit
Wet	Moisture content above liquid limit

10. Rock Hardness and Rock Quality Designation

a. The following terms are used to describe the relative hardness of the **bedrock.**

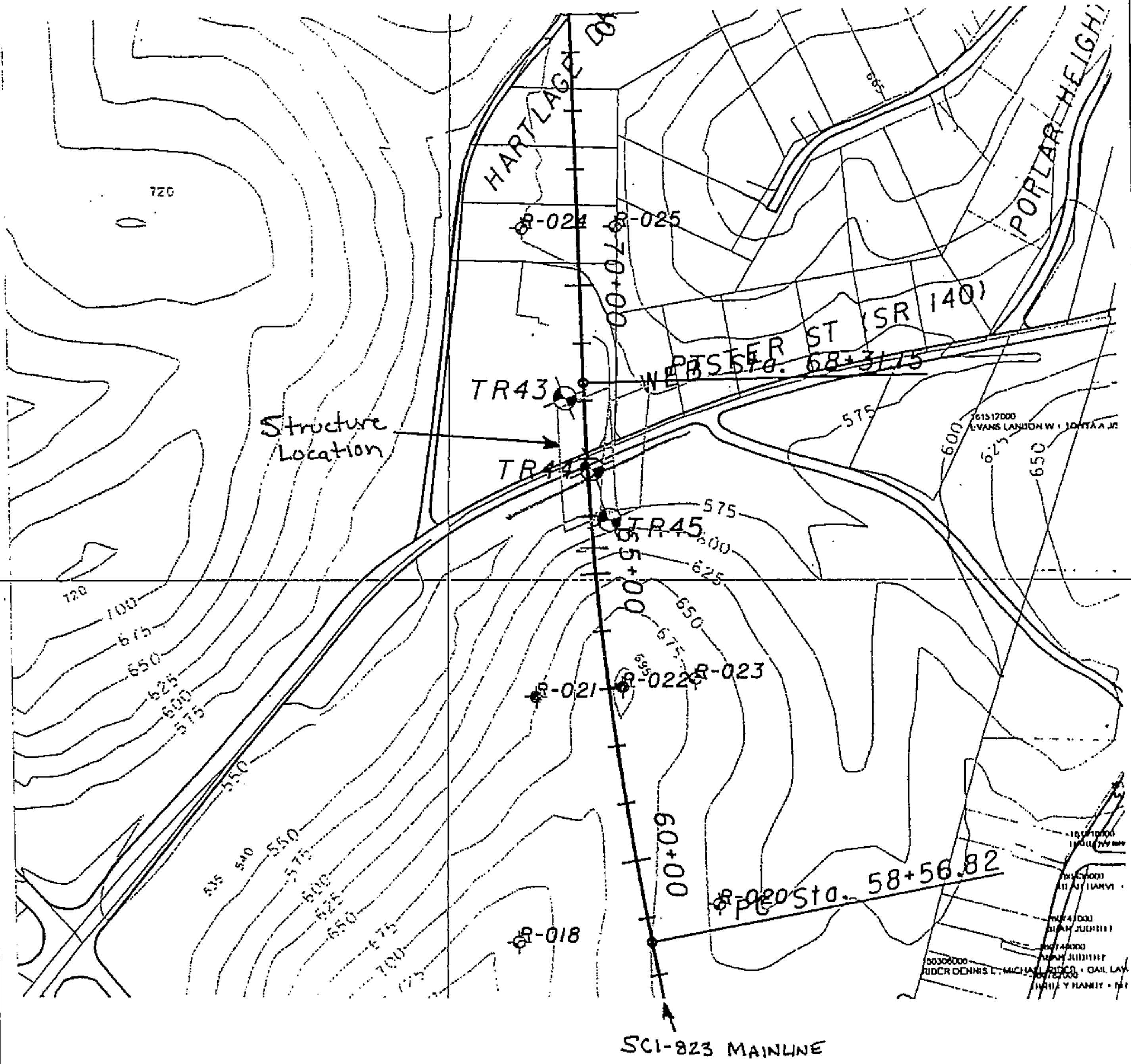
Term	Description
Very Soft	Permits denting by moderate pressure of the fingers. Resembles hard soil but has rock structure. (Crushes under pressure of fingers and/or thumb)
Soft	Resists denting by fingers, but can be abraded and pierced to shallow depth by a pencil point. (Crushes under pressure of pressed hammer)
Medium Hard	Resists pencil point, but can be scratched with a knife blade. (Breaks easily under single hammer blow, but with crumbly edges.)
Hard	Can be deformed or broken by light to moderate hammer blows. (Breaks under one or two strong hammer blow, but with resistant sharp edges.)
Very Hard	Can be broken only by heavy and in some rocks repeated hammer blows.

b. Rock Quality Designation, RQD – This value is expressed in percent and is an indirect measure of rock soundness. It is obtained by summing the total length of all core pieces which are at least four inches long, and then dividing this sum by the total length of the core run.

11. Gradation – when tests are performed, the percentage of each particle size is listed in the appropriate column (defined in Item 9c).

12. When a test is performed to determine the natural moisture content, liquid limit moisture content, or plastic limit moisture content, the moisture content is indicated graphically.

13. The standard penetration (N) value in blows per foot is indicated graphically.



Source: Topographic Mapping provided by TranSystems Corporation, Dated 2004

↑ NORTH

DLZ
ENGINEERS * ARCHITECTS * SCIENTISTS

SITE PLAN

Webster Street - SR 140
SCI-823 over SR 140
SCI-823-0.00

FIGURE 1.

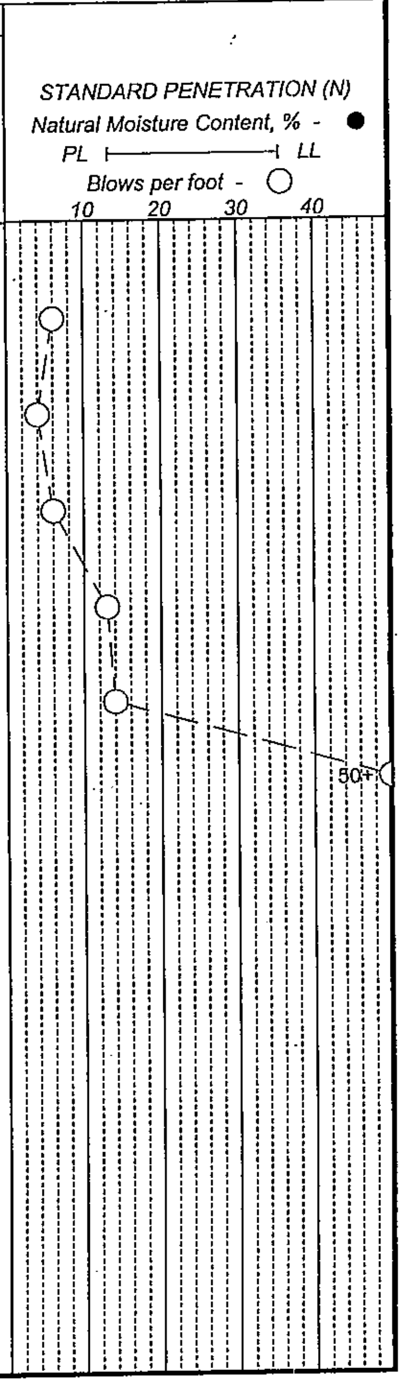
DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-43 | Location: SCI-823-0.00 over Webster St. (Forward Abutment) | Date Drilled: 02/03/05

WATER OBSERVATIONS: Water seepage at: None
Water level at completion: 2.0' (includes drill water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetro-meter (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	570.0						Very stiff brown SILT AND CLAY (A-6a), trace fine sand; damp to moist.						
		2 3 3	15	1		2.25							
		2 2 2	16	2		1.75 - 2.25	@ 3.5-5.5', stiff to very stiff, brown and gray.						
5 5.5	564.5						Stiff to very stiff brown and gray SILTY CLAY (A-6b), little fine sand, trace fine gravel; moist.						
		2 3 3	17	3		2.0							
		3 5 8	18	4		1.75							
10													
11.6	558.4	5 8 6	14	5			Very soft brown SANDSTONE, very fine grained, decomposed argillaceous, broken.						
		15 50/5	10	6		4.5+							
15.0	555.0						Medium hard gray SANDSTONE; very fine grained, highly weathered, argillaceous, micaceous, thinly bedded, highly fractured, with typical low and high angle clay filled and rust stained fractures.						
20		Core 120"	Rec 120"	RQD 78%	R-1								
21.0	549.0						Medium hard to hard gray SANDSTONE; very fine grained, slightly weathered, argillaceous, micaceous, thinly bedded, slightly fractured.						
25													
30		Core 120"	Rec 120"	RQD 100%	R-2								



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Client: TranSystems, Inc.

Project: SCI-823-0.00

Job No. 0121-3070.03

LOG OF: Boring TR-43

Location: SCI-823-0.00 over Webster St. (Forward Abutment)

Date Drilled: 02/03/05

WATER OBSERVATIONS:
Water seepage at: None
Water level at completion: 2.0' (includes drill water)

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢—⊣ *LL*
Blows per foot - ○
10 20 30 40

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
30	540.0						Medium hard to hard gray SANDSTONE; very fine grained, slightly weathered, argillaceous, micaceous, thinly bedded, slightly fractured.						
35.0	535.0						Bottom of Boring - 35.0'						
40													
45													
50													
55													
60													

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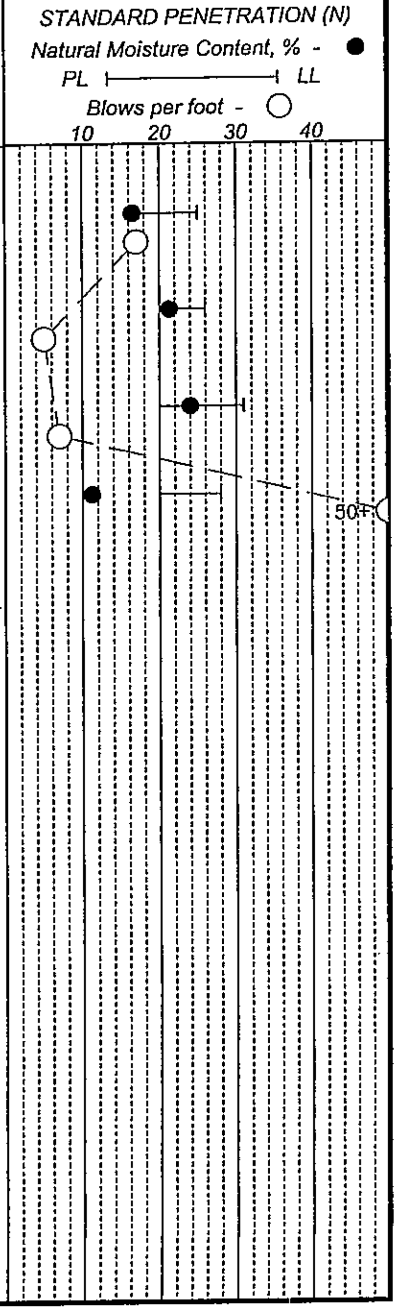
Client: TranSystems, Inc.
Project: SCI-823-0.00
Job No. 0121-3070.03

LOG OF: Boring TR-44
Location: SCI-823.0.00 over Webster St. (Pier)
Date Drilled: 02/02/05

WATER OBSERVATIONS: Water seepage at: None
Water level at completion: 5.0' (includes drill water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	555.0						Asphalt Concrete Pavement - 12"						
1.0	554.0	9 8 9	16	1		4.0	Hard brown and gray SILT (A-4b), some clay, trace fine to coarse sand; damp.	1	2	–	6	62	29
3.0	552.0	3 2 3	13	2			Loose brown SANDY SILT (A-4a), some gravel, little clay; damp.	22	12	–	12	44	10
5 5.5	549.5	3 3 4	14	3		2.25	Very stiff brown and gray SILT AND CLAY (A-6a), trace fine sand; moist.	0	3	–	6	61	30
8.0 10	547.0	26 50/3	8	4			Soft to medium hard gray and brown SANDSTONE; highly weathered to decomposed.	0	1	–	6	70	23
11.0 15	544.0	Core 108"	Rec 108"	RQD 73%	R-1		Medium hard gray SANDSTONE; very fine grained, highly weathered, argillaceous, micaceous, thinly bedded, highly fractured, with typical low angle rust stained fractures. @ 17.7'-18.0', broken zone, clay filled. @ 19.0'-20.0', high angle fractures.						
20.0 25	535.0	Core 120"	Rec 116"	RQD 92%	R-2		Medium hard to hard gray SANDSTONE; very fine grained, slightly weathered, argillaceous, micaceous, thinly bedded, slightly fractured.						
30.0	525.0						Bottom of Boring - 30.0'						



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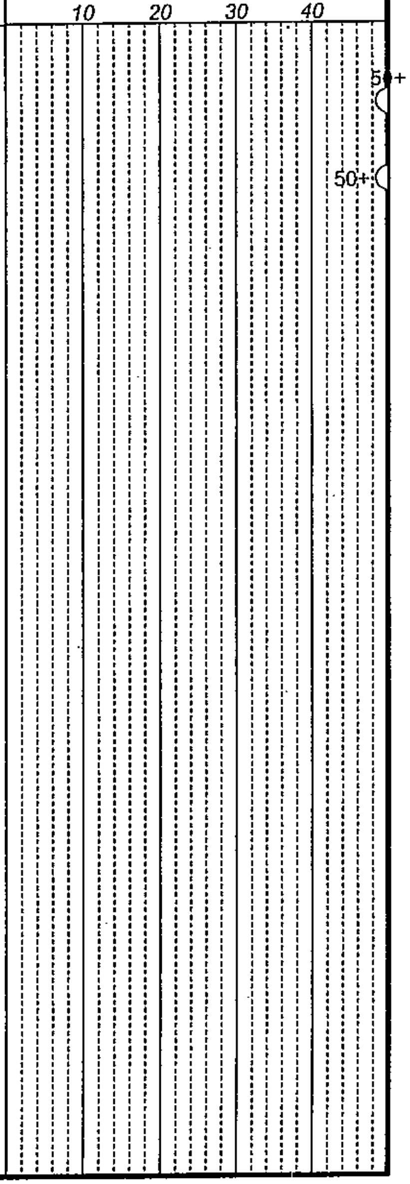
Client: TranSystems, Inc.
Project: SCI-823-0.00
Job No. 0121-3070.03

LOG OF: Boring TR-45
Location: SCI-823-0.00 over Webster St. (Rear Abutment)
Date Drilled: 02/24/05

WATER OBSERVATIONS: Water seepage at: None
Water level at completion: 6.7' measured inside augers

Depth (ft)	*Elev. (ft)*	*Blows per 6"*	*Recovery (in)*	*Sample No.* *Drive*	*Sample No.* *Press / Core*	*Hand Penetro-meter (tsf)*	*DESCRIPTION*	*% Aggregate*	*% C. Sand*	*% M. Sand*	*% F. Sand*	*% Silt*	*% Clay*
0.1	585.0 584.9						Topsoil - 2"						
		15 50/4	10	1			Very soft brown SANDSTONE; very fine grained, decomposed, argillaceous, broken.						
		50/3	3	2									
5.0	580.0	Core 120"	Rec 120"	RQD 79%	R-1		Soft to medium hard brownish gray SANDSTONE; very fine grained, highly weathered to decomposed, argillaceous, micaceous, thinly bedded, highly fractured, with typical low angle rust stained and clay filled fractures. @ 5.0'-5.1', broken zones. @ 7.4'-7.6', broken zones. @ 9.3'-9.6', high angle rust stained fracture. @ 11.1'- 11.4', broken zones. @ 14.2'-14.5', high angle rust stained fracture.						
15.4	569.6	Core 120"	Rec 120"	RQD 100%	R-2		Medium hard to hard gray SANDSTONE; very fine grained, slightly weathered, argillaceous, micaceous, thinly bedded, slightly fractured. @ 16.1'-16.3', rust stained zone. @ 17.3', low angle clay filled fracture. @ 20.2', low angle clay filled fracture.						
25.0	560.0						Bottom of Boring - 25.0'						

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ *LL*
Blows per foot - ○



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MAY 0 9 2006
TranSystems

May 8, 2006

Michael D. Weeks, P.E., P.S.
TranSystems Corporation
5747 Perimeter Drive, Suite 240
Dublin, OH 43017

Re: **Preliminary MSE Wall Evaluations**
SCI-823 over SR 140 (Webster Street)
SCI-823-0.00 Portsmouth Bypass
DLZ Job No.: 0121-3070.03
Document # 0013

Dear Mr. Weeks:

This letter includes the findings of preliminary evaluations of mechanically stabilized earth (MSE) retaining walls on the above-referenced project. The findings included in this letter pertain to the MSE walls at the crossing of proposed 823 and SR 140 (Webster Street). The findings of other preliminary MSE wall evaluations will be submitted in separate documents at a later date.

It should be noted that the results of these evaluations are based upon the findings of three preliminary structural borings. After the bridge design is finalized, it may be necessary to drill additional borings in the area of the proposed MSE walls in accordance with ODOT's specifications for subsurface investigations in order to finalize the MSE wall evaluations. Boring logs for borings TR-43, TR-44, and TR-45 are attached.

An MSE retaining wall essentially consists of good quality backfill material with layers of metal or plastic reinforcing that are attached to concrete facing panels. The MSE wall and associated backfill should be constructed in accordance with the specifications of the manufacturer of the MSE wall.

At the time this letter was prepared, it was understood that the plan location of the bridge structure for proposed 823 over SR 140 (Webster Street) is similar to the configuration shown on the plan and profile drawings dated 07/13/05. See attached plan and profile drawing. It is understood that the planned structure is being modified as follows: MSE walls will be placed at approximately stations 61+54 and 62+45 to contain the abutments and hold back the roadway embankment for proposed 823. Furthermore, it is assumed that the maximum height of the MSE wall at station 61+54 (Rear Abutment) will be approximately 34 feet. Similarly, the maximum height of the MSE wall station 62+45 (Forward Abutment) is also assumed to be approximately 34 feet high.

A preliminary global stability analysis and preliminary bearing capacity analysis were performed for the MSE walls at this bridge location in accordance with ODOT and AASHTO guidelines. The MSE walls were also analyzed for sliding, overturning and settlement. At the time this letter was prepared, it was not known what foundation type was to be used at this site to support the bridge abutments. However, the use of MSE walls at this site does not preclude the use of most common foundation types. Once a foundation type has been selected, DLZ should be informed so that the analyses may be revised as necessary.

Preliminary calculations for bearing capacity, sliding, and overturning as well as the results of the global stability analyses are attached. Other external and internal stability analyses are required for the design of an MSE wall, but are considered outside the scope of this report. The parameters required to perform the stability analyses are presented below.

In accordance with ODOT guidelines, a unit weight of 120 pcf and a friction angle of 34 degrees were selected for the backfill material in the reinforced zone. Similarly, the fill material used to construct the roadway embankments is assumed to have a unit weight of 120 pcf and a friction angle of 30 degrees. If the embankment fill material or backfill material for the reinforcing zone has properties significantly different from these values, DLZ should be informed so that the analyses may be revised as necessary.

Due to differences in the soil profiles at this location, the analyses of the MSE walls at the forward abutment and rear abutment were evaluated separately for stability. It should be noted, variations may be found in borings drilled for the final design that may change the results of these analyses.

MSE Wall Evaluation at Station 61+54 (Rear Abutment)

In the area of the proposed MSE wall at the rear abutment location, boring TR-44 encountered 12 inches of asphalt concrete pavement at the surface. Below the pavement layer, primarily hard silt (A-4b) was encountered to a depth of 3.0 feet below ground surface. Below 3.0 feet, primarily very stiff silt and clay (A-6a) was encountered to a depth of 8.0 feet below ground surface. Below 8.0 feet, highly weathered to decomposed brown sandstone was encountered to a depth of approximately 11.0 feet below ground surface, at the top of competent bedrock. Underlying the soil, this boring encountered medium hard to hard gray sandstone to the bottom of the boring, at a depth of 30.0 feet.

Also in the area of the proposed MSE wall at the rear abutment location, boring TR-45 generally encountered 2 inches of topsoil at the surface. Below the topsoil layer, primarily highly weathered to decomposed sandstone was encountered to a depth of 5.0

feet below ground surface, at the top of competent bedrock. Underlying the soil, this boring encountered medium hard to hard gray sandstone to the bottom of the boring, at a depth of 25.0 feet.

The MSE wall at the rear abutment is assumed to have a maximum height of approximately 34 feet. The recommended minimum embedment depth for this wall is approximately 4.8 feet.

The MSE wall at the rear abutment location lies at the base of a 2:1 slope. It should also be noted that a creek is located at approximately station 61+73, immediately up-station from the proposed wall. Given the relatively thin overburden (approx. 5 feet) in this area it is recommended that the MSE wall leveling pad be extended into competent bedrock. Significant amounts of rock excavation may be necessary to accommodate the reinforcing straps of the MSE wall. In areas where compacted granular fill is to be placed on bedrock, a level bench must be cut into the rock to place the fill for stability purposes. For stability, preliminary calculations have shown that a minimum reinforcement length of 0.7H or 27.0 feet is required for stability.

It should be noted that the foundation leveling pad of the MSE wall at the rear abutment is in close proximity to a creek, which is running essentially parallel to SR 140 Webster Street. The approximate elevation of bedrock under the MSE wall is 549 feet, which is near the bottom of the creek. If scour and erosion near the toe of the MSE wall are a concern, then slope protection should be provided with riprap or other means.

Bearing capacity, settlement and global stability was not analyzed at the rear abutment location due to the MSE wall being founded on bedrock. All stability is assumed to be within acceptably limits. Settlement at this location is assumed to be negligible.

MSE Wall Evaluation at Station 62+45 (Forward Abutment)

In the area of the proposed MSE wall in the forward abutment location, boring TR-43 encountered no topsoil at the surface. At the surface, primarily stiff to very stiff silt and clay (A-6a) was encountered to a depth of 5.5 feet below ground surface. Below 5.5 feet, stiff to very stiff silty clay (A-6b) was encountered to a depth of approximately 11.6 feet below ground surface. Below 11.6 feet, highly weathered to decomposed sandstone was encountered to a depth of 15.0 feet below ground surface, at the top of competent bedrock. Underlying the soil, this boring encountered medium hard to hard, slightly to highly weathered sandstone to the bottom of the boring, at a depth of 35.0 feet.

The MSE wall at the forward abutment is assumed to have a maximum height of approximately 34 feet. The recommended minimum embedment depth for this wall is 3.4 feet.

Initial analyses for the MSE walls bearing on natural soils at this location yielded inadequate factors of safety for undrained bearing capacity. Analyses were then performed assuming a undercut to the top of weathered bedrock (approximately 3.5 feet), in addition to the minimum embedment, backfilled with compacted, granular fill. These analyses raised undrained bearing capacity to acceptable levels. Consequently, it is recommended that an undercut be performed at this location to facilitate adequate undrained stability. As an alternative to the formerly mentioned remedy, the MSE wall at the forward abutment could be built without the undercut and compacted granular fill placement, using staged construction to maintain a drained condition. The foundation soils are relatively thin, approximately 7 to 9 feet, allowing consolidation to occur in a relatively short amount of time. Stability analyses have determined that the MSE wall may be built in twenty-foot stages between settlement periods. Using staged construction, it is also recommended that pore water pressures and settlement be monitored during construction to ensure that a drained condition is maintained throughout the construction process.

For stability, preliminary calculations have shown that a minimum reinforcement length of 0.8(H+D) or 29.6 feet is required for stability.

The total maximum settlement of the MSE wall volume at the forward abutment location was estimated to be approximately 1 inch at the centerline of the wall, assuming that the MSE wall is constructed using the minimum embedment as recommended. If an undercut to weathered bedrock replaced with compacted granular fill the settlement will be essentially zero. Differential settlement at this location was estimated to be less than 1.0%, and is not anticipated to be problematic at this location. MSE retaining walls are able to withstand relatively large amounts of differential settlement, typically up to 100 millimeters per 10 meters of wall length (1/100).

Calculations for bearing capacity, overturning, sliding, and settlement are attached for the MSE wall at the forward abutment. A drawing showing the results of the global stability analyses is also attached.

A summary of soil properties, summary of the results of calculations, and results of global stability analyses are attached.

We appreciate having the opportunity to be of service to you on this project. Please do not hesitate to call if you have any questions concerning our preliminary findings.

Respectfully submitted,

DLZ OHIO, INC.

Steven J. Riedy
Geotechnical Engineer

Arthur (Pete) Nix, P.E.
Geotechnical Division Manager

Encl: As noted

cc: file

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DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

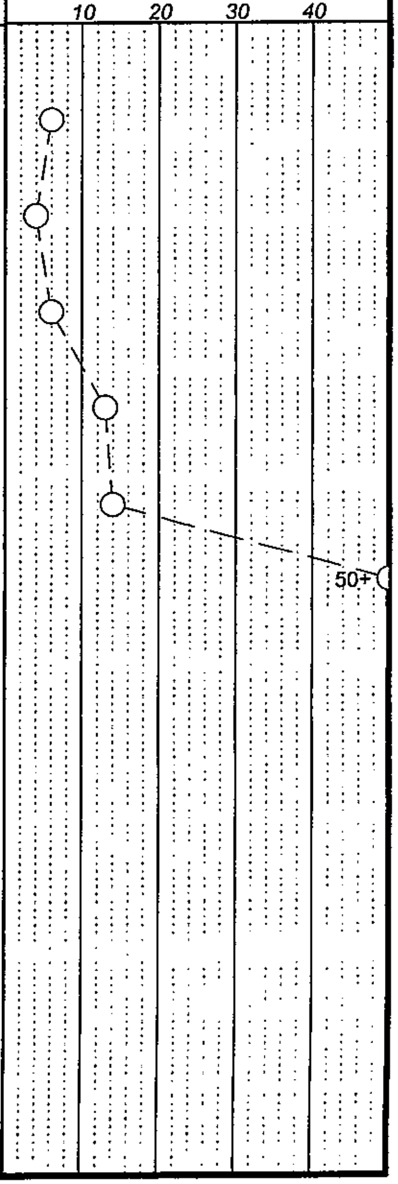
Client: TranSystems, Inc. | *Project:* SCI-823-0.00 | *Job No.* 0121-3070.03

LOG OF: Boring TR-43 | *Location:* SCI-823-0.00 over Webster St. (Forward Abutment) | *Date Drilled:* 02/03/05

WATER OBSERVATIONS: Water seepage at: None
Water level at completion: 2.0' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	558.4						Very stiff brown SILT AND CLAY (A-6a), trace fine sand; damp to moist.						
		2 3 3	15	1		2.25							
		2 2 2	16	2		1.75	@ 3.5 to 5.5', stiff to very stiff, brown and gray.						
5													
5.5	552.9						Stiff to very stiff brown and gray SILTY CLAY (A-6b), little fine sand, trace fine gravel; moist.						
		2 3 3	17	3		2.0							
		3 5 8	18	4		1.75							
10													
11.6	546.8						Severely weathered brown SANDSTONE argillaceous.						
		5 8 6	14	5									
		15 50/5	10	6									
15.0	543.4						Medium hard gray SANDSTONE; very fine to fine grained, highly weathered, argillaceous, micaceous, massively bedded, highly fractured, with typical low and high angle clay filled and rust stained fractures.						
20		Core 120"	Rec 120"	RQD 78%	R-1		@ 20.1' to 20.4', ferric band. @ 20.5', argillaceous lamination.						
21.0	537.4						Medium hard to hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, massively bedded, unfractured to slightly fractured.						
25													
30		Core 120"	Rec 120"	RQD 100%	R-2								

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○



DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: TranSystems, Inc.
Project: SCI-823-0.00
Job No. 0121-3070.03

LOG OF: Boring TR-43
Location: SCI-823-0.00 over Webster St. (Forward Abutment)
Date Drilled: 02/03/05

WATER OBSERVATIONS: Water seepage at: None
Water level at completion: 2.0' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.		Hand Penetrometer (tsf)	DESCRIPTION	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ⊢—⊣ LL Blows per foot - ○ 10 20 30 40
				Drive	Press /Core			% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	
30	528.4													
30.3	528.1						Medium hard to hard gray SANDSTONE; very fine grained, slightly weathered, argillaceous, micaceous, thinly bedded, unfractured to slightly fractured.							
35.0	523.4						Bottom of Boring - 35.0'							
40														
45														
50														
55														
60														

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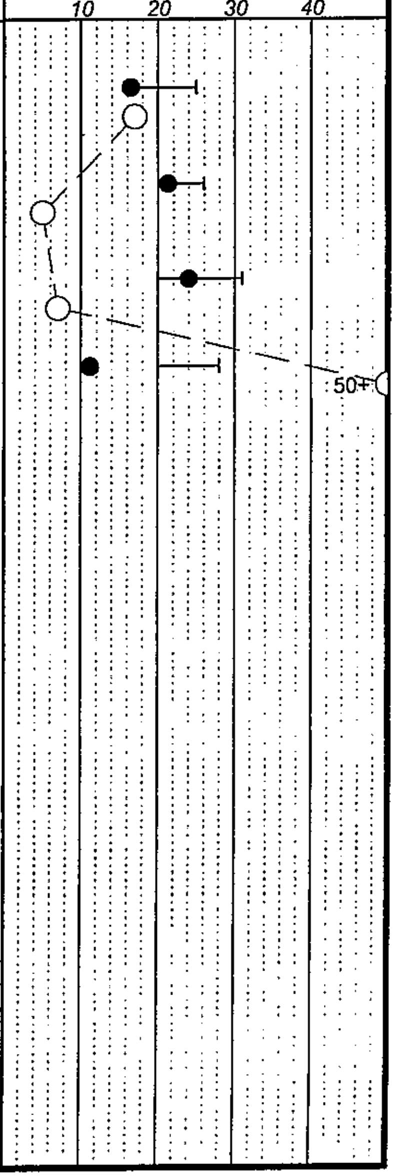
Client: TranSystems, Inc.
Project: SCI-823-0.00
Job No. 0121-3070.03

LOG OF: Boring TR-44
Location: SCI-823.0.00 over Webster St. (Pier)
Date Drilled: 02/02/05

WATER OBSERVATIONS: Water seepage at: None
Water level at completion: 5.0' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetro-meter (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	556.7						Asphalt Concrete Pavement - 12"						
1.0	555.7	9 8 9	16	1		4.0	Hard brown and gray SILT (A-4b), some clay, trace fine to coarse sand; damp.	1	2	–	6	62	29
3.0	553.7	3 2 3	13	2			Loose brown SANDY SILT (A-4a), some gravel, little clay; damp.	22	12	–	12	44	10
5.5	551.2	3 3 4	14	3		2.25	Very stiff brown and gray SILT AND CLAY (A-6a), trace fine sand; moist.	0	3	–	6	61	30
8.0	548.7	26 50/3	8	4			Severely weathered brown SANDSTONE argillaceous, micaceous.	0	1	–	6	70	23
11.0	545.7	Core 108"	Rec 108"	RQD 73%	R-1		Medium hard gray SANDSTONE; very fine to fine grained, highly weathered, argillaceous, micaceous, massively bedded, highly fractured, with typical low angle rust stained fractures.						
12.4	544.3						Medium hard to hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, massively bedded, unfractured to slightly fractured. @ 17.7' to 18.0', broken zone, clay filled. @ 19.0' to 20.0', high angle fractures.						
20		Core 120"	Rec 116"	RQD 92%	R-2		@ 24.2' to 24.6', ferric band.						
30.0	526.7						Bottom of Boring - 30.0'						

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ *LL*
Blows per foot - ○



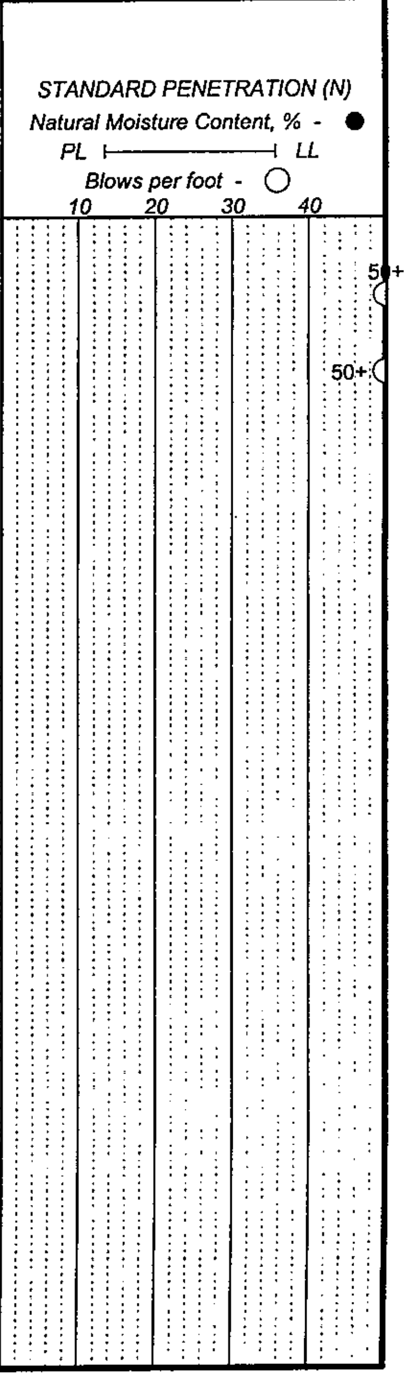
DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

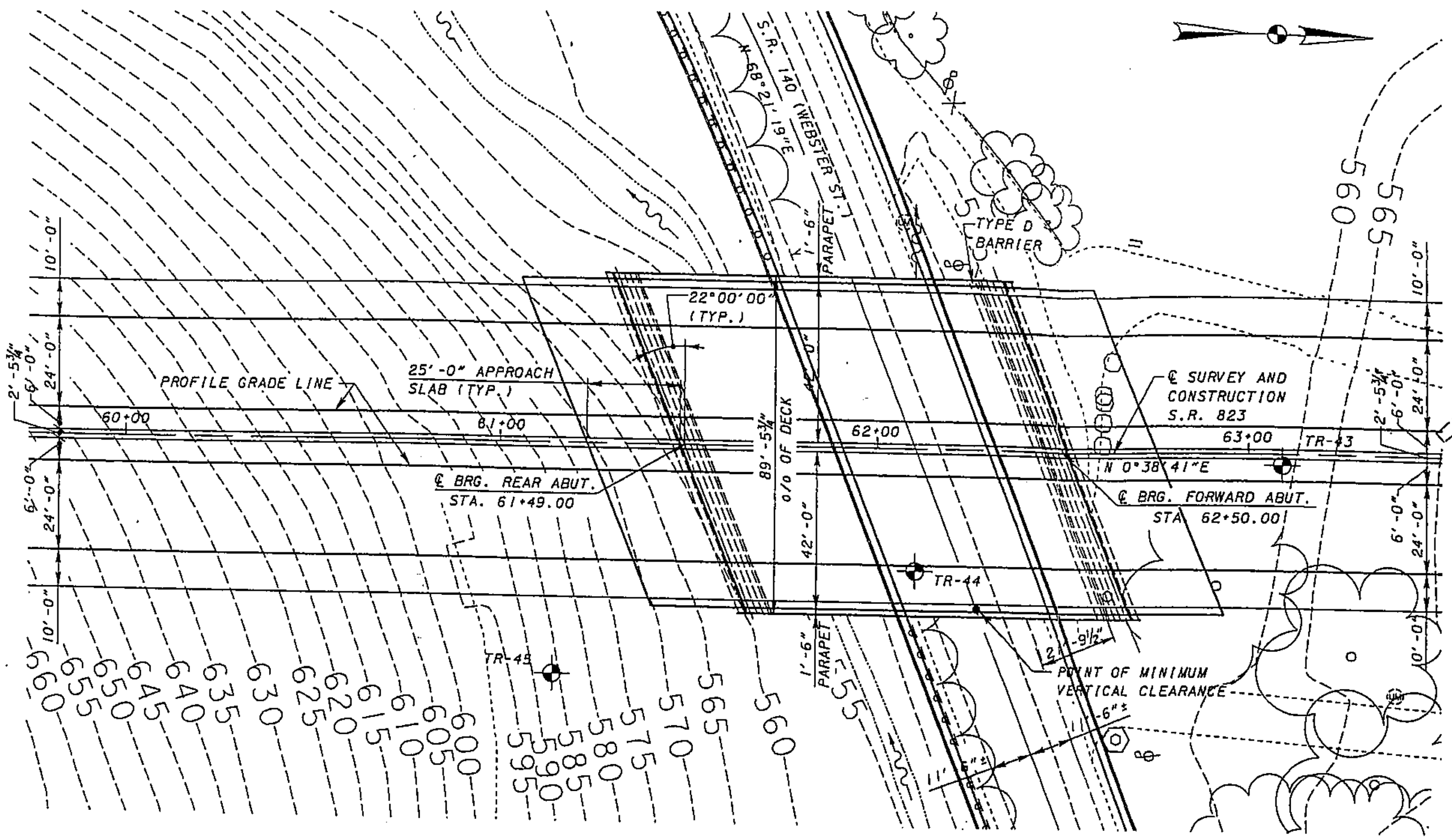
Client: TranSystems, Inc. | *Project:* SCI-823-0.00 | *Job No.* 0121-3070.03

LOG OF: Boring TR-45 | *Location:* SCI-823-0.00 over Webster St. (Rear Abutment) | *Date Drilled:* 02/24/05

WATER OBSERVATIONS: Water seepage at: None
Water level at completion: 6.7' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	596.6						Topsoil - 2"						
0.1	596.5	15 50/4	10	1			Severely weathered brown SANDSTONE argillaceous.						
		50/3	3	2			@ 5.0'-5.1', broken zones.						
5.0	591.6	Core 120"	Rec 120"	RQD 79%	R-1		Soft to medium hard brownish gray SANDSTONE; very fine grained, highly weathered to decomposed, argillaceous, micaceous, massively bedded, highly fractured, with typical low angle rust stained and clay filled fractures. @ 7.4' to 7.6', broken zones. @ 9.3' to 9.6', high angle rust stained fracture. @ 11.1' to 11.4', broken zones. @ 14.2'-14.5', high angle rust stained fracture.						
15.4	581.2	Core 120"	Rec 120"	RQD 100%	R-2		Medium hard to hard gray SANDSTONE; very fine grained, slightly weathered, argillaceous, micaceous, massively bedded, slightly fractured. @ 16.1'-16.3', rust stained zone. @ 17.3', low angle clay filled fracture. @ 20.2', low angle clay filled fracture.						
25.0	571.6						Bottom of Boring - 25.0'						
30													

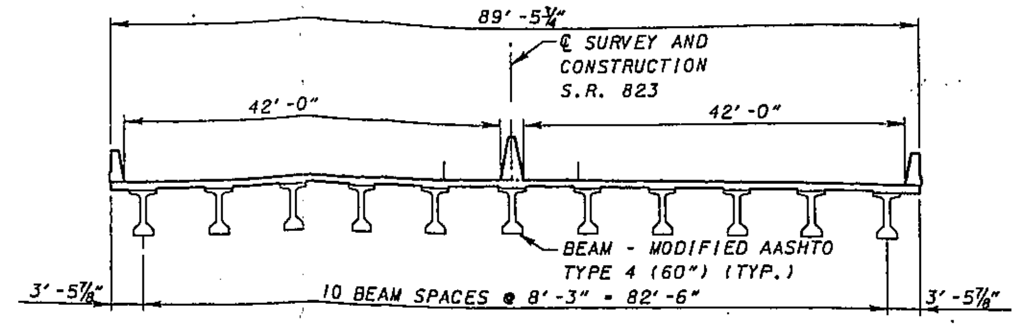




PLAN

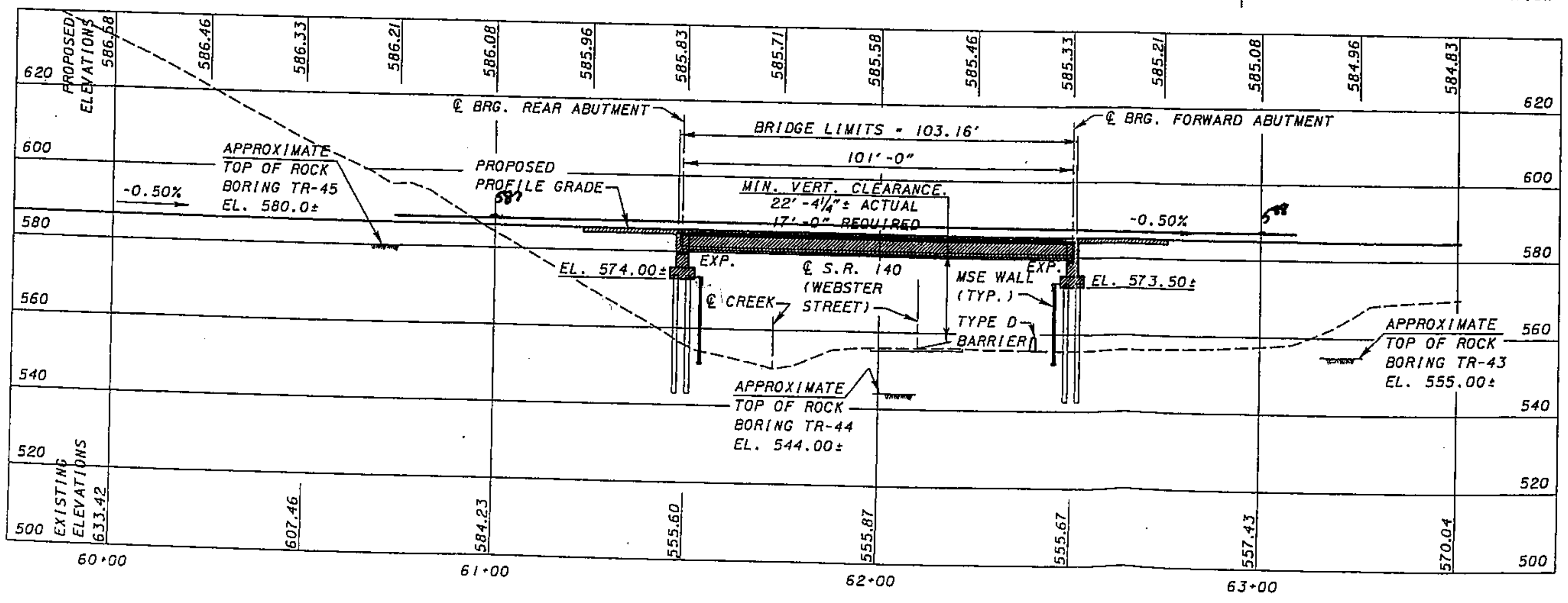
⯐ DENOTES SOIL BORING LOCATION

SUPERSTRUCTURE DATA



STRUCTURE DEPTH

SLAB	-	8½"
HAUNCH	-	2"
BEAM	-	5'-0"
		5'-10½"



ELEVATION ALONG PROFILE GRADE S.R. 823

NOTES:

1. ALL SHEETS WITH PLAN DIMENSIONS ARE SHOWN HORIZONTAL.
2. EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.
3. THE PROPOSED PROFILE GRADE IS WITHIN BRIDGE LIMITS. SEE ROADWAY PLANS FOR PAVEMENT ELEVATIONS BEYOND BRIDGE LIMITS.

FOUNDATION DATA:

ALL NEW PILES SHALL BE HP 12x53 PILES AND HAVE A MAXIMUM CAPACITY OF 70 TONS PER PILE.

DATE: 07/2/2005 FILE: g:\C003\00640\dgs\BTS\04-SR140Webster\823-04spOLALT2.dgn

DESIGN AGENCY

DESIGNED

DRAWN

REVIEWED

DATE

PRELIMINARY SITE PLAN - ALTERNATIVE 2

Soil Parameters Used in MSE Wall Stability Analyses
Morris Lane Blue Run Road

Zone	Soil Type	Unit Weight (pcf)	Strength Parameters			
			Undrained		Drained	
			c	ϕ	c'	ϕ'
Reinforced Fill	Compacted Granular Fill	120	0	34	0	34
Retained Soil	Compacted Embankment Fill	120	0	30	0	30
Foundation Rock (Rear Abutment)	Bedrock	145	NA	NA	NA	NA
Foundation Soil (Forward Abutment) (Borings TR-43 & 44)	Medium Stiff to hard Silt and Clay	125	1750	0	0	29
Foundation Soil (Forward Abutment)	Compacted Granular Fill	125	0	36	0	36

MSE Retaining Wall Parameters and Analyses Results
SR 140 – Webster St. (Rear Abutment)
Bedrock Foundation

Retained Soil (New Embankment)
Unit Weight = 120 pcf
Coefficient of Active Earth Pressure (K_a) = 0.33
(Based on $\Phi = 30^{o}$)

Sliding along base of MSE wall
Sliding Coefficient (μ)(0.67) = tan 36°(0.67) = 0.49
Use (μ)(0.67) =0.55 as a maximum value as per AASHTO, BDM,303.4.1.1

Allowable Bearing Capacity – Undrained Condition
q_{all} = 20,000 psf (approx.)
For MSE wall with minimum 27.0-foot long reinforcing

Allowable Bearing Capacity – Drained Condition
q_{all} = 20,000 psf (approx.)
For MSE wall with minimum 27.0-foot long reinforcing

Global Stability *No Calculations performed – Foundation on Bedrock*
Factor of Safety – Undrained Condition >1.5
Factor of Safety – Drained Condition > 1.5
Factor of Safety – Seismic Condition > 1.3
For MSE wall with 27.0-foot long reinforcing

Estimated Settlement of MSE volume
Total settlement = 0 inches

Full Height of MSE Wall = 33.8 feet
Minimum Embedment Depth = 4.8 feet
Minimum Length of Reinforcement for External Stability = 27.0 feet

MSE Retaining Wall Parameters and Analyses Results
SR 140 – Webster St (Forward Abutment)
Natural Soil Foundation

Retained Soil (New Embankment)
Unit Weight = 120 pcf
Coefficient of Active Earth Pressure (K_a) = 0.33
(Based on $\Phi = 30^{o}$)

Sliding along base of MSE wall
Sliding Coefficient (μ)(0.67) = tan 29°(0.67) = 0.37
Use (μ)(0.67) =0.35 as a maximum value as per AASHTO, BDM,303.4.1.1

Allowable Bearing Capacity – Undrained Condition
q_{all} = 3,676 psf
For MSE wall with minimum 29.6-foot long reinforcing

Allowable Bearing Capacity – Drained Condition
q_{all} = 6,635 psf
For MSE wall with minimum 29.6-foot long reinforcing

Global Stability
Factor of Safety – Undrained Condition = 2.0
Factor of Safety – Drained Condition = 1.7
Factor of Safety – Seismic Condition = 1.6
For MSE wall with 29.6-foot long reinforcing

Estimated Settlement of MSE volume
Total settlement = 1 inches
Differential settlement = 0.1% < 1/100

Full Height of MSE Wall = 33.6 feet
Minimum Embedment Depth = 3.4 feet
Minimum Length of Reinforcement for External Stability = 29.6 feet

MSE Retaining Wall Parameters and Analyses Results
SR 140 – Webster St (Forward Abutment)
Granular Fill Foundation

Retained Soil (New Embankment)
Unit Weight = 120 pcf
Coefficient of Active Earth Pressure (K_a) = 0.33
(Based on $\Phi = 30^o$)

Sliding along base of MSE wall
Sliding Coefficient (μ)(0.67) = tan 36°(0.67) = 0.49
Use (μ)(0.67) =0.55 as a maximum value as per AASHTO, BDM,303.4.1.1

Allowable Bearing Capacity – Undrained Condition
q_{all} = 18,526 psf
For MSE wall with minimum 29.6-foot long reinforcing

Allowable Bearing Capacity – Drained Condition
q_{all} = 18,526 psf
For MSE wall with minimum 29.6-foot long reinforcing

Global Stability
Factor of Safety – Undrained Condition = 2.0
Factor of Safety – Drained Condition = 1.7
Factor of Safety – Seismic Condition = 1.6
For MSE wall with 29.6-foot long reinforcing

Estimated Settlement of MSE volume
Total settlement = 0 inches

Full Height of MSE Wall = 33.6 feet
Minimum Embedment Depth = 3.4 feet
Minimum Length of Reinforcement for External Stability = 29.6 feet

DLZ

SUBJECT

Client	TranSystems ODOT D-9	JOB NUMBER	0121-3070.03
Project	SCI 823-0.00 Portsmouth Bypass	SHEET NO.	OF
Item	MSE Wall Stability	COMP. BY	SJR DATE 05/06/06
09 SCI-823 over SR 140 (Webster St)		CHECKED BY	DATE

Forward Abutment - Native Soils

STABILITY OF MSE WALL

Assumptions:

1 Estimated height of embankment; H=33.6'
2 It is assumed that the bridge is supported on piles
3 Ground water; Dw=0.0'
4 Traffic loading is neglacted in resisting forces
5

Wall Properties

H+D = 37 feet
γ_{mse} = 120 pcf
L = 29.6 feet
L factor = 0.80 Length factor-range (0.7 - 1.0)
ϕ = 30 deg Friction Angle of Embankment Fill

Foundational Soil Properties

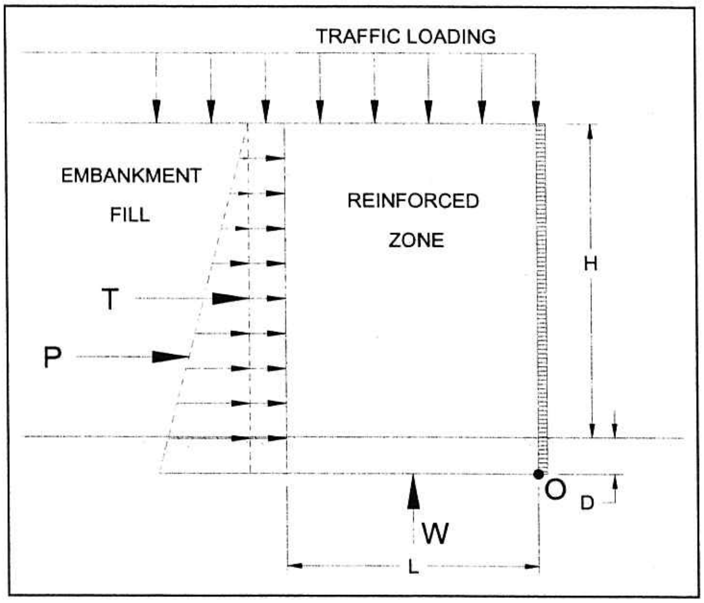
c = 1750 psf Cohesion
ϕ' = 29 deg Friction angle
ω_T = 240 psf Traffic loading

RESISTANCE AGAINST SLIDING ALONG BASE

Thrust: $P_a = K_a\left[\frac{1}{2}\gamma H^2 + \omega_T H\right]$

where; $K_a = \tan^2(45-\frac{\phi}{2})$ K_a = 0.33

P_a = 30,037 lbs per foot of wall



Resistance: $P_r = W(0.67)(\mu)$ (Drained)

where; $\mu = \tan(\phi)$ 0.67μ = 0.37

0.67μ Max. = 0.35 {AASHTO, Bridge Design Manual, 303.4.1.1}

P_r = 45,998 lbs per foot of wall

USE THIS VALUE

$P_r = L(c)$ (Undrained)

P_r = 51,800 lbs per foot of wall

Use Drained Value

$FS = \frac{P_r}{P_a}$

	Calculated	Required	
	FS = **1.53**	FS = 1.50	Resistance Against Sliding is **OK**

RESISTANCE AGAINST OVERTURNING

* Summation of Moments about point "O" (base of wall).

* Traffic loading is neglected in resisting forces

$\Sigma M_{resisting}$ = 1,945,075 lb-ft

$$\Sigma M_{resisting} = \gamma HL\left(\frac{L}{2}\right)$$

$\Sigma M_{overturning}$ = 388,522 lb-ft

$$\Sigma M_{overturnig} = K_a\left[\frac{1}{2}\gamma H^2\left(\frac{H}{3}\right) + \omega_T H\left(\frac{H}{2}\right)\right]$$

$$FS = \frac{\Sigma M_{resisting}}{\Sigma M_{overturnin\ g}}$$

	Calculated	Required	
	FS = **5.01**	FS = 2.00	Resistance Against Overturning is **OK**

DLZ

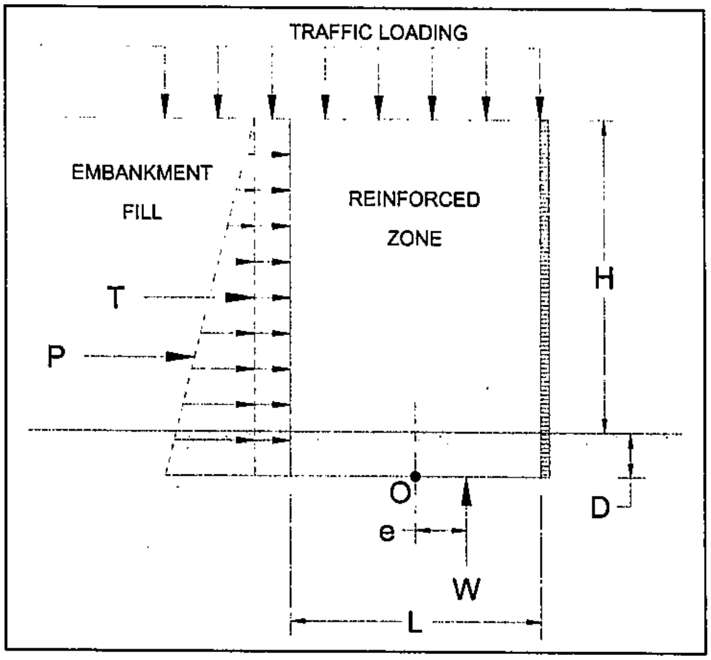
SUBJECT
Client TranSystems
Project SCI 823-0.00 Portsmouth Bypass
Item Bearing Capacity Based on TR-43
09 SCI-823 over SR 140 (Webster St)

JOB NUMBER 0121-3070.03
SHEET NO. OF
COMP. BY SJR DATE 5/6/06
CHECKED BY DATE

Forward Abutment - Native Soils

BEARING CAPACITY OF A MSE WALL

Ref: {AASHTO; STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, 17th Edition, 2002}



Effective Bearing Pressure

$$\sigma_v = \frac{W_t + W_{MSE}}{L - 2e}$$

σ_v = 5,772 psf

Ultimate undrained bearing capacity, q_{ult}

$$q_{ULT} = cN_c + \sigma'_D N_q + \frac{1}{2}\gamma B N_\gamma$$

q_{ULT} = 9,191 psf

$$q_{ALL} = \frac{q_{ULT}}{FS}$$

q_{ALL} = 3,676 psf

Factor of Safety = 1.59 **No Good**

Ultimate drained bearing capacity, q_{ult}

$$q_{ULT} = c'N_c + \sigma'_D N_q + \frac{1}{2}\gamma B N_\gamma$$

q_{ULT} = 16,587 psf

$$q_{ALL} = \frac{q_{ULT}}{FS}$$

q_{ALL} = 6,635 psf

Factor of Safety = 2.87 **OK**

Soil Properties

γ_{EMB}	=	120	pcf	Unit weight	Embankment fill
ϕ'_{EMB}	=	30	deg.	Friction ang.	Embankment fill
γ_{FDN}	=	120	pcf	Unit weight	Foundation soil
c	=	1750	psf	Cohesion	Foundation soil
ϕ	=	0	deg.	Friction ang.	Foundation soil
c'	=	0	psf	Cohesion	Foundation soil
ϕ'	=	29	deg.	Friction ang.	Foundation soil

Loads and Parameters

ω_t	=	240	psf	Traffic loading
L=B	=	29.6	ft	Length of MSE reinforcement
L factor	=	0.8		Length factor-range (0.7 - 1.0)
D	=	3.4	ft	Embedment depth
Dw	=	0	ft	Groundwater depth
H+D	=	37	ft	
H	=	33.6	ft	Height of wall
Ka	=	0.33		
Γ Pa	=	12.333	ft	Moment arm
Γ Wt	=	18.5	ft	Moment arm
B'	=	24.00	ft	
γ'	=	57.6	pcf	
W_t		7,104	lb/ft of wall	Weight from traffic
W_{mse}	=	131,424	lb/ft of wall	Weight from MSE wall

Bearing Capacity Factors for Equations

Undrained		Drained	
N_c	5.14	N_c	27.86
N_q	1.00	N_q	16.44
N_γ	0.00	N_γ	19.34

Eccentricity of Resultant Force

e = 2.80 ft

Kern

e < L/6 = 4.93 ft

DLZ SUBJECT

Client TranSystems ODOT D-9
Project SCI 823-0.00 Portsmouth Bypass
Item MSE Wall Stability
09 SCI-823 over SR 140 (Webster St)

JOB NUMBER 0121-3070.03
SHEET NO. OF
COMP. BY SJR DATE 05/06/06
CHECKED BY DATE

Forward Abutment - Granular Fill

STABILITY OF MSE WALL

Assumptions:

1 Estimated height of embankment; H=33.6'
2 It is assumed that the bridge is supported on piles
3 Ground water; Dw=0.0'
4 Traffic loading is neglacted in resisting forces
5

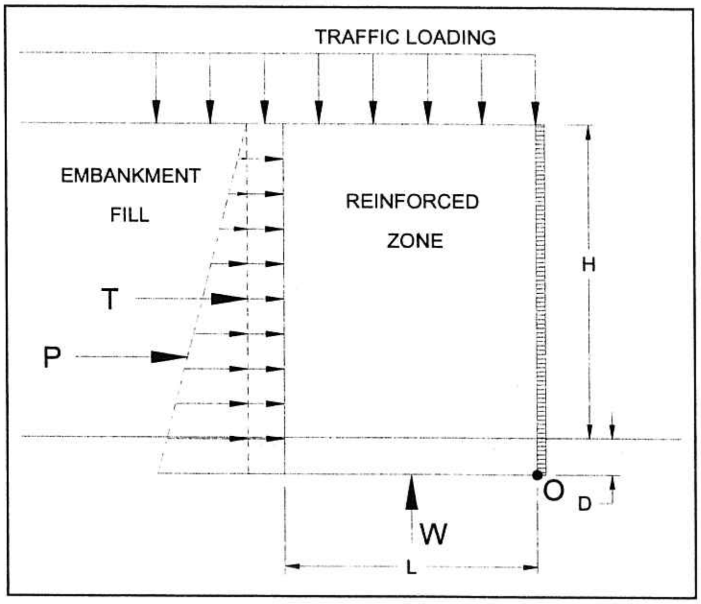
Wall Properties

$H+D$ = 37 feet
γ_{mse} = 120 pcf
L = 29.6 feet
L factor = 0.80
ϕ = 30 deg

Foundational Soil Properties

c = 0 psf Cohesion
ϕ' = 36 deg Friction angle
ω_T = 240 psf Traffic loading
Length factor-range (0.7 - 1.0)
Friction Angle of Embankment Fill

RESISTANCE AGAINST SLIDING ALONG BASE



Thrust: $P_a = K_a\left[\frac{1}{2}\gamma H^2 + \omega_T H\right]$

where; $K_a = \tan^2(45 - \frac{\phi}{2})$ K_a = 0.33

P_a = 30,037 lbs per foot of wall

Resistance: $P_r = W(0.67)(\mu)$ (Drained)

where; $\mu = \tan(\phi)$ 0.67μ = 0.49

0.67μ Max. = 0.55 (AASHTO, Bridge Design Manual, 303.4.1.1)

P_r = 64,398 lbs per foot of wall

USE THIS VALUE

$P_r = L(c)$ (Undrained)

P_r = 0 lbs per foot of wall

Use Drained Value

$FS = \frac{P_r}{P_a}$

Calculated FS = **2.14**

Required FS = 1.50

Resistance Against Sliding is **OK**

RESISTANCE AGAINST OVERTURNING

* Summation of Moments about point "O" (base of wall).
* Traffic loading is neglected in resisting forces

$\Sigma M_{resisting}$ = 1,945,075 lb-ft

$$\Sigma M_{resisting} = \gamma HL\left(\frac{L}{2}\right)$$

$\Sigma M_{overturning}$ = 388,522 lb-ft

$$\Sigma M_{overturning} = K_a\left[\frac{1}{2}\gamma H^2\left(\frac{H}{3}\right) + \omega_T H\left(\frac{H}{2}\right)\right]$$

$$FS = \frac{\Sigma M_{resisting}}{\Sigma M_{overturnin\ g}}$$

Calculated FS = **5.01**

Required FS = 2.00

Resistance Against Overturning is **OK**

DLZ

SUBJECT

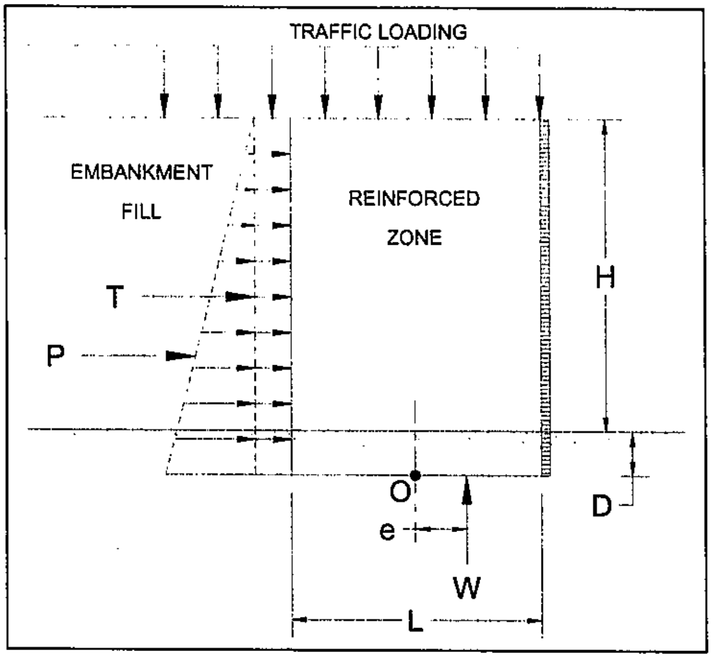
Client TranSystems
Project SCI 823-0.00 Portsmouth Bypass
Item Bearing Capacity Based on TR-43
09 SCI-823 over SR 140 (Webster St)

JOB NUMBER 0121-3070.03
SHEET NO. OF
COMP. BY SJR DATE 5/6/06
CHECKED BY DATE

Forward Abutment - Granular Fill

BEARING CAPACITY OF A MSE WALL

Ref: {AASHTO; STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, 17th Edition, 2002}



Effective Bearing Pressure

$$\sigma_v = \frac{W_t + W_{MSE}}{L-2e}$$

σ_v = 5,772 psf

Ultimate undrained bearing capacity, q_{ult}

$$q_{ULT} = cN_c + \sigma'_D N_q + \frac{1}{2}\gamma' B N_\gamma$$

q_{ULT} = 46,314 psf

$$q_{ALL} = \frac{q_{ULT}}{FS}$$

q_{ALL} = 18,526 psf

Factor of Safety = **8.02** **OK**

Ultimate drained bearing capacity, q_{ult}

$$q_{ULT} = c'N_c + \sigma'_D N_q + \frac{1}{2}\gamma' B N_\gamma$$

q_{ULT} = 46,314 psf

$$q_{ALL} = \frac{q_{ULT}}{FS}$$

q_{ALL} = 18,526 psf

Factor of Safety = **8.02** **OK**

Soil Properties

γ_{EMB}	=	120	pcf	Unit weight	Embankment fill
ϕ'_{EMB}	=	30	deg.	Friction ang.	Embankment fill
γ_{FDN}	=	120	pcf	Unit weight	Foundation soil
c	=	0	psf	Cohesion	Foundation soil
ϕ	=	36	deg.	Friction ang.	Foundation soil
c'	=	0	psf	Cohesion	Foundation soil
ϕ'	=	36	deg.	Friction ang.	Foundation soil

Loads and Parameters

ω_t	=	240	psf	Traffic loading
L=B	=	29.6	ft	Length of MSE reinforcement
L factor	=	0.8		Length factor-range (0.7 - 1.0)
D	=	3.4	ft	Embedment depth
Dw	=	0	ft	Groundwater depth
H+D	=	37	ft	
H	=	33.6	ft	Height of wall
Ka	=	0.33		
Γ Pa	=	12.333	ft	Moment arm
Γ Wt	=	18.5	ft	Moment arm
B'	=	24.00	ft	
γ'	=	57.6	pcf	
W_t		7,104	lb/ft of wall	Weight from traffic
W_{mse}	=	131,424	lb/ft of wall	Weight from MSE wall

Bearing Capacity Factors for Equations

Undrained		Drained	
N_c	50.59	N_c	50.59
N_q	37.75	N_q	37.75
N_γ	56.31	N_γ	56.31

Eccentricity of Resultant Force

e = 2.80 ft

Kern

e < L/6 = 4.93 ft

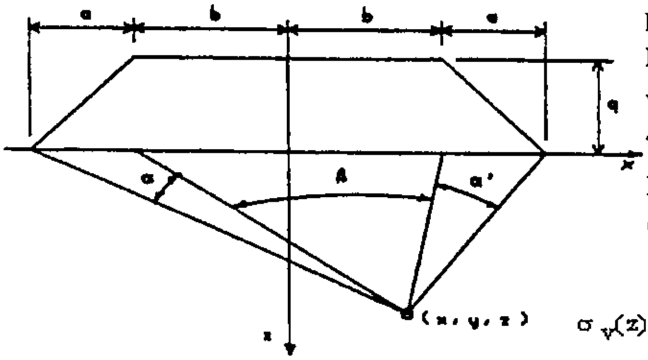
DLZ SUBJECT

Client TranSystems / ODOT D-9
Project SCI-823 Portsmouth Bypass
Item Forward Abutment Settlement

JOB NUMBER
SHEET NO. OF
COMP. BY SJR DATE 05/06/06
CHECKED BY DATE

SETTLEMENT ANALYSIS - EMBANKMENT

Embankment Informaiton:



Groundwater Table:	D=	0.0	ft			
Embankment Height:	H =	33.6	ft			
Fill Unit Weight:	γ_{emb} =	120	pcf	q =	4,032	psf
Width of Slope:	a =	67				
Top half-width of Emb:	b =	75				
Distance from CL:	x =	0				
Output Range:	z =	0	to	7	ft	

**See Data output Attached*

$$\sigma_v(z) := \left(\frac{q}{\pi\,a}\right)\left(a\cdot(\alpha(z)+\beta(z)+\alpha'(z)) + b\cdot(\alpha(z)+\alpha'(z)) + x\cdot(\alpha(z)-\alpha'(z))\right)$$

$$\beta(z) := \operatorname{atan}\left[\frac{(b-x)}{z}\right] + \operatorname{atan}\left[\frac{(b+x)}{z}\right] \qquad \alpha'(z) := \operatorname{atan}\left[\frac{(a+b-x)}{z}\right] - \operatorname{atan}\left[\frac{(b-x)}{z}\right] \qquad \alpha(z) := \operatorname{atan}\left[\frac{(a+b+x)}{z}\right] - \operatorname{atan}\left[\frac{(b+x)}{z}\right]$$

Reference: US Army Corps of Engineers EM 1110-1-1904 "Settlement Analysis", Table C-1

Soil Properites: *Settlement is calculated at mid-point of layer*

									Cohesionless Soils	Cohesive Soils		
No.	Bot. of Laye		Soil Type	γ_{soil} (pcf)	σ'_c (psf)	σ'_o (psf)	$\Delta\sigma z$ (psf)	σ'_f (psf)	C'	C_r	C_c	e_o
1	3.8	ft	Silty Clay	125	4,200	119	4,032	4,151	0.0	0.02	0.00	0.660
2	6.8	ft	Weathered BR	130	5,000	339	4,032	4,371	125.0	0.00	0.00	0.743
3	0.0			0	0							
4	0.0			0	0							
5	0.0			0	0							
6	0.0			0	0							
7	0.0			0	0							
8	0.0			0	0							
9	0.0			0	0							
10	0.0			0	0							

No.	Settlement:		Total Settlement	
1	0.085	ft		
2	0.027	ft	0.111	ft
3				
4				
5			1.3	in
6				
7				
8				
9				
0				

Reference: Geotechnical Engineering Principles and Practices; Coduto, 1999

Overconsolidated Soils - Case I ($\sigma'_0<\sigma'_c$) Eqn:11.24

$$(\delta_c)_{ult} = \Sigma\frac{C_r}{1+e_0}H\log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

Overconsolidated Soils - Case II ($\sigma'_0<\sigma'_c<\sigma_f$) Eqn:11.25

$$(\delta_c)_{ult} = \Sigma\left[\frac{C_r}{1+e_0}H\log\left(\frac{\sigma'_c}{\sigma'_0}\right)+\frac{C_c}{1+e_0}H\log\left(\frac{\sigma'_f}{\sigma'_c}\right)\right]$$

Normally Consolidated Soils ($\sigma'_0=\sigma'_c$) Eqn: 11.23

$$(\delta_c)_{ult} = \Sigma\frac{C_c}{1+e_0}H\log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

Cohesionless Soils ($\sigma'_0=\sigma'_c$)

$$(\delta_c)_{ult} = \Sigma\frac{1}{C'}H\log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

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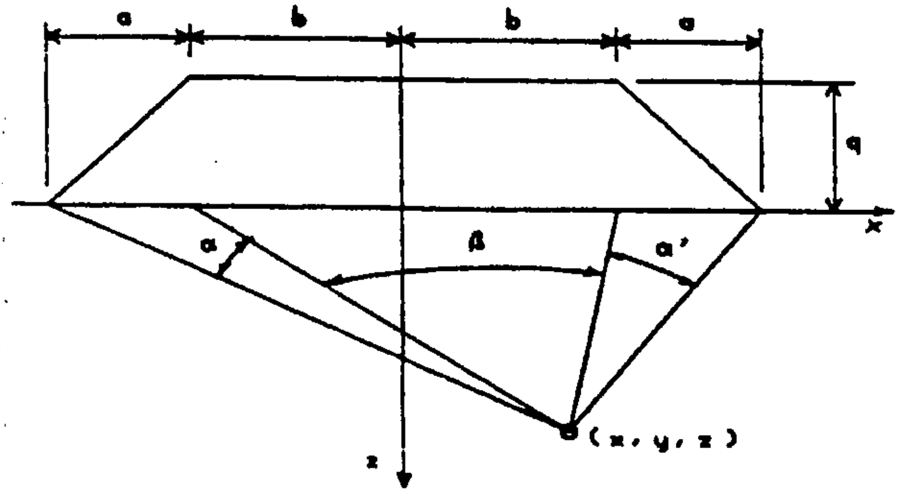
0		CHECKED BY	DATE

INCREASE IN VERTICAL STRESS DUE TO EMBANKMENT LOADING



q = 4032 load

a = 67 width of slope

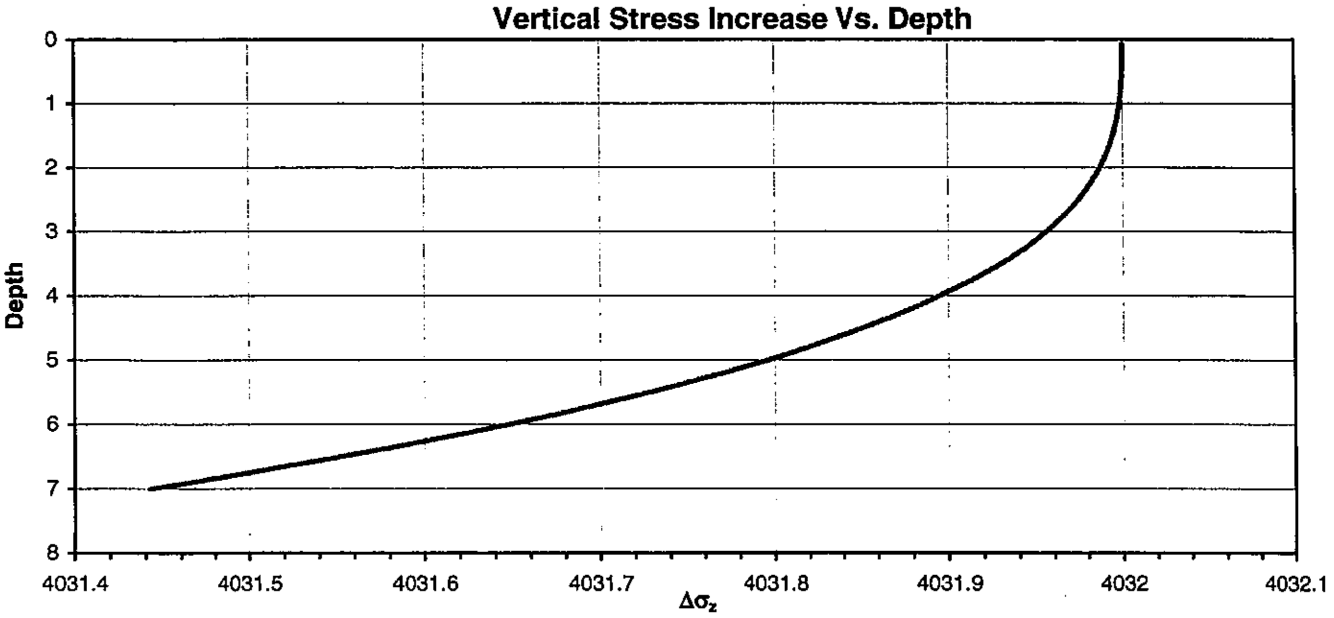
b = 75 top half-width of embankment

x = 0 distance from CL

z = 0 to 7 depth range

$$\sigma_y(z) := \left(\frac{q}{\pi\, a}\right)\left(a\cdot(\alpha(z)+\beta(z)+\alpha'(z))+b\cdot(\alpha(z)+\alpha'(z))+x\cdot(\alpha(z)-\alpha'(z))\right)$$

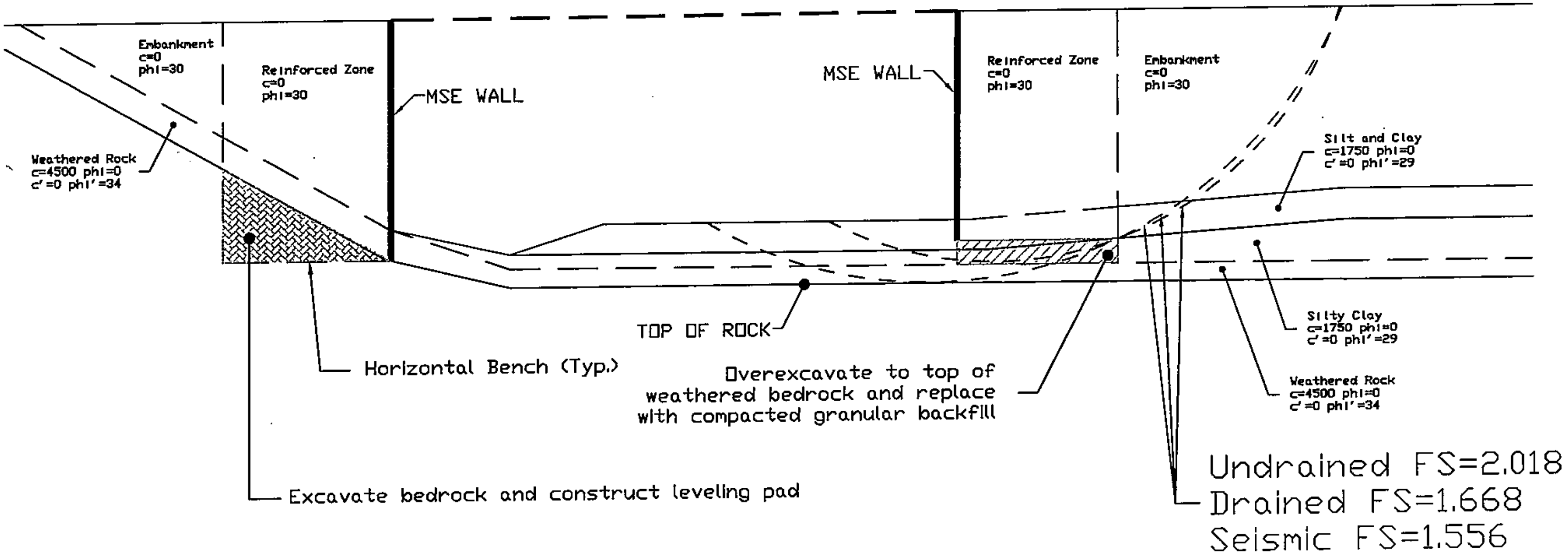
$$\beta(z) := \operatorname{atan}\left[\frac{(b-x)}{z}\right]+\operatorname{atan}\left[\frac{(b+x)}{z}\right] \; ; \quad \alpha'(z) := \operatorname{atan}\left[\frac{(a+b-x)}{z}\right]-\operatorname{atan}\left[\frac{(b-x)}{z}\right] \quad \alpha(z) := \operatorname{atan}\left[\frac{(a+b+x)}{z}\right]-\operatorname{atan}\left[\frac{(b+x)}{z}\right]$$


Vertical Stress Increase Vs. Depth

Reference: US Army Corps of Engineers EM 1110-1-1904 "Settlement Analysis", Table C-1

MSE Wall Stability
SR 140 (Webster St.)
Rear Abutment Sta. 61+54
Based on TR-44 & TR-45
H=33.8′ (full height)
Embedment=4.8′
Length=0.7(H+D)=27.0′

MSE Wall Stability
SR 140 (Webster St.)
Forward Abutment Sta. 62+45
Based on TR-44 & TR-43
H=33.6′ (full height)
Embedment=3.4′
Length=0.8(H+D)=29.6′



SR 140 (WEBSTER ST.)

REAR ABUTMENT STA: 61+54
FORWARD ABUTMENT STA. 62+45

MSE WALL STABILITY ANALYSIS
PRELIMINARY DESIGN ANALYSIS
SCI-823-0. 00

PROJECT NO. 0121-3070. 03	CALC: SJR	DATE 05-06-06

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