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Structure Type Study

SR-823 Mainline Over Norfolk Southern Railway and US-23

SCI-823-0.00
PID No. 19415

Prepared for

Ohio Department of Transportation

July 2005

CH2MHILL

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1. Introduction

Eight (8) alternatives for construction of the proposed SR-823 Mainline bridge over Norfolk Southern (NS) Railway and US-23 are evaluated in this study, and are designated (in no particular order) Alternatives 1 through 8. Where concrete and steel superstructure options are evaluated for the same span arrangement, the alternatives are grouped in pairs: Alternatives 1 and 2 consist of a 4-span layout; Alternatives 3 and 4 consist of a 5-span layout; and Alternatives 5 and 6 consist of a 6-span layout. In each case, the former alternative uses prestressed concrete I-beams, while the latter alternative uses either steel rolled beams or steel plate girders. Finally, Alternative 7 consists of a 3-span layout using steel plate girders, while Alternative 8 consists of a 2-span layout also using steel plate girders. As part of the SCI-823-0.00 project, three roadway alignments, SR-823 Mainline, Ramp B, and Ramp C, pass over the existing double-track NS railroad. Only the SR-823 Mainline bridge continues west across US-23. Due to the close proximity of the three roadway alignments at the proposed railroad crossings, it is important from a construction, maintenance, and overall aesthetic standpoint to use compatible structure types and arrangements for the three bridges. As such, the preferred alternative is based not only on the analysis contained in this report, but also on the pertinent characteristics of the adjacent bridges. The reader is referred to the Structure Type Studies for the other two bridges (under separate cover) for further information regarding those crossings.

The Department should consider performing both a Hydraulic Analysis and Scour Analysis of the proposed bridge structure. Per the Department's new Project Development Process, Step 7 requires that a hydraulic report containing the aforementioned elements be included with the Structure Type Study. Based on the FEMA study, the 100-year flood elevation at the proposed structure is 543 feet, due to backwater from the Scioto River. From such an evaluation, final selection of both the type and the depth of bridge pier foundations could be made.

Each alternative is evaluated with regard to estimated construction cost, projected maintenance costs, horizontal and vertical clearances, aesthetics, constructability, and maintenance of traffic. Based on these evaluations, one alternative is recommended for further design development in the Bridge Preliminary Design Report stage.

2. Design Criteria

All proposed structure types are in accordance with the most current version of the Ohio Department of Transportation Bridge Design Manual and the 2002 AASHTO Standard Specifications for Highway Bridges, 17th edition. Railroad clearances conform to the Norfolk Southern Guidelines for Design of Highway Separation Structures Over Railroad and the 2005 AREMA Manual for Railway Engineering.

3. Bridge Transverse Section and Alignment

At the proposed bridge location, the SR-823 Mainline is on a tangent horizontal alignment. The proposed eastbound section consists of one 16-foot lane, a 6'-1 1/8" left shoulder, and an 8-foot right shoulder. The proposed westbound section also consists of one 16-foot lane, a 6'-1 1/8" left shoulder, and an 8-foot right shoulder. With two 1'-6" wide single slope

outside deflector parapets and a 2'-9 ¾" wide single slope Type B1 median barrier, the out-to-out deck width is a constant 66'-0" for all alternatives. The SR-823 Mainline bridge deck will consist of a 1.6% cross slope.

The existing railroad section consists of two tangent tracks on approximately 26'-6" centers, proceeding north on an approximate 0.3% downgrade. SR-823 Mainline crosses the railway at a skew angle of approximately 22°36'. No modifications to the existing railroad are anticipated as part of the project.

The existing US-23 section consists of approximately two 12-foot lanes in each direction (northbound and southbound), with 8-foot outside shoulders and 4-foot inside shoulders. The depressed median measures approximately 40 feet from inside edge-of-pavement to inside edge-of-pavement. SR-823 Mainline crosses US-23 at an approximate skew angle of 22°40'. The proposed US-23 section consists of the existing section described above, with the addition of a southbound, 12-foot acceleration lane (with an 8-foot shoulder) for traffic exiting westbound SR-823 and merging onto southbound US-23. The design speed for this acceleration lane is 60 mph. Substructures along US-23 for alternatives consisting of spill-through slopes are located outside the minimum preferred horizontal clear zone of 30'-0" to the toe of slope. Substructures consisting of abutments behind MSE walls are located outside the minimum horizontal clear zone width of 8'-0" to the toe of roadway barrier.

4. Proposed Maintenance of Traffic Solution

The proposed SR-823 Mainline alignment will carry traffic both exiting southbound US-23 onto eastbound SR-823 and exiting westbound SR-823 onto southbound US-23. Because the SR-823 Mainline is new construction, maintenance of highway traffic during construction of the bridge will be minimal. With the exception of limited US-23 closure for superstructure beam setting, existing culvert replacement, and US-23 acceleration lane construction, as well as traffic safety precautions throughout bridge construction, no additional maintenance of traffic solutions will need to be investigated.

Coordination with railway traffic below the proposed bridge will be required during construction. All features have been located such that permanent and temporary works will allow uninterrupted train operations during construction of the substructure. However, minor track closures should be expected during construction of the superstructure (e.g., while setting the beams). The Contractor may be required to occupy one or both tracks for a limited time to perform certain construction activities, depending on the means and methods selected. Appropriate railroad flagging and insurance will be required throughout construction.

5. Evaluation of Structure Alternatives

Common Considerations

Construction costs for each alternative have been developed for an identical length of improvement, equal to the out-to-out length of the longest alternative. Estimated construction costs for each alternative include all proposed work between these limits. The roadway profile over the bridge is controlled by global geometric concerns (namely, a -3.00 percent maximum slope criteria and the required profile backstation of the bridge) and not the vertical clearance over the railroad. As such, there is not an opportunity to optimize the

profile for different superstructure depths, and cost differentials due to profile adjustments need not be considered. Costs to relocate utilities, and costs for services or construction to be provided by Norfolk Southern Railway are not included in this document. It is reasonable to assume that these costs will be similar for all alternatives, and would not influence the selection of the preferred alternative.

Railroad horizontal clearance is a primary consideration in determining the possible span arrangements. The following minimum horizontal clearances to the centerline of the nearest track were maintained for all alternatives:

- MSE wall abutments, or piers without crash walls: 25'-0"
- Pier footings: 11'-0" (to allow for temporary shoring)
- Piers with crash walls, or piers of heavy construction: 13'-0"

Piers meeting the AREMA definition of "heavy construction" do not require separate crash walls. The foregoing horizontal clearances allow adequate room to maintain existing railroad drainage. Some minor ditch modifications may be required, but these are not anticipated to impact the railway roadbed nor decrease the existing capacity. It is assumed that situating a pier in the railroad bed between tracks is unacceptable, because it would prevent a third (future) track from being located there. Roadway horizontal clearances were discussed previously in Section 3.

The horizontal clearance constraints imposed by the railroad and by US-23 restrict the range of possible pier locations, and limit the number of feasible span arrangements. The alternatives selected for investigation include main span lengths from 83 feet to 201.5 feet. Both precast concrete and steel beams are evaluated for each span arrangement, except that where span lengths exceed 125 feet, only steel is considered. In addition, unpainted weathering steel is selected in lieu of coated steel, to minimize initial construction and future maintenance costs; this is consistent with the Department's recommendation to use weathering steel anytime over railway crossings. Use of weathering steel is also consistent with the proposed adjacent bridges carrying Ramp B and Ramp C.

The pier shape is influenced by the need to provide a drainage channel underneath the bridge between the railroad and US-23, and also by the aesthetic precedent set by the adjacent bridges carrying Ramp B and Ramp C. Currently, an open channel maintains flow from the outlet of an existing culvert under the railroad to the inlet of an existing culvert under US-23. The proposed interchange geometry requires that the culvert under US-23 be relocated to the south. However, the railroad culvert is expected to serve adequately in its current location. Preservation of the existing railroad culvert is desirable, because of the considerable costs associated with railroad interference during potential relocation of that drainage structure. A clear distance of approximately 15 feet is required between pier columns to provide adequate room for a relocated open channel. Therefore, a double hammerhead-type pier was selected because it provides both a wide column spacing and a style similar to the single hammerheads proposed for the adjacent bridges carrying Ramp B and Ramp C. This pier type also provides a clean, unobtrusive view, while making economical use of materials. It should be noted that the non-continuous cap on a double hammerhead pier requires an even number of beams to be used in the superstructure alternatives. Practically, this limits the typical superstructure section to eight beams at 8'-6"

spacing. Using six beams would require 12'-0" spacing, which is normally not economical for the span lengths under consideration.

The designer has greater flexibility in selecting the abutment type at this site, as opposed to the pier type. Both spill-through type and retained-fill type abutments are feasible for the forward abutment. At the rear abutment location, MSE abutment walls placed less than 25 feet from a track centerline would require a cast-in-place crash wall. The significant expense of building such a wall is not likely to be overcome by the cost savings realized with a nominally shorter superstructure. Therefore, MSE abutment walls within 25 feet of the track centerline are not considered in this study. Based on analysis of similar options for the adjacent ramp bridges (see Structure Type Studies for Ramp B Over NS Railway and Ramp C Over NS Railway, under separate cover), the expense of an MSE wall area will overshadow the benefit in reduced bridge length at this site. In addition, it is aesthetically consistent to use an abutment type similar to the adjacent ramp bridges. Therefore, the rear abutment is limited to the spill-through type for all alternatives. The 22°36'19" skew and total bridge length less than 500 feet permits the use of semi-integral abutments for all alternatives.

As previously mentioned in Section 1, a FEMA study estimates the 100-year flood at elevation 543 feet, due to backwater from the Scioto River. Pier 3, Pier 4, and the forward abutment would be inundated in this event. Pier 1 could also be affected, due to backwater in the existing railroad drainage ditch. It is anticipated that MSE walls at the forward abutment may require specialized fill material, rip-rap, or other means to protect against scour. The Department should consider performing both a Hydraulic Analysis and Scour Analysis to aid in selection of pier foundation details, MSE wall details, and foundation details at the forward abutment.

Alternative 1

Alternative 1 is a prestressed concrete beam bridge with four spans of 83'-0", 118'-6", 118'-6", and 83'-0" center-to-center of bearings (70% end span-to-middle span ratio). The semi-integral rear abutment is on steel H-piles behind a spill-through 2:1 slope. The semi-integral forward abutment is on a spread footing behind an MSE wall. In the Preliminary Design Report submission, the footing width will need to be sized accordingly to satisfy the maximum bearing pressure of 4,000 psf, as required by the AASHTO specifications and ODOT Bridge Design Manual. The double hammerhead piers rest on steel H-pile-supported rectangular footings. All piles will be driven to bedrock. The superstructure consists of eight 66"-deep AASHTO Type 4 Modified prestressed concrete beams spaced at 8'-6" on center.

The initial bridge construction cost for Alternative 1 is estimated to be $4,201,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $1,437,000, resulting in a total estimated ownership cost of $5,638,000 in year 2008 dollars.

Alternative 2

Alternative 2 is identical to Alternative 1, except that the superstructure consists of eight high-strength plate girders with 48-inch webs spaced at 8'-6" on center.

The initial bridge construction cost for Alternative 2 is estimated to be $3,736,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $1,301,000, resulting in a total estimated ownership cost of $5,037,000 in year 2008 dollars.

Alternative 3

Alternative 3 is a prestressed concrete beam bridge with five spans of 71'-0", 83'-0", 83'-0", 83'-0", and 83'-0" center-to-center of bearings. The semi-integral rear abutment is on steel H-piles behind a spill-through 2:1 slope. The semi-integral forward abutment is on a spread footing behind an MSE wall. In the Preliminary Design Report submission, the footing width will need to be sized accordingly to satisfy the maximum bearing pressure of 4,000 psf, as required by the AASHTO specifications and ODOT Bridge Design Manual. The double hammerhead piers rest on steel H-pile-supported rectangular footings. All piles will be driven to bedrock. The superstructure consists of eight 45"-deep AASHTO Type 3 prestressed concrete beams spaced at 8'-6" on center.

The initial bridge construction cost for Alternative 3 is estimated to be $3,913,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $1,389,000, resulting in a total estimated ownership cost of $5,302,000 in year 2008 dollars.

Alternative 4

Alternative 4 is identical to Alternative 3, except that the superstructure consists of eight high-strength W33 rolled beams spaced at 8'-6" on center.

The initial bridge construction cost for Alternative 4 is estimated to be $3,563,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $1,301,000, resulting in a total estimated ownership cost of $4,864,000 in year 2008 dollars.

Alternative 5

Alternative 5 is a prestressed concrete beam bridge with six spans of 71'-0", 83'-0", 83'-0", 83'-0", 83'-0", and 71'-0" center-to-center of bearings (86% end span-to-middle span ratio). Both abutments are on steel H-piles behind a spill-through 2:1 slope. The double hammerhead piers rest on steel H-pile-supported rectangular footings. All piles will be driven to bedrock. The superstructure consists of eight 45"-deep AASHTO Type 3 prestressed concrete beams spaced at 8'-6" on center.

The initial bridge construction cost for Alternative 5 is estimated to be $4,292,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $1,614,000, resulting in a total estimated ownership cost of $5,906,000 in year 2008 dollars.

Alternative 6

Alternative 6 is identical to Alternative 5, except that the superstructure consists of eight high-strength W33 rolled beams spaced at 8'-6" on center.

The initial bridge construction cost for Alternative 6 is estimated to be $3,872,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $1,509,000, resulting in a total estimated ownership cost of $5,381,000 in year 2008 dollars.

Alternative 7

Alternative 7 is a steel plate girder bridge with 3 spans of 150'-0", 170'-0", and 150'-0" center-to-center of bearings (88% end span-to-middle span ratio). Both abutments are on steel H-piles behind a spill-through 2:1 slope. The double hammerhead piers rest on steel H-pile-supported rectangular footings. All piles will be driven to bedrock. The superstructure consists of eight 66"-deep high-strength plate girders spaced at 8'-6" on center.

The initial bridge construction cost for Alternative 7 is estimated to be $4,111,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $1,498,000, resulting in a total estimated ownership cost of $5,609,000 in year 2008 dollars.

Alternative 8

Alternative 8 is a steel plate girder bridge with 2 spans of 201'-6" and 201'-6" center-to-center of bearings. The semi-integral rear abutment is on steel H-piles behind a spill-through 2:1 slope. The semi-integral forward abutment is on a spread footing behind an MSE wall. In the Preliminary Design Report submission, the footing width will need to be sized accordingly to satisfy the maximum bearing pressure of 4,000 psf, as required by the AASHTO specifications and ODOT Bridge Design Manual. The double hammerhead pier rests on steel H-pile-supported rectangular footings. All piles will be driven to bedrock. The superstructure consists of eight 78"-deep high-strength plate girders spaced at 8'-6" on center.

The initial bridge construction cost for Alternative 8 is estimated to be $4,429,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $1,301,000, resulting in a total estimated ownership cost of $5,730,000 in year 2008 dollars.

6. Recommended Alternative

Eight (8) structural solutions for the construction of the proposed SR-823 Mainline bridge over Norfolk Southern Railway and US-23 have been evaluated in this Structure Type Study. All alternatives provide comparable operational characteristics and meet minimum horizontal and vertical clearance requirements. Alternative 4 offers the following desirable attributes:

- Lowest initial construction cost
- Lowest total ownership costs
- Pier placement facilitates relocation of stream channel between pier columns
- Weathering steel girders consistent with proposed adjacent ramp bridges (similar aesthetic look)

Based on the foregoing advantages, **CH2M HILL recommends that the five-span bridge of ALTERNATIVE 4 be constructed for the bridge carrying SR-823 Mainline over Norfolk Southern Railway and US-23.**

7. Subsurface Conditions and Foundation Recommendation

Subsurface investigations for the SCI-823-0.00 project will be conducted in two, possibly three, phases. The first mobilization is complete, and included all of the proposed pavement and embankment borings, and a limited number of bridge borings. The second mobilization will include the remaining bridge borings (if necessary), and the majority of the proposed MSE retaining wall borings. If required, a third mobilization will target specific boring locations or in-situ testing recommended in the bridge and retaining wall Preliminary Design Report submissions.

Four borings at the SR-823 Mainline bridge over Norfolk Southern Railway and US-23 were taken during the first mobilization. Based on these initial borings, geotechnical subconsultant DLZ has made preliminary foundation recommendations. A copy of the preliminary report is included with this submission.

The recommended alternative, Alternative 4, consists of a semi-integral forward abutment on a spread footing behind an MSE wall. The spread footing is assumed to rest directly on the MSE select granular fill to avoid conflicts with the MSE reinforcing straps. If pile foundations are required and used, the piles are envisioned to be HP 14x73 H-pile sections driven to bedrock. The final pile arrangement should consider avoiding potential conflicts with typical MSE reinforcing strap patterns. The semi-integral rear abutment is supported by piles behind a spill-through 2:1 slope. Piles will be HP 14x73 driven to bedrock, with the front row battered. Each pier is supported by HP 14x73 piles driven to bedrock. The pile layout is envisioned to consist of three pile rows, with the outer piles being battered to resist horizontal loads. An alternative to driven H-piles would be the use of drilled shafts extending to bedrock.

Final foundation size, capacity, and possible pile length recommendations will be made upon completion of the remaining bridge and retaining wall borings, and will be included with the bridge Preliminary Design Report submission.

APPENDIX A

Cost Comparison Summary

SCI-823-0.00

SCI-823 Over Norfolk Southern RR and US-23

STRUCTURE TYPE STUDY

Filename: \\aries\proj\TranSystems\319861\19415\structures documents\Step 7 - Type Study\Bridge SCI823-1601C 823 over Railroad_US23\[1601C Cost Comp.xls]Alternative Summary

By: WRT/SKT Date: 07/08/2005

Checked: Date:

COST COMPARISON SUMMARY

Alternative No.	Span Arrangement No. Spans	Span Arrangement Lengths	Framing Alternative	Proposed Stringer Section	Total Initial Superstructure Cost	Total Initial Substructure Cost	Total Initial Construction Cost	Superstructure Life Cycle Maintenance Cost	Total Relative Ownership Cost
1	4	83 - 118.5 - 118.5 - 83	8 ~ P.S. Concrete I-Beams	AASHTO Type 4 Mod. (66")	$2,058,000	$934,000	$4,201,000	$1,437,000	**$5,638,000**
2	4	83 - 118.5 - 118.5 - 83	8 ~ Steel Plate Girders	48" Web - Grade 50	$1,716,000	$942,000	$3,736,000	$1,301,000	**$5,037,000**
3	5	71 - 83 - 83 - 83 - 83	8 ~ P.S. Concrete I-Beams	AASHTO Type 3	$1,678,000	$1,107,000	$3,913,000	$1,389,000	**$5,302,000**
4	5	71 - 83 - 83 - 83 - 83	8 ~ Steel Rolled Beams	W33 - Grade 50	$1,420,000	$1,114,000	$3,563,000	$1,301,000	**$4,864,000**
5	6	71 - 83 - 83 - 83 - 83 - 71	8 ~ P.S. Concrete I-Beams	AASHTO Type 3	$1,968,000	$1,116,000	$4,292,000	$1,614,000	**$5,906,000**
6	6	71 - 83 - 83 - 83 - 83 - 71	8 ~ Steel Rolled Beams	W33 - Grade 50	$1,659,000	$1,123,000	$3,872,000	$1,509,000	**$5,381,000**
7	3	150 - 170 - 150	8 ~ Steel Plate Girders	66" Web - Grade 50	$2,293,000	$658,000	$4,111,000	$1,498,000	**$5,609,000**
8	2	201.5 - 201.5	8 ~ Steel Plate Girders	78" Web - Grade 50	$2,521,000	$635,000	$4,429,000	$1,301,000	**$5,730,000**

SCI-823-0.00

SCI-823 Over Norfolk Southern RR and US-23

STRUCTURE TYPE STUDY

Filename: \\aries\proj\TranSystems\319861\19415\structures documents\Step 7 - Type Study\Bridge SCI823-1601C 823 over Railroad_US23\[1601C Cost Comp.xls]Alternative Summary
By: WRT/SKT Date: 07/08/2005
Checked: Date:

ALTERNATIVE COST SUMMARY

Alternative No.	Span Arrangement No. Spans	Lengths	Total Span Length (ft.)	Framing Alternative	Proposed Stringer Section	Subtotal Superstructure Cost	Subtotal Substructure Cost	Approach Roadway Length (1)	Approach Roadway Cost (2, 3)	Profile Adjustment Cost (7)	Structure Incidental Cost (16%)	Structure Contingency Cost (20%)	Roadway Incidental & Contingency Cost (30%)	Total Initial Construction Cost	Superstructure Life Cycle Maintenance Cost	Total Relative Ownership Cost
1	4	83 - 118.5 - 118.5 - 83	403.00	8 ~ P.S. Concrete I-Beams	AASHTO Type 4 Mod. (66")	$2,058,000	$934,000	71.0	$28,000	$0	$479,000	$694,200	$8,000	$4,201,000	$1,437,000	$5,638,000
2	4	83 - 118.5 - 118.5 - 83	403.00	8 ~ Steel Plate Girders	48" Web - Grade 50	$1,716,000	$942,000	71.0	$28,000	$0	$425,000	$616,600	$8,000	$3,736,000	$1,301,000	$5,037,000
3	5	71 - 83 - 83 - 83 - 83	403.00	8 ~ P.S. Concrete I-Beams	AASHTO Type 3	$1,678,000	$1,107,000	71.0	$28,000	$0	$446,000	$646,200	$8,000	$3,913,000	$1,389,000	$5,302,000
4	5	71 - 83 - 83 - 83 - 83	403.00	8 ~ Steel Rolled Beams	W33 - Grade 50	$1,420,000	$1,114,000	71.0	$28,000	$0	$405,000	$587,800	$8,000	$3,563,000	$1,301,000	$4,864,000
5	6	71 - 83 - 83 - 83 - 83 - 71	474.00	8 ~ P.S. Concrete I-Beams	AASHTO Type 3	$1,968,000	$1,116,000	0.0	$0	$0	$493,000	$715,400	$0	$4,292,000	$1,614,000	$5,906,000
6	6	71 - 83 - 83 - 83 - 83 - 71	474.00	8 ~ Steel Rolled Beams	W33 - Grade 50	$1,659,000	$1,123,000	0.0	$0	$0	$445,000	$645,400	$0	$3,872,000	$1,509,000	$5,381,000
7	3	150 - 170 - 150	470.00	8 ~ Steel Plate Girders	66" Web - Grade 50	$2,293,000	$658,000	4.0	$2,000	$0	$472,000	$684,600	$1,000	$4,111,000	$1,498,000	$5,609,000
8	2	201.5 - 201.5	403.00	8 ~ Steel Plate Girders	78" Web - Grade 50	$2,521,000	$635,000	71.0	$28,000	$0	$505,000	$732,200	$8,000	$4,429,000	$1,301,000	$5,730,000

NOTES:

1. Approach roadway length equals the difference between the maximum bridge length and the bridge length for the alternative being considered.

2. Use 2004 pavement cost = $33.20 /sq. yd. Allow 3.5% escalation for years 2005 - 2008 2008 Unit Cost = $38.10 /sq. yd.

   Pavement Widths:

Alternative	Average Rear Approach		Average Fwd. Approach		Combined Average	
Alt. 1	66.00	ft.	66.00	ft.	66.00	ft.
Alt. 2	66.00	ft.	66.00	ft.	66.00	ft.
Alt. 3	66.00	ft.	66.00	ft.	66.00	ft.
Alt. 4	66.00	ft.	66.00	ft.	66.00	ft.
Alt. 5	66.00	ft.	66.00	ft.	66.00	ft.
Alt. 6	66.00	ft.	66.00	ft.	66.00	ft.
Alt. 7	66.00	ft.	66.00	ft.	66.00	ft.
Alt. 7	66.00	ft.	66.00	ft.	66.00	ft.

3. Use 2004 Concrete Barrier, Single Slope, Type B1 cost = $50.30 /ft.
   Allow 3.5% escalation for years 2005 - 2008 2008 Unit Cost = $57.70 /ft.

4. Structure incidental cost allowance includes provision for structure excavation, porous backfill & drainage pipe, sealing of concrete surfaces, structural steel painting, bearings, (minor) temporary shoring, crushed aggregate slope protection, pile driving equipment mobilization, shear connectors, settlement platforms, expansion joints, joint sealers, and joint fillers costs.

5. Roadway incidental cost allowance includes provision for drainage, maintenance of traffic, and traffic control costs.

6. Estimated construction cost does not include existing structure removal, which should be quantified separately, if required.

7. Minimum vertical clearance criteria, either over the railroad or over US-23, do not control the roadway profile across this bridge. Therefore, no profile adjustments have been considered.

Alternative	Vertical Clearance Provided @ NS RR (ft.)	Vertical Clearance Provided @ US-23 (ft.)	Profile Adjustment Permitted (ft.)
Alt. 1	25.85	27.39	0.00
Alt. 2	27.14	28.89	0.00
Alt. 3	27.60	29.14	0.00
Alt. 4	28.77	30.31	0.00
Alt. 5	27.60	29.14	0.00
Alt. 6	28.77	30.31	0.00
Alt. 7	25.77	27.31	0.00
Alt. 8	24.68	26.22	0.00

SCI-823-0.00

SCI-823 Over Norfolk Southern RR and US-23

STRUCTURE TYPE STUDY

Filename: \\aries\proj\TranSystems\319861\19415\structures documents\Step 7 - Type Study\Bridge SCI823-1601C 823 over Railroad_US23\[1601C Cost Comp.xls]Alternative Summary
By: WRT/SKT Date: 07/08/2005
Checked: Date:

SUPERSTRUCTURE

Alternative No.	Span Arrangement No. Spans	Lengths	Total Span Length (ft.)	Deck Length (ft.)	Deck Area (sq. ft.)	Deck Volume (cu. yd.)	Deck Concrete Cost	Deck Reinforcing Cost	Approach Slab Cost	Framing Alternative	Proposed Stringer Section	Structural Steel Weight (pounds)	Structural Steel Cost	Prestressed Girder Cost	Initial Superstructure Cost
1	4	83 - 118.5 - 118.5 - 83	403.00	405.00	26,700	1,039	$623,100	$260,500	$60,500	8 ~ P.S. Concrete I-Beams	AASHTO Type 4 Mod. (66")	0	$0	$1,114,300	**$2,058,000**
2	4	83 - 118.5 - 118.5 - 83	403.00	405.00	26,700	1,039	$623,100	$260,500	$60,500	8 ~ Steel Plate Girders	48" Web - Grade 50	640800	$772,100	$0	**$1,716,000**
3	5	71 - 83 - 83 - 83 - 83	403.00	405.00	26,700	1,039	$623,100	$260,500	$60,500	8 ~ P.S. Concrete I-Beams	AASHTO Type 3	0	$0	$734,300	**$1,678,000**
4	5	71 - 83 - 83 - 83 - 83	403.00	405.00	26,700	1,039	$623,100	$260,500	$60,500	8 ~ Steel Rolled Beams	W33 - Grade 50	560700	$476,100	$0	**$1,420,000**
5	6	71 - 83 - 83 - 83 - 83 - 71	474.00	476.00	31,400	1,221	$732,300	$306,100	$60,500	8 ~ P.S. Concrete I-Beams	AASHTO Type 3	0	$0	$868,700	**$1,968,000**
6	6	71 - 83 - 83 - 83 - 83 - 71	474.00	476.00	31,400	1,221	$732,300	$306,100	$60,500	8 ~ Steel Rolled Beams	W33 - Grade 50	659400	$559,900	$0	**$1,659,000**
7	3	150 - 170 - 150	470.00	472.00	31,200	1,210	$726,200	$303,500	$60,500	8 ~ Steel Plate Girders	66" Web - Grade 50	998400	$1,203,000	$0	**$2,293,000**
8	2	201.5 - 201.5	403.00	405.00	26,700	1,039	$623,100	$260,500	$60,500	8 ~ Steel Plate Girders	78" Web - Grade 50	1308300	$1,576,400	$0	**$2,521,000**

Deck Cross-Sectional Area:

Parapets:

	No.	Individual Area (sq. ft.)	Parapet Area (sq. ft.)
Parapets	2	4.26	8.52
Median	1	9.29	9.29

Slab:

	T (ft.)	Ave. W (ft.)	Slab Area	Haunch & Overhang Area	Total Concrete Area (sq. ft.)
Alt. 1	0.71	66.00	46.8	4.7	69.2
Alt. 2	0.71	66.00	46.8	4.7	69.2
Alt. 3	0.71	66.00	46.8	4.7	69.2
Alt. 4	0.71	66.00	46.8	4.7	69.2
Alt. 5	0.71	66.00	46.8	4.7	69.2
Alt. 6	0.71	66.00	46.8	4.7	69.2
Alt. 7	0.71	66.00	46.8	4.7	69.2
Alt. 8	0.71	66.00	46.8	4.7	69.2

Note: Deck width measured as average width.
10% of deck area allowed for haunches and overhangs (excludes slab alternative).

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 for concrete or steel girder bridges
230 lbs of reinforcing steel per cubic yard of deck concrete for slab bridges

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

Prestressed Concrete Girders
Unit Costs:

	Year 2004		Annual Escalation	Year 2008		No. Required
Alt. 1						
AASHTO Type IV Modified Beams						
Type 4 I-Beams (66")	$26,000	ea.	3.5%	$29,840	ea.	32
Pier Diaphragms	$1,800	ea.	3.5%	$2,070	ea.	21
Abutment Diaphragms	$1,200	ea.	3.5%	$1,380	ea.	0
Intermediate Diaphragms	$1,200	ea.	3.5%	$1,380	ea.	84
Alt. 3						
AASHTO Type 3 Beams						
Type 3 I-Beams (45")	$12,000	ea.	3.5%	$13,770	ea.	40
Pier Diaphragms	$1,800	ea.	3.5%	$2,070	ea.	28
Abutment Diaphragms	$1,200	ea.	3.5%	$1,380	ea.	0
Intermediate Diaphragms	$1,200	ea.	3.5%	$1,380	ea.	91
Alt. 5						
AASHTO Type 3 Beams						
Type 3 I-Beams (45")	$12,000	ea.	3.5%	$13,770	ea.	48
Pier Diaphragms	$1,800	ea.	3.5%	$2,070	ea.	35
Abutment Diaphragms	$1,200	ea.	3.5%	$1,380	ea.	0
Intermediate Diaphragms	$1,200	ea.	3.5%	$1,380	ea.	98

Structural Steel
Unit Costs ($/lb.):

	Cost Ratio	Year 2004	Annual Escalation	Year 2008
Rolled Beams - Grade 50	n/a	$0.74	3.5%	$0.85
Plate Girders - Grade 50	n/a	$1.05	3.5%	$1.20
Hybrid Plate Girders - Grade 50/70W	1.10	$1.16	3.5%	$1.33

Note - structural steel weight is estimated at:
24 pounds per each square foot of bridge deck area for Alt. 2.
21 pounds per each square foot of bridge deck area for Alt. 4 & Alt. 6.
32 pounds per each square foot of bridge deck area for Alt. 7.
49 pounds per each square foot of bridge deck area for Alt. 8.

Reinforced Concrete Approach Slabs (T=15")
Unit Cost ($/sq. yd.):

Alt. 1 - 8
Length = 25 ft. Width = 66.00 ft
Area = 183 sq. yd.

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

SCI-823-0.00

SCI-823 Over Norfolk Southern RR and US-23

STRUCTURE TYPE STUDY

Filename: \\aries\proj\TranSystems\319861\19415\structures documents\Step 7 - Type Study\Bridge SCI823-1601C 823 over Railroad_US23\[1601C Cost Comp.xls]Alternative Summary
By: WRT/SKT Date: 07/08/2005
Checked: Date:

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 Abutment & Wingwall Cost	Temporary Shoring Cost	Initial Substructure Cost
1	4	83 - 118.5 - 116.5 - 83	8 - P.S. Concrete I-Beams	AASHTO Type 4 Mod. (66")	$306,300	$89,600	$161,800	$26,500	$138,600	$209,600	$21,500	**$934,000**
2	4	83 - 118.5 - 116.5 - 83	8 - Steel Plate Girders	48" Web - Grade 50	$313,600	$71,400	$152,100	$24,900	$138,600	$219,600	$21,500	**$942,000**
3	5	71 - 83 - 83 - 83 - 83	8 - P.S. Concrete I-Beams	AASHTO Type 3	$417,800	$95,100	$152,100	$24,900	$168,500	$219,800	$26,900	**$1,107,000**
4	5	71 - 83 - 83 - 83 - 83	8 - Steel Rolled Beams	W33 - Grade 50	$422,900	$96,300	$143,400	$23,500	$168,500	$230,000	$26,900	**$1,114,000**
5	6	71 - 83 - 83 - 83 - 83 - 71	8 - P.S. Concrete I-Beams	AASHTO Type 3	$516,500	$117,600	$155,000	$25,400	$272,500	$0	$26,900	**$1,116,000**
6	6	71 - 83 - 83 - 83 - 83 - 71	8 - Steel Rolled Beams	W33 - Grade 50	$522,500	$119,000	$155,000	$25,400	$272,500	$0	$26,900	**$1,123,000**
7	3	150 - 170 - 150	8 - Steel Plate Girders	66" Web - Grade 50	$212,700	$48,400	$163,300	$26,800	$188,300	$0	$18,700	**$658,000**
8	2	201.5 - 201.5	8 - Steel Plate Girders	78" Web - Grade 50	$113,400	$25,800	$172,000	$26,200	$93,300	$201,800	$0	**$635,000**

Pier QC/QA Concrete, Class QSC1 Cost:

Alt 1; (Pier 1 - Pier 3)

	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Cap	233.4	$421.00	3.5%	$483.00	$112,730
Stem	256.8	$421.00	3.5%	$483.00	$124,030
Footings	144.6	$421.00	3.5%	$483.00	$69,550
Total Pier Cost					$306,300

Alt 2; (Pier 1 - Pier 3)

	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Cap	233.4	$421.00	3.5%	$483.00	$112,730
Stem	271.8	$421.00	3.5%	$483.00	$131,280
Footings	144.0	$421.00	3.5%	$483.00	$69,550
Total Pier Cost					$313,600

Alt 3; (Pier 1 - Pier 4)

	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Cap	317.8	$421.00	3.5%	$483.00	$153,500
Stem	355.1	$421.00	3.5%	$483.00	$171,510
Footings	192.0	$421.00	3.5%	$483.00	$92,740
Total Pier Cost					$417,800

Alt 4; (Pier 1 - Pier 4)

	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Cap	310.0	$421.00	3.5%	$483.00	$149,730
Stem	373.5	$421.00	3.5%	$483.00	$180,400
Footings	192.0	$421.00	3.5%	$483.00	$92,740
Total Pier Cost					$422,900

Alt 5; (Pier 1 - Pier 5)

	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Cap	397.5	$421.00	3.5%	$483.00	$191,990
Stem	431.8	$421.00	3.5%	$483.00	$208,560
Footings	240.0	$421.00	3.5%	$483.00	$115,920
Total Pier Cost					$516,500

Alt 6; (Pier 1 - Pier 5)

	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Cap	386.5	$421.00	3.5%	$483.00	$186,680
Stem	455.2	$421.00	3.5%	$483.00	$219,860
Footings	240.0	$421.00	3.5%	$483.00	$115,920
Total Pier Cost					$522,500

Alt 7; (Pier 1 - Pier 2)

	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Cap	153.9	$421.00	3.5%	$483.00	$74,330
Stem	158.4	$421.00	3.5%	$483.00	$76,510
Footings	128.0	$421.00	3.5%	$483.00	$61,820
Total Pier Cost					$212,700

Alt 8; (Pier 1)

	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Cap	80.8	$421.00	3.5%	$483.00	$39,030
Stem	90.0	$421.00	3.5%	$483.00	$43,470
Footings	64.0	$421.00	3.5%	$483.00	$30,910
Total Pier Cost					$113,400

Pile Foundation Unit Cost ($/ft.):

HP14 x 73 Steel Piles, Furnished & Driven

Pier Piles:

	Number Pier 1	Pier 2	Pier 3	Pier 4	Pier 5	Top Elevation Pier 1	Pier 2	Pier 3	Pier 4	Pier 5	Bottom Elevation Pier 1	Pier 2	Pier 3	Pier 4	Pier 5	Length Per Pier 1 Pile	Length Per Pier 2 Pile	Length Per Pier 3 Pile	Length Per Pier 4 Pile	Length Per Pier 5 Pile	Total Pile Length	Total Cost
Alt. 1	36	36	36	0	0	539.0	532.0	533.5	0.0	0.0	522.5	518.5	515.0	0.0	0.0	20	20	20	0	0	2,160	$89,200
Alt. 2	36	36	36	0	0	539.0	532.0	533.5	0.0	0.0	522.5	518.5	515.0	0.0	0.0	20	20	20	0	0	2,160	$89,200
Alt. 3	36	36	36	36	0	539.0	538.0	532.0	533.5	0.0	523.0	520.0	517.5	515.0	0.0	20	20	20	20	0	2,680	$116,900
Alt. 4	36	36	36	36	0	539.0	538.0	532.0	533.5	0.0	523.0	520.0	517.5	515.0	0.0	20	20	20	20	0	2,680	$116,900
Alt. 5	36	36	36	36	36	539.0	538.0	532.0	533.5	533.0	523.0	520.0	517.5	515.0	509.0	20	20	20	20	30	3,990	$163,500
Alt. 6	36	36	36	36	36	539.0	538.0	532.0	533.5	533.0	523.0	520.0	517.5	515.0	509.0	20	20	20	20	30	3,990	$163,500
Alt. 7	48	48	0	0	0	538.0	533.5	0.0	0.0	0.0	520.0	515.0	0.0	0.0	0.0	20	20	0	0	0	1,920	$79,300
Alt. 8	48	0	0	0	0	532.0	0.0	0.0	0.0	0.0	518.5	0.0	0.0	0.0	0.0	20	0	0	0	0	960	$39,600

Abutment Piles:

	Number Rear	Forward	Top Elevation Rear	Forward	Bottom Elevation Rear	Fwd.	Length Per Rear Pile	Length Per Forward Pile	Total Pile Length	Total Cost
Alt. 1	24	0	574.5	0.0	525.0	0.0	50	0	1,200	$49,600
Alt. 2	24	0	574.5	0.0	525.0	0.0	50	0	1,200	$49,600
Alt. 3	24	0	574.5	0.0	525.0	0.0	50	0	1,200	$49,600
Alt. 4	24	0	574.5	0.0	525.0	0.0	50	0	1,200	$49,600
Alt. 5	24	24	574.5	562.0	525.0	504.0	50	60	2,640	$109,000
Alt. 6	24	24	574.5	562.0	525.0	504.0	50	60	2,640	$109,000
Alt. 7	24	24	574.5	560.5	525.0	504.5	50	60	2,640	$109,000
Alt. 8	26	0	573.5	0.0	525.0	0.0	50	0	1,300	$53,700

HP14 x 73 Steel Piles, Furnished & Driven

	Year 2004 Unit Cost	Annual Escalation	Year 2008
Furnished	$24.41	3.5%	$26.00
Driven	$11.57	3.5%	$13.30
Total			$41.30

Abutment QC/QA Concrete, Class QSC1 Cost:

Alt. 1

Component		Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Abutment						
	Rear	127.0	$421.00	3.5%	$483.00	$61,300
	Forwa	126.0	$421.00	3.5%	$483.00	$60,900
Wingwalls						
	Rear	47.0	$421.00	3.5%	$483.00	$22,700
	Forwa	35.0	$421.00	3.5%	$483.00	$18,900

Alt. 2 - 3

Component		Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Abutment						
	Rear	127.0	$421.00	3.5%	$483.00	$61,300
	Forwa	114.0	$421.00	3.5%	$483.00	$55,100
Wingwalls						
	Rear	47.0	$421.00	3.5%	$483.00	$22,700
	Forwa	27.0	$421.00	3.5%	$483.00	$13,000

Alt. 4

Component		Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Abutment						
	Rear	127.0	$421.00	3.5%	$483.00	$61,300
	Forwa	102.0	$421.00	3.5%	$483.00	$49,300
Wingwalls						
	Rear	47.0	$421.00	3.5%	$483.00	$22,700
	Forwa	21.0	$421.00	3.5%	$483.00	$10,100

Alt. 5 - 6

Component		Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Abutment						
	Rear	127.0	$421.00	3.5%	$483.00	$61,300
	Forwa	113.0	$421.00	3.5%	$483.00	$54,600
Wingwalls						
	Rear	47.0	$421.00	3.5%	$483.00	$22,700
	Forwa	34.0	$421.00	3.5%	$483.00	$16,400

Alt. 7

Component		Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Abutment						
	Rear	127.0	$421.00	3.5%	$483.00	$61,300
	Forwa	126.0	$421.00	3.5%	$483.00	$60,900
Wingwalls						
	Rear	47.0	$421.00	3.5%	$483.00	$22,700
	Forwa	38.0	$421.00	3.5%	$483.00	$18,400

Alt. 8

Component		Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Abutment						
	Rear	134.0	$421.00	3.5%	$483.00	$64,700
	Forwa	134.0	$421.00	3.5%	$483.00	$64,700
Wingwalls						
	Rear	50.0	$421.00	3.5%	$483.00	$24,200
	Forwa	38.0	$421.00	3.5%	$483.00	$18,400

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.):

	Rear Abutment Area (sq. ft.)	Forward Abutment Area (sq. ft.)	Total Cost
Alt. 1	0	3,380	$209,600
Alt. 2	0	3,545	$219,800
Alt. 3	0	3,545	$219,800
Alt. 4	0	3,710	$230,000
Alt. 5	0	0	$0
Alt. 6	0	0	$0
Alt. 7	0	0	$0
Alt. 8	0	3,255	$201,800

	Year 2004 Unit Cost	Annual Escalation	Year 2008
MSE Wall	$54.00	3.5%	$62.00

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

	Temp. Shoring Area (sq. ft.)	Temp. MSE Wall Area (sq. ft.)	Total Cost
Alt. 1	797	0	$21,500
Alt. 2	797	0	$21,500
Alt. 3	1,069	0	$28,900
Alt. 4	1,069	0	$28,900
Alt. 5	1,069	0	$28,900
Alt. 6	1,069	0	$28,900
Alt. 7	693	0	$18,700
Alt. 8	0	0	$0

	Year 2004 Unit Cost	Annual Escalation	Year 2008
Temporary Shoring	$23.50	3.5%	$27.00
Temporary MSE Wall	$27.50	3.5%	$31.60

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SCI-823 Over Norfolk Southern RR and US-23

STRUCTURE TYPE STUDY

Filename: \\aries\proj\TranSystems\319861\19415\structures documents\Step 7 - Type Study\Bridge SCI823-1601C 823 over Railroad_US23\[1601C Cost Comp.xls]Alternative Summary
By: WRT/SKT Date: 07/08/2005
Checked: Date:

LIFE CYCLE MAINTENANCE COST

Alt. No.	Span Arrangement No. Spans	Lengths	Framing Alternative	Structural Steel Painting: Cost Per Cycle	Number of Maintenance Cycles	Total Life Cycle Cost	Superstructure Sealing: Cost Per Cycle	Number of Maintenance Cycles	Total Life Cycle Cost	Approach Pavement Resurfacing: Cost Per Cycle	Number of Maintenance Cycles	Total Life Cycle Cost
1	4	83 - 118.5 - 118.5 - 83	8 ~ P.S. Concrete I-Beams	$0	0	$0	$68,000	2	$136,000	$2,400	7	$16,800
2	4	83 - 118.5 - 118.5 - 83	8 ~ Steel Plate Girders	$0	0	$0	$0	0	$0	$2,400	7	$16,800
3	5	71 - 83 - 83 - 83 - 83	8 ~ P.S. Concrete I-Beams	$0	0	$0	$44,400	2	$88,800	$2,400	7	$16,800
4	5	71 - 83 - 83 - 83 - 83	8 ~ Steel Rolled Beams	$0	0	$0	$0	0	$0	$2,400	7	$16,800
5	6	71 - 83 - 83 - 83 - 83 - 71	8 ~ P.S. Concrete I-Beams	$0	0	$0	$52,300	2	$104,600	$0	0	$0
6	6	71 - 83 - 83 - 83 - 83 - 71	8 ~ Steel Rolled Beams	$0	0	$0	$0	0	$0	$0	0	$0
7	3	150 - 170 - 150	8 ~ Steel Plate Girders	$0	0	$0	$0	0	$0	$100	7	$700
8	2	201.5 - 201.5	8 ~ Steel Plate Girders	$0	0	$0	$0	0	$0	$2,400	7	$16,800

Alt. No.	Span Arrangement No. Spans	Lengths	Framing Alternative	Bridge Deck Overlay (5): Deck Demo & Chipping	Deck Overlay	Deck Joint Gland (2)	Number of Maintenance Cycles	Total Life Cycle Cost	Bridge Redecking (5): 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	4	83 - 118.5 - 118.5 - 83	8 ~ P.S. Concrete I-Beams	$80,900	$98,100	n/a	1	$179,000	$623,100	$260,500	n/a	$221,100	1	$1,104,700	**$1,437,000**	**$4,201,000**	**$5,638,000**
2	4	83 - 118.5 - 118.5 - 83	8 ~ Steel Plate Girders	$80,900	$98,100	n/a	1	$179,000	$623,100	$260,500	n/a	$221,100	1	$1,104,700	**$1,301,000**	**$3,736,000**	**$5,037,000**
3	5	71 - 83 - 83 - 83 - 83	8 ~ P.S. Concrete I-Beams	$80,900	$98,100	n/a	1	$179,000	$623,100	$260,500	n/a	$221,100	1	$1,104,700	**$1,389,000**	**$3,913,000**	**$5,302,000**
4	5	71 - 83 - 83 - 83 - 83	8 ~ Steel Rolled Beams	$80,900	$98,100	n/a	1	$179,000	$623,100	$260,500	n/a	$221,100	1	$1,104,700	**$1,301,000**	**$3,563,000**	**$4,864,000**
5	6	71 - 83 - 83 - 83 - 83 - 71	8 ~ P.S. Concrete I-Beams	$95,200	$115,400	n/a	1	$210,600	$732,300	$306,100	n/a	$260,000	1	$1,298,400	**$1,614,000**	**$4,292,000**	**$5,906,000**
6	6	71 - 83 - 83 - 83 - 83 - 71	8 ~ Steel Rolled Beams	$95,200	$115,400	n/a	1	$210,600	$732,300	$306,100	n/a	$260,000	1	$1,298,400	**$1,509,000**	**$3,872,000**	**$5,381,000**
7	3	150 - 170 - 150	8 ~ Steel Plate Girders	$94,600	$114,700	n/a	1	$209,300	$726,200	$303,500	n/a	$258,300	1	$1,288,000	**$1,498,000**	**$4,111,000**	**$5,609,000**
8	2	201.5 - 201.5	8 ~ Steel Plate Girders	$80,900	$98,100	n/a	1	$179,000	$623,100	$260,500	n/a	$221,100	1	$1,104,700	**$1,301,000**	**$4,429,000**	**$5,730,000**

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	0	0	403.0	0.00	0	20%	0
Alt. 4	0	0	403.0	0.00	0	20%	0
Alt. 6	0	0	474.0	0.00	0	20%	0
Alt. 7	0	0	470.0	0.00	0	20%	0
Alt. 8	0	0	403.0	0.00	0	20%	0

Painting Cost per sq. ft.:

	Year 2004	Annual Escalation	Year 2008
Prep	$5.00	3.5%	$5.74
Prime	$1.25	3.5%	$1.43
Intermed.	$1.25	3.5%	$1.43
Finish	$1.25	3.5%	$1.43
Total			$10.03

Superstructure Sealing:

PS Concrete I-Beam Area:
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
Total Exposed Perimeter					186.31 in.

45° AASHTO Type 3

	H	V	Diag.	No.	Total
Bot. Flange	22			1	22.00
		7		2	14.00
Lower Fillets	7.5	7.5	10.60	2	21.20
Web		19		2	38.00
Upper Fillets	4.5	4.5	6.36	2	12.72
Top Flange		7		2	14.00
Total Exposed Perimeter					121.92 in.

PS Concrete Area:

	No. Stringers	Total Span Length (ft.)	Nominal Exposed Beam Area (sq. ft.)	Secondary Member Allowance	Total Exposed Concrete Area (sq. yd.)
Alt. 1	8	403.00	50,054	10%	6,120
Alt. 3	8	403.00	32,756	10%	4,000
Alt. 5	8	474.00	38,527	10%	4,710

Sealing Cost per sq. yd.:

	Year 2004	Annual Escalation	Year 2008
Epoxy-Urethane Sealer	$9.88	3.5%	$11.11

Bridge Redecking:

Bridge Deck Joint Cost per foot:

	Year 2004	Annual Escalation	Year 2008
Structural Expansion Joint Including Elastomeric Strip Seal	$238.00	3.5%	$273.11

	Bridge Width (ft.)	No. Joints
Alt. 1	66.00	0
Alt. 2	66.00	0
Alt. 3	66.00	0
Alt. 4	66.00	0
Alt. 5	66.00	0
Alt. 6	66.00	0
Alt. 7	66.00	0

Bridge Deck Removal Cost:

	Deck Area (3) (sq. ft.)	Year 2008	Deck Removal Cost
Alt. 1	26,700	$8.28	$221,100
Alt. 2	26,700	$8.28	$221,100
Alt. 3	26,700	$8.28	$221,100
Alt. 4	26,700	$8.28	$221,100
Alt. 5	31,400	$8.28	$260,000
Alt. 6	31,400	$8.28	$260,000
Alt. 7	31,200	$8.28	$258,300
Alt. 8	26,700	$8.28	$221,100

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 (10% of deck area)	$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	26,700	2,967	74	67
Alt. 2	26,700	2,967	74	67
Alt. 3	26,700	2,967	74	67
Alt. 4	26,700	2,967	74	67
Alt. 5	31,400	3,489	87	79
Alt. 6	31,400	3,489	87	79
Alt. 7	31,200	3,467	87	78
Alt. 7	26,700	2,967	74	67

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 2004	Annual Escalation	Year 2008
Elastomeric Strip Seal Gland	$59.50	3.5%	$68.28

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.
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:

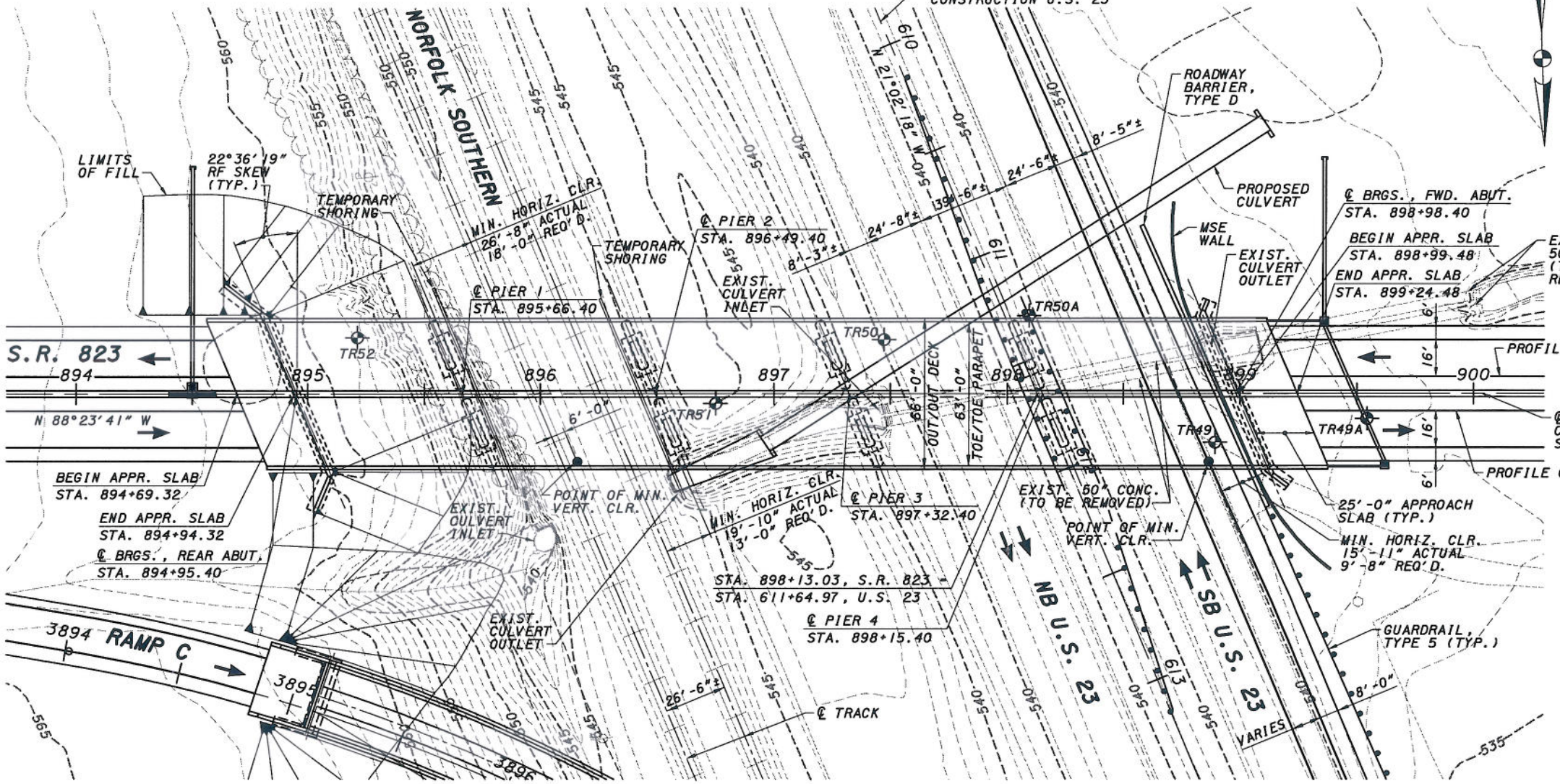
	Year 2004	Annual Escalation	Year 2008
Pavement Planing, Asphalt Concrete, per sq. yd. (Item 254)	$0.98	3.5%	$1.12
Asphalt Concrete Surface Course, per cu. yd.	$72.00	3.5%	$82.62

Asphalt Resurfacing Costs:

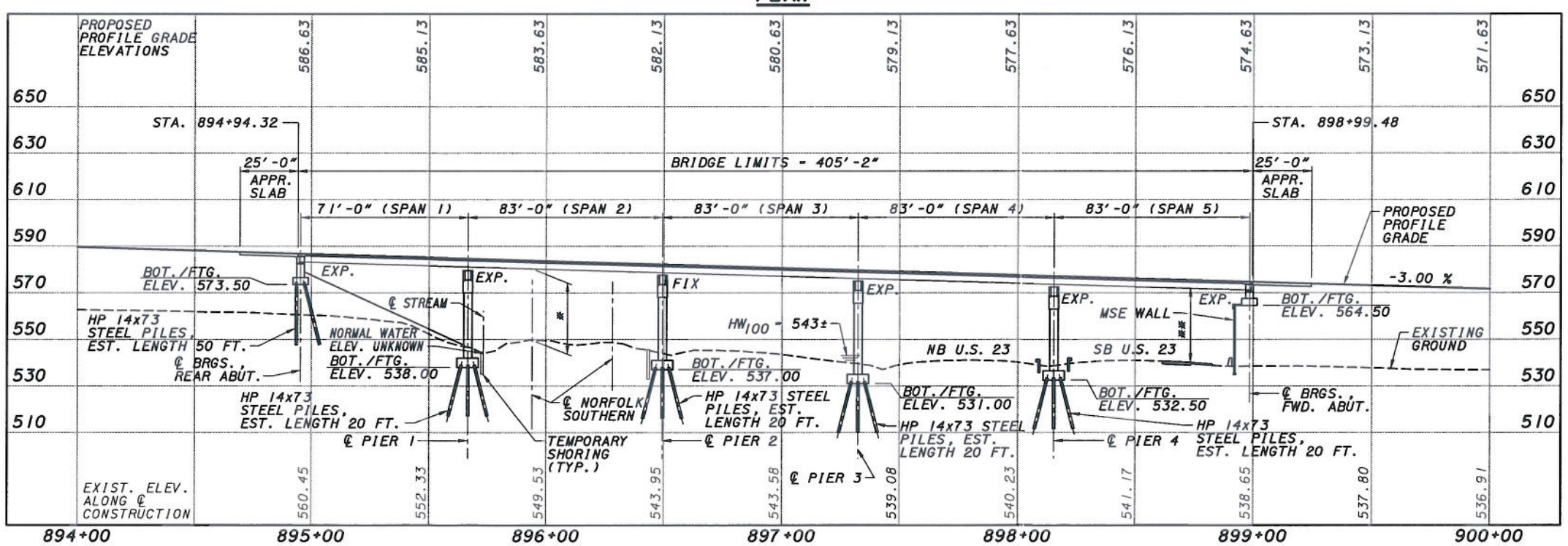
	Approach Roadway Length (ft.) (4)	Approach Roadway Width (ft.)	Resurfacing Area (sq. yd.)	Wearing Course Thickness (in.)	Wearing Course Volume (cu. yd.)
Alt. 1	71.0	66.0	521	1.50	21.7
Alt. 2	71.0	66.0	521	1.50	21.7
Alt. 3	71.0	66.0	521	1.50	21.7
Alt. 4	71.0	66.0	521	1.50	21.7
Alt. 5	0.0	66.0	0	1.50	0.0
Alt. 6	0.0	66.0	0	1.50	0.0
Alt. 7	4.0	66.0	29	1.50	1.2
Alt. 8	71.0	66.0	521	1.50	21.7

APPENDIX B

Preferred Alternative Site Plan and Details



PLAN



PROFILE ALONG PROFILE GRADE LINE, S.R. 823

* MIN. VERT. CLR. 28'-9" ACTUAL 23'-0" REQ'D.

** MIN. VERT. CLR. 30'-3" ACTUAL 17'-0" REQ'D.

BENCHMARKS

TRAFFIC DATA

CURRENT ADT (2010) - 8900
DESIGN ADT (2030) - 13000
DESIGN ADTT - 1820

LEGEND

◈ DENOTES SOIL BORING LOCATION

NOTE

EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.

PROPOSED STRUCTURE

TYPE: FIVE-SPAN COMPOSITE STEEL ROLLED BEAMS (NON-PAINTED ASTM A709, GR 50W) WITH REINFORCED CONCRETE DECK ON SEMI-INTEGRAL ABUTMENTS WITH SIDE-BY-SIDE T-TYPE PIERS

LENGTH OF SPAN: 71'-0", 83'-0", 83'-0", 83'-0", AND 83'-0", MEASURED ALONG ℄ SURVEY & CONSTRUCTION

ROADWAY: 30'-1⅛" TOE/TOE PARAPETS (RB)
30'-1⅛" TOE/TOE PARAPETS (LB)

SIDEWALK: NONE

DESIGN LOADING: HS25 (CASE II) AND THE ALTERNATE MILITARY LOADING, FWS = 60 LB/FT²

SKEW: 22°36'19" RIGHT FORWARD

WEARING SURFACE: MONOLITHIC CONCRETE

APPROACH SLABS: AS-1-81 (25'-0" LONG)

ALIGNMENT: TANGENT

CROWN: 0.016 FT/FT

LATITUDE: N 38°53'32"

LONGITUDE: W 82°59'58"

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

DESIGNED	DRAWN	REVIEWED	DATE
WRT	MME	GAS	07/05
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

SCIOTO COUNTY
STA. 894+94.32 TO STA. 898+99.48

SITE PLAN

BRIDGE NO. SCI-823-1601
S.R. 823 OVER NORFOLK SOUTHERN & U.S. 23 - ALT. 4

SCI-823-0.00

1 / 3

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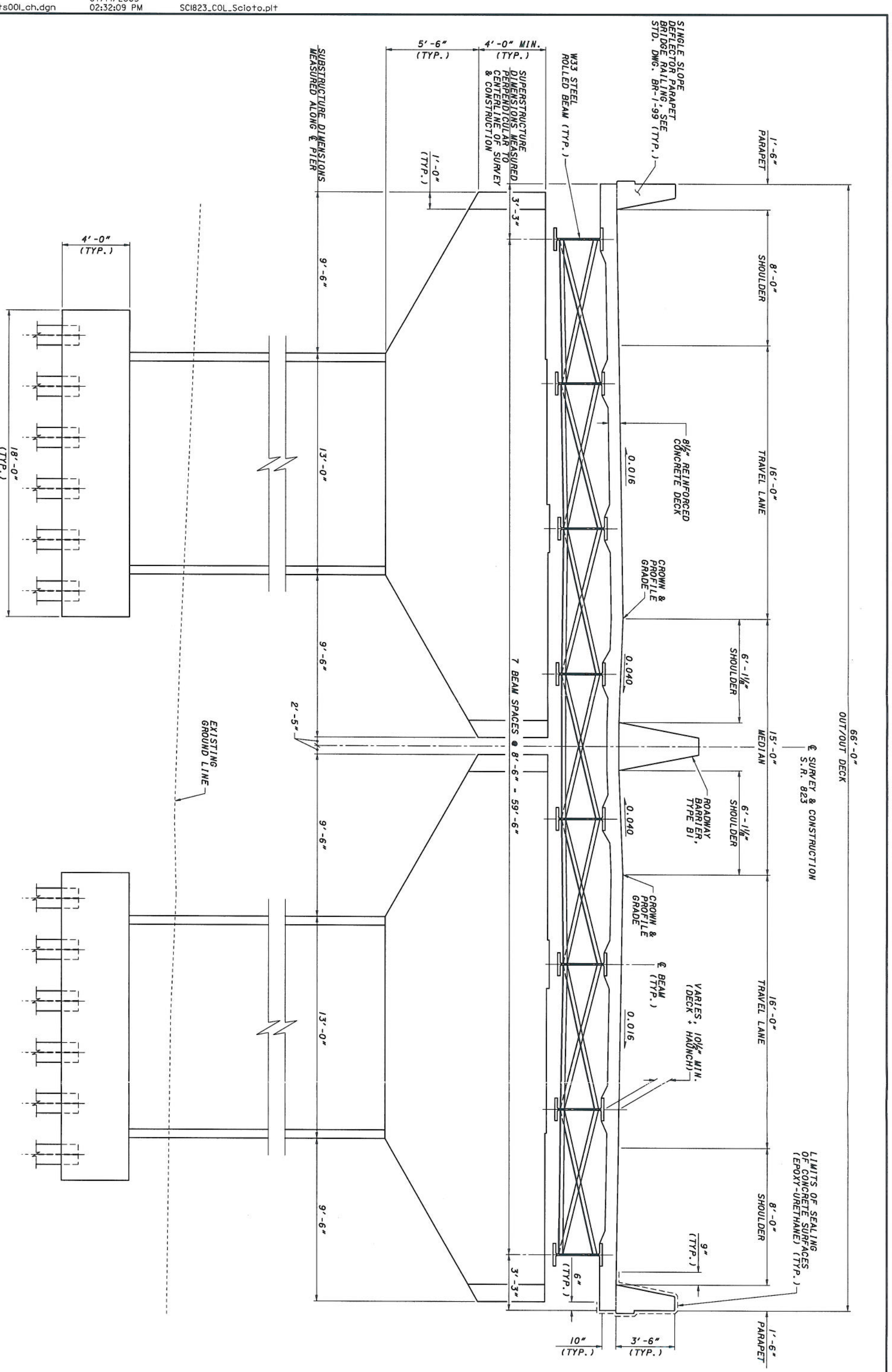

TYPICAL TRANSVERSE SECTION

2/3	SCI-823-0.00	TYPICAL TRANSVERSE SECTION BRIDGE NO. SCI-823-1601 S.R. 823 OVER NORFOLK SOUTHERN & U.S. 23 - ALT. 4	DESIGNED WRT	DRAWN DGS	REVIEWED GAS	DATE 07/05
			CHECKED SKT	REVISED	STRUCTURE FILE NUMBER	

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

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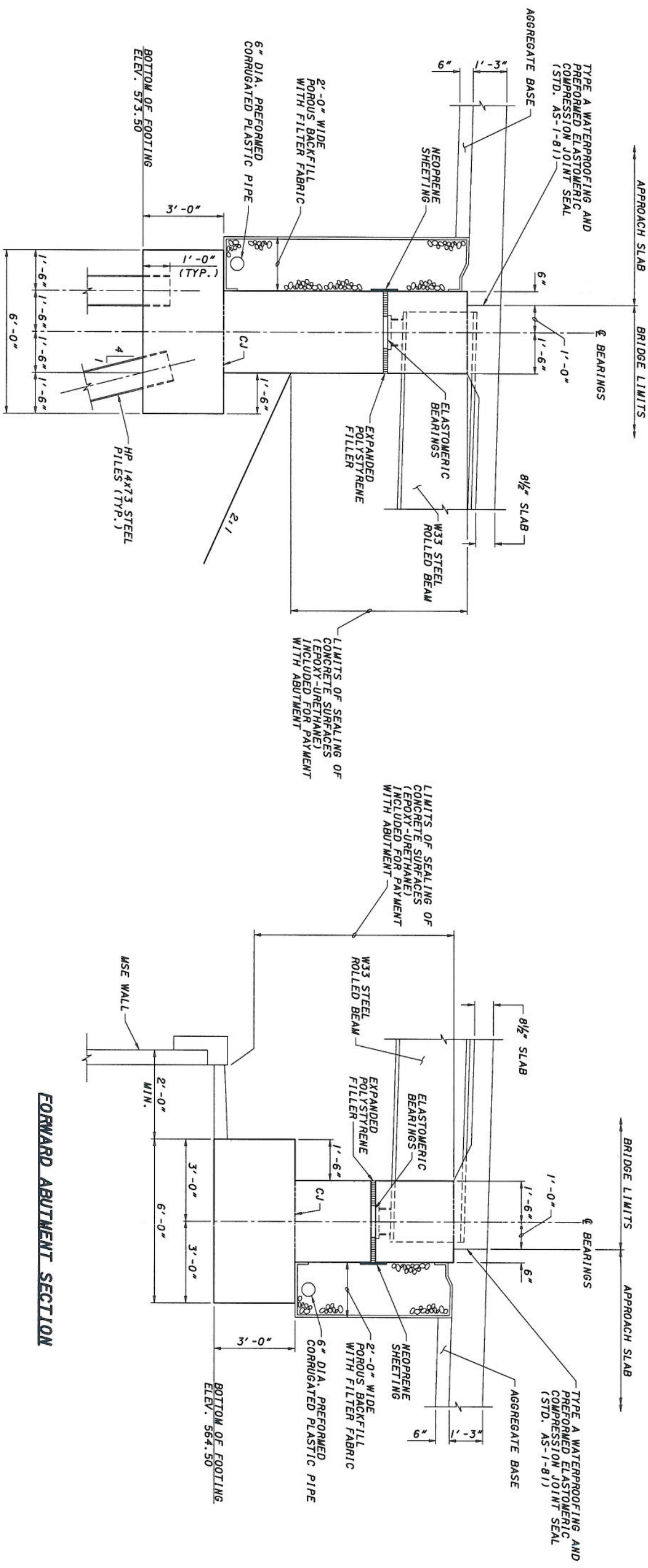


3/3	SCI-823-0.00	ABUTMENT SECTION BRIDGE NO. SCI-823-1601 S.R. 823 OVER NORFOLK SOUTHERN & U.S. 23 - ALT. 4	DESIGNED WRT	DRAWN DGS	REVIEWED GAS	DATE 07/05	DESIGN AGENCY CH2MHILL 5775 Perimeter Drive, Suite 190 Dublin, Ohio 43017
			CHECKED SKT	REVISED	STRUCTURE FILE NUMBER		

APPENDIX C

Vertical Clearance Calculations

SCI-823-0.00

SR 823 MAINLINE OVER NORFOLK SOUTHERN RAILROAD AND US-23 / RAMP D

VERTICAL CLEARANCES

Filename: \\aries\proj\TranSystems\319861\19415\structures documents\Step 7 - Type Study\Bridge SCI823-1601C 823 over Railroad_US23\[SR823_RR_Vert_Clr.xls]Alternative 1

By: DGS Date: #######

Checked: Date:

LEGEND:

User Input - Not Critical

User Input - Critical to Output

Alternative 1 - AASHTO Type 4 Modified (66") Concrete I-Beams

PROFILE DATA - NORFOLK SOUTHERN RAILWAY

Use existing top of high rail elevations, as profile adjustments to the railroad are not anticipated in this project.

POINT	RAILROAD LOCATION		RAILROAD STATION	RAILROAD - EXISTING ELEV. @ POINT
1	Top of Rail	East	n/a	550.53
2	Top of Rail	West	n/a	549.22
3	Top of Rail	East	n/a	550.40
4	Top of Rail	West	n/a	548.98

PROFILE DATA - RAMP D

POINT	RAMP D LOCATION	EXISTING ELEV. @ US-23 EDGE OF PVMT.	DISTANCE ACROSS TAPER	PAVEMENT X-SLOPE	DISTANCE ACROSS SHLDR.	SHOULDER X-SLOPE	RAMP D - FINISHED GRADE @ POINT
5	RT. EDGE OF PVMT	540.91	10.66	-1.6%		-4.0%	540.74
6	RT. EDGE OF SHLDR.	540.91	10.72	-1.6%	8.23	-4.0%	540.41

PROFILE DATA - SR 823 MAINLINE

Linear:

PVT Sta. 875+00.00 PVC Sta. 904+00.00

PVT Elev. 646.63 PVC Elev. 559.63

g -3.00%

Superelevation Data:

Station	Pavement
875+00.00	-1.6%
904+00.00	-1.6%

POINT	SR 823 MAINLINE LOCATION DESCRIPTION	STA.	OFF.	SR 823 PG ELEV.	PAVEMENT X-SLOPE	SR 823 - FINISHED GRADE @ POINT
1	LT. FASCIA BEAM	895+91.29	22.25	583.89	-1.6%	583.53
2	LT. FASCIA BEAM	896+20.02	22.25	583.03	-1.6%	582.67
3	RT. FASCIA BEAM	896+15.97	22.25	583.15	-1.6%	582.79
4	RT. FASCIA BEAM	896+44.79	22.25	582.28	-1.6%	581.93
5	RT. FASCIA BEAM	898+86.70	22.25	575.03	-1.6%	574.67
6	RT. FASCIA BEAM	898+95.70	22.25	574.76	-1.6%	574.40

STRUCTURE DEPTH

Haunch + Max. Top Flange = 4.0 in

POINT	BEAM DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	AASHTO TYPE 4	8.50	4.00	0.0	66	0.0	-	78.50 in
2	AASHTO TYPE 4	8.50	4.00	0.0	66	0.0	-	78.50 in
3	AASHTO TYPE 4	8.50	4.00	0.0	66	0.0	-	78.50 in
4	AASHTO TYPE 4	8.50	4.00	0.0	66	0.0	-	78.50 in
5	AASHTO TYPE 4	8.50	4.00	0.0	66	0.0	-	78.50 in
6	AASHTO TYPE 4	8.50	4.00	0.0	66	0.0	-	78.50 in

VERTICAL CLEARANCE - SR 823 MAINLINE OVER NORFOLK SOUTHERN RAILROAD AND US-23 / RAMP D

POINT	LOCATION	SR 823 MAINLINE - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. BEAM ELEVATION	RR / RAMP D - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)		
1	LT. FASCIA BEAM	583.53	78.500	576.99	550.53	**26.46**	OK	
2	LT. FASCIA BEAM	582.67	78.500	576.13	549.22	**26.91**	OK	MINIMUM VERT.
3	RT. FASCIA BEAM	582.79	78.500	576.25	550.40	**25.85**	OK	CLR = 23'-0"
4	RT. FASCIA BEAM	581.93	78.500	575.39	548.98	**26.41**	OK	
5	RT. FASCIA BEAM	574.67	78.500	568.13	540.74	**27.39**	OK	MINIMUM VERT.
6	RT. FASCIA BEAM	574.40	78.500	567.86	540.41	**27.45**	OK	CLR = 17'-0"

SCI-823-0.00

SR 823 MAINLINE OVER NORFOLK SOUTHERN RAILROAD AND US-23 / RAMP D

VERTICAL CLEARANCES

Filename: \\aries\proj\TranSystems\319861\19415\structures documents\Step 7 - Type Study\Bridge SCI823-1601C 823 over Railroad_US23\[SR823_RR_Vert_Clr.xls]Alternative 1

By: DGS Date: #######

Checked: Date:

LEGEND:

User Input - Not Critical

User Input - Critical to Output

Alternative 2 - 48" Steel Plate Girder

PROFILE DATA - NORFOLK SOUTHERN RAILWAY

Use existing top of high rail elevations, as profile adjustments to the railroad are not anticipated in this project.

POINT	RAILROAD LOCATION		RAILROAD STATION	RAILROAD - EXISTING ELEV. @ POINT
1	Top of Rail	East	n/a	550.53
2	Top of Rail	West	n/a	549.22
3	Top of Rail	East	n/a	550.40
4	Top of Rail	West	n/a	548.98

PROFILE DATA - RAMP D

POINT	RAMP D LOCATION	EXISTING ELEV. @ US-23 EDGE OF PVMT.	DISTANCE ACROSS TAPER	PAVEMENT X-SLOPE	DISTANCE ACROSS SHLDR.	SHOULDER X-SLOPE	RAMP D - FINISHED GRADE @ POINT
5	RT. EDGE OF PVMT	540.91	10.66	-1.6%		-4.0%	540.74
6	RT. EDGE OF SHLDR.	540.91	10.72	-1.6%	8.23	-4.0%	540.41

PROFILE DATA - SR 823 MAINLINE

Linear:

PVT Sta. 875+00.00 PVC Sta. 904+00.00

PVT Elev. 646.63 PVC Elev. 559.63

g -3.00%

Superelevation Data:

Station	Pavement
875+00.00	-1.6%
904+00.00	-1.6%

POINT	SR 823 MAINLINE LOCATION DESCRIPTION	STA.	OFF.	SR 823 PG ELEV.	PAVEMENT X-SLOPE	SR 823 - FINISHED GRADE @ POINT
1	LT. FASCIA GIRDER	895+91.29	22.25	583.89	-1.6%	583.53
2	LT. FASCIA GIRDER	896+20.02	22.25	583.03	-1.6%	582.67
3	RT. FASCIA GIRDER	896+15.97	22.25	583.15	-1.6%	582.79
4	RT. FASCIA GIRDER	896+44.79	22.25	582.28	-1.6%	581.93
5	RT. FASCIA GIRDER	898+86.70	22.25	575.03	-1.6%	574.67
6	RT. FASCIA GIRDER	898+95.70	22.25	574.76	-1.6%	574.40

STRUCTURE DEPTH

Haunch + Max. Top Flange = 3.0 in

POINT	GIRDER DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total	
1	48" Steel Plate Girder	8.50	2.00	1.0	48	1.0	2.5	63.00	in
2	48" Steel Plate Girder	8.50	2.00	1.0	48	1.0	-	60.50	in
3	48" Steel Plate Girder	8.50	2.00	1.0	48	1.0	2.5	63.00	in
4	48" Steel Plate Girder	8.50	2.00	1.0	48	1.0	-	60.50	in
5	48" Steel Plate Girder	8.50	2.00	1.0	48	1.0	-	60.50	in
6	48" Steel Plate Girder	8.50	2.00	1.0	48	1.0	-	60.50	in

VERTICAL CLEARANCE - SR 823 MAINLINE OVER NORFOLK SOUTHERN RAILROAD AND US-23 / RAMP D

POINT	LOCATION	SR 823 MAINLINE - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. GIRDER ELEVATION	RR / RAMP D - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)		
1	LT. FASCIA GIRDER	583.53	63.000	578.28	550.53	**27.75**	OK	
2	LT. FASCIA GIRDER	582.67	60.500	577.63	549.22	**28.41**	OK	MINIMUM VERT.
3	RT. FASCIA GIRDER	582.79	63.000	577.54	550.40	**27.14**	OK	CLR = 23'-0"
4	RT. FASCIA GIRDER	581.93	60.500	576.89	548.98	**27.91**	OK	
5	RT. FASCIA GIRDER	574.67	60.500	569.63	540.74	**28.89**	OK	MINIMUM VERT.
6	RT. FASCIA GIRDER	574.40	60.500	569.36	540.41	**28.95**	OK	CLR = 17'-0"

SCI-823-0.00

SR 823 MAINLINE OVER NORFOLK SOUTHERN RAILROAD AND US-23 / RAMP D

VERTICAL CLEARANCES

Filename: \\aries\proj\TranSystems\319861\19415\structures documents\Step 7 - Type Study\Bridge SCI823-1601C 823 over Railroad_US23\[SR823_RR_Vert_Clr.xls]Alternative 1

By: DGS Date: #######

Checked: Date:

LEGEND:

User Input - Not Critical

User Input - Critical to Output

Alternative 3 - AASHTO Type 3 Concrete I-Beams

PROFILE DATA - NORFOLK SOUTHERN RAILWAY

Use existing top of high rail elevations, as profile adjustments to the railroad are not anticipated in this project.

POINT	RAILROAD LOCATION		RAILROAD STATION	RAILROAD - EXISTING ELEV. @ POINT
1	Top of Rail	East	n/a	550.53
2	Top of Rail	West	n/a	549.22
3	Top of Rail	East	n/a	550.40
4	Top of Rail	West	n/a	548.98

PROFILE DATA - RAMP D

POINT	RAMP D LOCATION	EXISTING ELEV. @ US-23 EDGE OF PVMT.	DISTANCE ACROSS TAPER	PAVEMENT X-SLOPE	DISTANCE ACROSS SHLDR.	SHOULDER X-SLOPE	RAMP D - FINISHED GRADE @ POINT
5	RT. EDGE OF PVMT	540.91	10.66	-1.6%		-4.0%	540.74
6	RT. EDGE OF SHLDR.	540.91	10.72	-1.6%	8.23	-4.0%	540.41

PROFILE DATA - SR 823 MAINLINE

Linear:

PVT Sta. 875+00.00 PVC Sta. 904+00.00

PVT Elev. 646.63 PVC Elev. 559.63

g -3.00%

Superelevation Data:

Station	Pavement
875+00.00	-1.6%
904+00.00	-1.6%

POINT	SR 823 MAINLINE LOCATION DESCRIPTION	STA.	OFF.	SR 823 PG ELEV.	PAVEMENT X-SLOPE	SR 823 - FINISHED GRADE @ POINT
1	LT. FASCIA BEAM	895+91.29	22.25	583.89	-1.6%	583.53
2	LT. FASCIA BEAM	896+20.02	22.25	583.03	-1.6%	582.67
3	RT. FASCIA BEAM	896+15.97	22.25	583.15	-1.6%	582.79
4	RT. FASCIA BEAM	896+44.79	22.25	582.28	-1.6%	581.93
5	RT. FASCIA BEAM	898+86.70	22.25	575.03	-1.6%	574.67
6	RT. FASCIA BEAM	898+95.70	22.25	574.76	-1.6%	574.40

STRUCTURE DEPTH

Haunch + Max. Top Flange = 4.0 in

POINT	BEAM DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	AASHTO TYPE 3	8.50	4.00	0.0	45	0.0	-	57.50 in
2	AASHTO TYPE 3	8.50	4.00	0.0	45	0.0	-	57.50 in
3	AASHTO TYPE 3	8.50	4.00	0.0	45	0.0	-	57.50 in
4	AASHTO TYPE 3	8.50	4.00	0.0	45	0.0	-	57.50 in
5	AASHTO TYPE 3	8.50	4.00	0.0	45	0.0	-	57.50 in
6	AASHTO TYPE 3	8.50	4.00	0.0	45	0.0	-	57.50 in

VERTICAL CLEARANCE - SR 823 MAINLINE OVER NORFOLK SOUTHERN RAILROAD AND US-23 / RAMP D

POINT	LOCATION	SR 823 MAINLINE - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. BEAM ELEVATION	RR / RAMP D - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)		
1	LT. FASCIA BEAM	583.53	57.500	578.74	550.53	**28.21**	OK	
2	LT. FASCIA BEAM	582.67	57.500	577.88	549.22	**28.66**	OK	MINIMUM VERT.
3	RT. FASCIA BEAM	582.79	57.500	578.00	550.40	**27.60**	OK	CLR = 23'-0"
4	RT. FASCIA BEAM	581.93	57.500	577.14	548.98	**28.16**	OK	
5	RT. FASCIA BEAM	574.67	57.500	569.88	540.74	**29.14**	OK	MINIMUM VERT.
6	RT. FASCIA BEAM	574.40	57.500	569.61	540.41	**29.20**	OK	CLR = 17'-0"

SCI-823-0.00

SR 823 MAINLINE OVER NORFOLK SOUTHERN RAILROAD AND US-23 / RAMP D

VERTICAL CLEARANCES

Filename: \\aries\proj\TranSystems\319861\19415\structures documents\Step 7 - Type Study\Bridge SCI823-1601C 823 over Railroad_US23\[SR823_RR_Vert_Clr.xls]Alternative 1

By: DGS Date: #######

Checked: Date:

LEGEND:

User Input - Not Critical

User Input - Critical to Output

Alternative 4 - W33 Steel Rolled Beam

PROFILE DATA - NORFOLK SOUTHERN RAILWAY

Use existing top of high rail elevations, as profile adjustments to the railroad are not anticipated in this project.

POINT	RAILROAD LOCATION		RAILROAD STATION	RAILROAD - EXISTING ELEV. @ POINT
1	Top of Rail	East	n/a	550.53
2	Top of Rail	West	n/a	549.22
3	Top of Rail	East	n/a	550.40
4	Top of Rail	West	n/a	548.98

PROFILE DATA - RAMP D

POINT	RAMP D LOCATION	EXISTING ELEV. @ US-23 EDGE OF PVMT.	DISTANCE ACROSS TAPER	PAVEMENT X-SLOPE	DISTANCE ACROSS SHLDR.	SHOULDER X-SLOPE	RAMP D - FINISHED GRADE @ POINT
5	RT. EDGE OF PVMT	540.91	10.66	-1.6%		-4.0%	540.74
6	RT. EDGE OF SHLDR.	540.91	10.72	-1.6%	8.23	-4.0%	540.41

PROFILE DATA - SR 823 MAINLINE

Linear:

PVT Sta. 875+00.00 PVC Sta. 904+00.00

PVT Elev. 646.63 PVC Elev. 559.63

g -3.00%

Superelevation Data:

Station	Pavement
875+00.00	-1.6%
904+00.00	-1.6%

POINT	SR 823 MAINLINE LOCATION DESCRIPTION	STA.	OFF.	SR 823 PG ELEV.	PAVEMENT X-SLOPE	SR 823 - FINISHED GRADE @ POINT
1	LT. FASCIA BEAM	895+91.29	22.25	583.89	-1.6%	583.53
2	LT. FASCIA BEAM	896+20.02	22.25	583.03	-1.6%	582.67
3	RT. FASCIA BEAM	896+15.97	22.25	583.15	-1.6%	582.79
4	RT. FASCIA BEAM	896+44.79	22.25	582.28	-1.6%	581.93
5	RT. FASCIA BEAM	898+86.70	22.25	575.03	-1.6%	574.67
6	RT. FASCIA BEAM	898+95.70	22.25	574.76	-1.6%	574.40

STRUCTURE DEPTH

Haunch + Max. Top Flange = 2.0 in

POINT	BEAM DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	W33 Steel Beam	8.50	2.00	0.0	33	0.0	-	43.50 in
2	W33 Steel Beam	8.50	2.00	0.0	33	0.0	2.5	46.00 in
3	W33 Steel Beam	8.50	2.00	0.0	33	0.0	-	43.50 in
4	W33 Steel Beam	8.50	2.00	0.0	33	0.0	2.5	46.00 in
5	W33 Steel Beam	8.50	2.00	0.0	33	0.0	-	43.50 in
6	W33 Steel Beam	8.50	2.00	0.0	33	0.0	-	43.50 in

VERTICAL CLEARANCE - SR 823 MAINLINE OVER NORFOLK SOUTHERN RAILROAD AND US-23 / RAMP D

POINT	LOCATION	SR 823 MAINLINE - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. BEAM ELEVATION	RR / RAMP D - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)		
1	LT. FASCIA BEAM	583.53	43.500	579.91	550.53	**29.38**	OK	
2	LT. FASCIA BEAM	582.67	46.000	578.84	549.22	**29.62**	OK	MINIMUM VERT.
3	RT. FASCIA BEAM	582.79	43.500	579.17	550.40	**28.77**	OK	CLR = 23'-0"
4	RT. FASCIA BEAM	581.93	46.000	578.10	548.98	**29.12**	OK	
5	RT. FASCIA BEAM	574.67	43.500	571.05	540.74	**30.31**	OK	MINIMUM VERT.
6	RT. FASCIA BEAM	574.40	43.500	570.78	540.41	**30.37**	OK	CLR = 17'-0"

SCI-823-0.00

SR 823 MAINLINE OVER NORFOLK SOUTHERN RAILROAD AND US-23 / RAMP D

VERTICAL CLEARANCES

Filename: \\aries\proj\TranSystems\319861\19415\structures documents\Step 7 - Type Study\Bridge SCI823-1601C 823 over Railroad_US23\[SR823_RR_Vert_Clr.xls]Alternative 1

By: DGS Date: #######

Checked: Date: LEGEND:

User Input - Not Critical

User Input - Critical to Output

Alternative 5 - AASHTO Type 3 Concrete I-Beams

PROFILE DATA - NORFOLK SOUTHERN RAILWAY

Use existing top of high rail elevations, as profile adjustments to the railroad are not anticipated in this project.

POINT	RAILROAD LOCATION		RAILROAD STATION	RAILROAD - EXISTING ELEV. @ POINT
1	Top of Rail	East	n/a	550.53
2	Top of Rail	West	n/a	549.22
3	Top of Rail	East	n/a	550.40
4	Top of Rail	West	n/a	548.98

PROFILE DATA - RAMP D

POINT	RAMP D LOCATION	EXISTING ELEV. @ US-23 EDGE OF PVMT.	DISTANCE ACROSS TAPER	PAVEMENT X-SLOPE	DISTANCE ACROSS SHLDR.	SHOULDER X-SLOPE	RAMP D - FINISHED GRADE @ POINT
5	RT. EDGE OF PVMT	540.91	10.66	-1.6%		-4.0%	540.74
6	RT. EDGE OF SHLDR.	540.91	10.72	-1.6%	8.23	-4.0%	540.41

PROFILE DATA - SR 823 MAINLINE

Linear:

PVT Sta.	875+00.00	PVC Sta.	904+00.00
PVT Elev.	646.63	PVC Elev.	559.63
g	-3.00%		

Superelevation Data:

Station	Pavement
875+00.00	-1.6%
904+00.00	-1.6%

POINT	SR 823 MAINLINE LOCATION DESCRIPTION	STA.	OFF.	SR 823 PG ELEV.	PAVEMENT X-SLOPE	SR 823 - FINISHED GRADE @ POINT
1	LT. FASCIA BEAM	895+91.29	22.25	583.89	-1.6%	583.53
2	LT. FASCIA BEAM	896+20.02	22.25	583.03	-1.6%	582.67
3	RT. FASCIA BEAM	896+15.97	22.25	583.15	-1.6%	582.79
4	RT. FASCIA BEAM	896+44.79	22.25	582.28	-1.6%	581.93
5	RT. FASCIA BEAM	898+86.70	22.25	575.03	-1.6%	574.67
6	RT. FASCIA BEAM	898+95.70	22.25	574.76	-1.6%	574.40

STRUCTURE DEPTH

Haunch + Max. Top Flange = 4.0 in

POINT	BEAM DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	AASHTO TYPE 3	8.50	4.00	0.0	45	0.0	-	57.50 in
2	AASHTO TYPE 3	8.50	4.00	0.0	45	0.0	-	57.50 in
3	AASHTO TYPE 3	8.50	4.00	0.0	45	0.0	-	57.50 in
4	AASHTO TYPE 3	8.50	4.00	0.0	45	0.0	-	57.50 in
5	AASHTO TYPE 3	8.50	4.00	0.0	45	0.0	-	57.50 in
6	AASHTO TYPE 3	8.50	4.00	0.0	45	0.0	-	57.50 in

VERTICAL CLEARANCE - SR 823 MAINLINE OVER NORFOLK SOUTHERN RAILROAD AND US-23 / RAMP D

POINT	LOCATION	SR 823 MAINLINE - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. BEAM ELEVATION	RR / RAMP D - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)		
1	LT. FASCIA BEAM	583.53	57.500	578.74	550.53	**28.21**	OK	
2	LT. FASCIA BEAM	582.67	57.500	577.88	549.22	**28.66**	OK	MINIMUM VERT.
3	RT. FASCIA BEAM	582.79	57.500	578.00	550.40	**27.60**	OK	CLR = 23'-0"
4	RT. FASCIA BEAM	581.93	57.500	577.14	548.98	**28.16**	OK	
5	RT. FASCIA BEAM	574.67	57.500	569.88	540.74	**29.14**	OK	MINIMUM VERT.
6	RT. FASCIA BEAM	574.40	57.500	569.61	540.41	**29.20**	OK	CLR = 17'-0"

SCI-823-0.00

SR 823 MAINLINE OVER NORFOLK SOUTHERN RAILROAD AND US-23 / RAMP D

VERTICAL CLEARANCES

Filename: \\aries\proj\TranSystems\319861\19415\structures documents\Step 7 - Type Study\Bridge SCI823-1601C 823 over Railroad_US23\[SR823_RR_Vert_Clr.xls]Alternative 1

By: DGS Date: #######

Checked: Date: LEGEND:

User Input - Not Critical

User Input - Critical to Output

Alternative 6 - W33 Steel Rolled Beam

PROFILE DATA - NORFOLK SOUTHERN RAILWAY

Use existing top of high rail elevations, as profile adjustments to the railroad are not anticipated in this project.

POINT	RAILROAD LOCATION		RAILROAD STATION	RAILROAD - EXISTING ELEV. @ POINT
1	Top of Rail	East	n/a	550.53
2	Top of Rail	West	n/a	549.22
3	Top of Rail	East	n/a	550.40
4	Top of Rail	West	n/a	548.98

PROFILE DATA - RAMP D

POINT	RAMP D LOCATION	EXISTING ELEV. @ US-23 EDGE OF PVMT.	DISTANCE ACROSS TAPER	PAVEMENT X-SLOPE	DISTANCE ACROSS SHLDR.	SHOULDER X-SLOPE	RAMP D - FINISHED GRADE @ POINT
5	RT. EDGE OF PVMT	540.91	10.66	-1.6%		-4.0%	540.74
6	RT. EDGE OF SHLDR.	540.91	10.72	-1.6%	8.23	-4.0%	540.41

PROFILE DATA - SR 823 MAINLINE

Linear:

PVT Sta. 875+00.00 PVC Sta. 904+00.00

PVT Elev. 646.63 PVC Elev. 559.63

g -3.00%

Superelevation Data:

Station	Pavement
875+00.00	-1.6%
904+00.00	-1.6%

POINT	SR 823 MAINLINE LOCATION DESCRIPTION	STA.	OFF.	SR 823 PG ELEV.	PAVEMENT X-SLOPE	SR 823 - FINISHED GRADE @ POINT
1	LT. FASCIA BEAM	895+91.29	22.25	583.89	-1.6%	583.53
2	LT. FASCIA BEAM	896+20.02	22.25	583.03	-1.6%	582.67
3	RT. FASCIA BEAM	896+15.97	22.25	583.15	-1.6%	582.79
4	RT. FASCIA BEAM	896+44.79	22.25	582.28	-1.6%	581.93
5	RT. FASCIA BEAM	898+86.70	22.25	575.03	-1.6%	574.67
6	RT. FASCIA BEAM	898+95.70	22.25	574.76	-1.6%	574.40

STRUCTURE DEPTH

Haunch + Max. Top Flange = 2.0 in

POINT	BEAM DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	W33 Steel Beam	8.50	2.00	0.0	33	0.0	-	43.50 in
2	W33 Steel Beam	8.50	2.00	0.0	33	0.0	2.5	46.00 in
3	W33 Steel Beam	8.50	2.00	0.0	33	0.0	-	43.50 in
4	W33 Steel Beam	8.50	2.00	0.0	33	0.0	2.5	46.00 in
5	W33 Steel Beam	8.50	2.00	0.0	33	0.0	-	43.50 in
6	W33 Steel Beam	8.50	2.00	0.0	33	0.0	-	43.50 in

VERTICAL CLEARANCE - SR 823 MAINLINE OVER NORFOLK SOUTHERN RAILROAD AND US-23 / RAMP D

POINT	LOCATION	SR 823 MAINLINE - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. BEAM ELEVATION	RR / RAMP D - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)		
1	LT. FASCIA BEAM	583.53	43.500	579.91	550.53	**29.38**	OK	
2	LT. FASCIA BEAM	582.67	46.000	578.84	549.22	**29.62**	OK	MINIMUM VERT.
3	RT. FASCIA BEAM	582.79	43.500	579.17	550.40	**28.77**	OK	CLR = 23'-0"
4	RT. FASCIA BEAM	581.93	46.000	578.10	548.98	**29.12**	OK	
5	RT. FASCIA BEAM	574.67	43.500	571.05	540.74	**30.31**	OK	MINIMUM VERT.
6	RT. FASCIA BEAM	574.40	43.500	570.78	540.41	**30.37**	OK	CLR = 17'-0"

SCI-823-0.00

SR 823 MAINLINE OVER NORFOLK SOUTHERN RAILROAD AND US-23 / RAMP D

VERTICAL CLEARANCES

Filename: \\aries\proj\TranSystems\319861\19415\structures documents\Step 7 - Type Study\Bridge SCI823-1601C 823 over Railroad_US23\[SR823_RR_Vert_Clr.xls]Alternative 1

By: DGS Date: #######

Checked: Date:

LEGEND:

User Input - Not Critical

User Input - Critical to Output

Alternative 7 - 66" Steel Plate Girder

PROFILE DATA - NORFOLK SOUTHERN RAILWAY

Use existing top of high rail elevations, as profile adjustments to the railroad are not anticipated in this project.

POINT	RAILROAD LOCATION		RAILROAD STATION	RAILROAD - EXISTING ELEV. @ POINT
1	Top of Rail	East	n/a	550.53
2	Top of Rail	West	n/a	549.22
3	Top of Rail	East	n/a	550.40
4	Top of Rail	West	n/a	548.98

PROFILE DATA - RAMP D

POINT	RAMP D LOCATION	EXISTING ELEV. @ US-23 EDGE OF PVMT.	DISTANCE ACROSS TAPER	PAVEMENT X-SLOPE	DISTANCE ACROSS SHLDR.	SHOULDER X-SLOPE	RAMP D - FINISHED GRADE @ POINT
5	RT. EDGE OF PVMT	540.91	10.66	-1.6%		-4.0%	540.74
6	RT. EDGE OF SHLDR.	540.91	10.72	-1.6%	8.23	-4.0%	540.41

PROFILE DATA - SR 823 MAINLINE

Linear:

PVT Sta. 875+00.00 PVC Sta. 904+00.00

PVT Elev. 646.63 PVC Elev. 559.63

g -3.00%

Superelevation Data:

Station	Pavement
875+00.00	-1.6%
904+00.00	-1.6%

POINT	SR 823 MAINLINE LOCATION DESCRIPTION	STA.	OFF.	SR 823 PG ELEV.	PAVEMENT X-SLOPE	SR 823 - FINISHED GRADE @ POINT
1	LT. FASCIA GIRDER	895+91.29	22.25	583.89	-1.6%	583.53
2	LT. FASCIA GIRDER	896+20.02	22.25	583.03	-1.6%	582.67
3	RT. FASCIA GIRDER	896+15.97	22.25	583.15	-1.6%	582.79
4	RT. FASCIA GIRDER	896+44.79	22.25	582.28	-1.6%	581.93
5	RT. FASCIA GIRDER	898+86.70	22.25	575.03	-1.6%	574.67
6	RT. FASCIA GIRDER	898+95.70	22.25	574.76	-1.6%	574.40

STRUCTURE DEPTH

Haunch + Max. Top Flange = 3.0 in

POINT	GIRDER DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total	
1	66" Steel Plate Girder	8.50	2.00	1.0	66	2.0	-	79.50	in
2	66" Steel Plate Girder	8.50	2.00	1.0	66	2.0	-	79.50	in
3	66" Steel Plate Girder	8.50	2.00	1.0	66	2.0	-	79.50	in
4	66" Steel Plate Girder	8.50	2.00	1.0	66	2.0	-	79.50	in
5	66" Steel Plate Girder	8.50	2.00	1.0	66	2.0	-	79.50	in
6	66" Steel Plate Girder	8.50	2.00	1.0	66	2.0	-	79.50	in

VERTICAL CLEARANCE - SR 823 MAINLINE OVER NORFOLK SOUTHERN RAILROAD AND US-23 / RAMP D

POINT	LOCATION	SR 823 MAINLINE - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. GIRDER ELEVATION	RR / RAMP D - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)		
1	LT. FASCIA GIRDER	583.53	79.500	576.91	550.53	**26.38**	OK	
2	LT. FASCIA GIRDER	582.67	79.500	576.05	549.22	**26.83**	OK	MINIMUM VERT.
3	RT. FASCIA GIRDER	582.79	79.500	576.17	550.40	**25.77**	OK	CLR = 23'-0"
4	RT. FASCIA GIRDER	581.93	79.500	575.30	548.98	**26.32**	OK	
5	RT. FASCIA GIRDER	574.67	79.500	568.05	540.74	**27.31**	OK	MINIMUM VERT.
6	RT. FASCIA GIRDER	574.40	79.500	567.78	540.41	**27.37**	OK	CLR = 17'-0"

SCI-823-0.00

SR 823 MAINLINE OVER NORFOLK SOUTHERN RAILROAD AND US-23 / RAMP D

VERTICAL CLEARANCES

Filename: \\aries\proj\TranSystems\319861\19415\structures documents\Step 7 - Type Study\Bridge SCI823-1601C 823 over Railroad_US23\[SR823_RR_Vert_Clr.xls]Alternative 1

By: DGS Date: #######

Checked: Date:

LEGEND:

User Input - Not Critical

User Input - Critical to Output

Alternative 8 - 78" Steel Plate Girder

PROFILE DATA - NORFOLK SOUTHERN RAILWAY

Use existing top of high rail elevations, as profile adjustments to the railroad are not anticipated in this project.

POINT	RAILROAD LOCATION		RAILROAD STATION	RAILROAD - EXISTING ELEV. @ POINT
1	Top of Rail	East	n/a	550.53
2	Top of Rail	West	n/a	549.22
3	Top of Rail	East	n/a	550.40
4	Top of Rail	West	n/a	548.98

PROFILE DATA - RAMP D

POINT	RAMP D LOCATION	EXISTING ELEV. @ US-23 EDGE OF PVMT.	DISTANCE ACROSS TAPER	PAVEMENT X-SLOPE	DISTANCE ACROSS SHLDR.	SHOULDER X-SLOPE	RAMP D - FINISHED GRADE @ POINT
5	RT. EDGE OF PVMT	540.91	10.66	-1.6%		-4.0%	540.74
6	RT. EDGE OF SHLDR.	540.91	10.72	-1.6%	8.23	-4.0%	540.41

PROFILE DATA - SR 823 MAINLINE

Linear:

PVT Sta. 875+00.00 PVC Sta. 904+00.00

PVT Elev. 646.63 PVC Elev. 559.63

g -3.00%

Superelevation Data:

Station	Pavement
875+00.00	-1.6%
904+00.00	-1.6%

POINT	SR 823 MAINLINE LOCATION DESCRIPTION	STA.	OFF.	SR 823 PG ELEV.	PAVEMENT X-SLOPE	SR 823 - FINISHED GRADE @ POINT
1	LT. FASCIA GIRDER	895+91.29	22.25	583.89	-1.6%	583.53
2	LT. FASCIA GIRDER	896+20.02	22.25	583.03	-1.6%	582.67
3	RT. FASCIA GIRDER	896+15.97	22.25	583.15	-1.6%	582.79
4	RT. FASCIA GIRDER	896+44.79	22.25	582.28	-1.6%	581.93
5	RT. FASCIA GIRDER	898+86.70	22.25	575.03	-1.6%	574.67
6	RT. FASCIA GIRDER	898+95.70	22.25	574.76	-1.6%	574.40

STRUCTURE DEPTH

Haunch + Max. Top Flange = 4.0 in

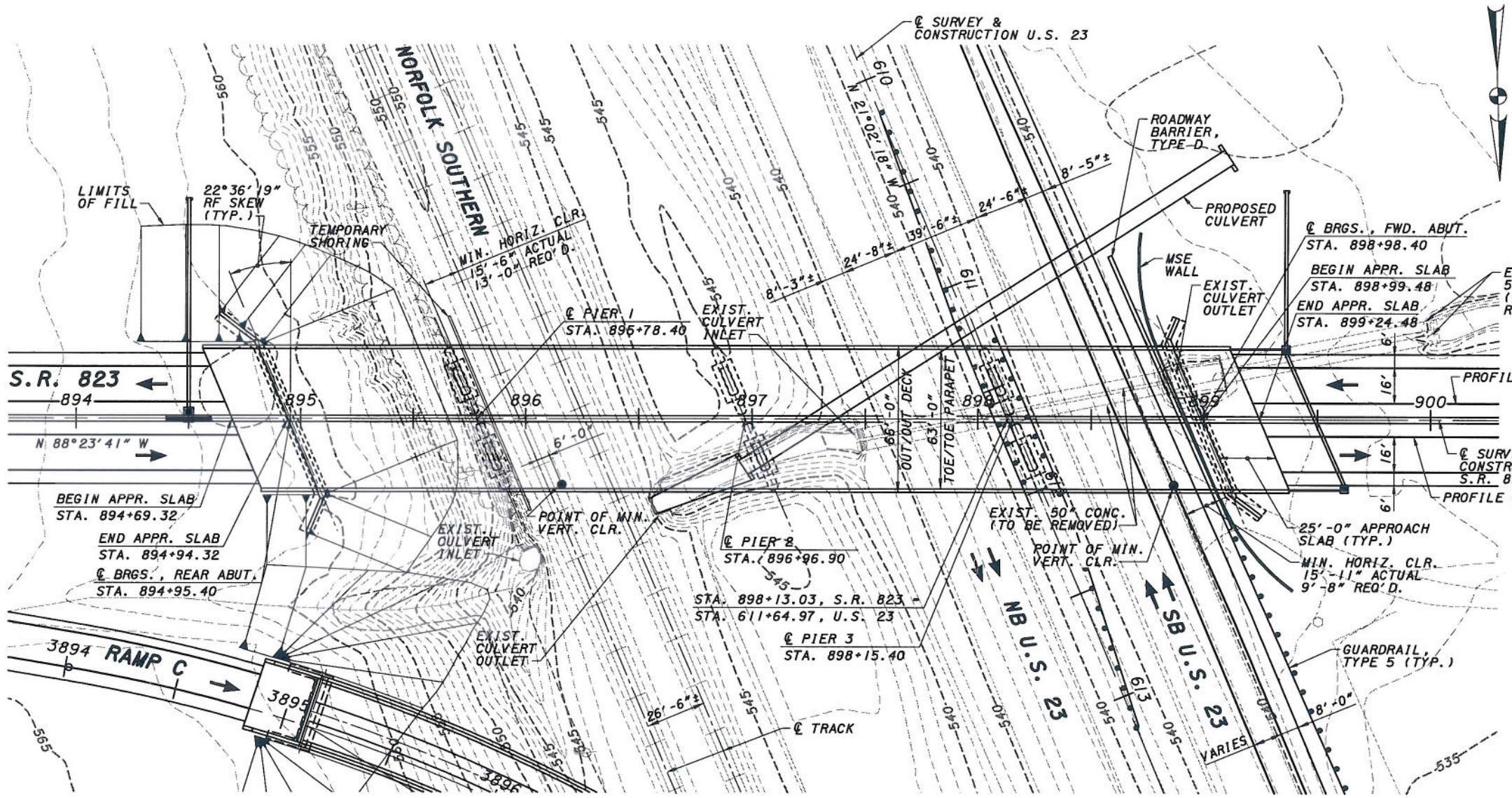
POINT	GIRDER DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	78" Steel Plate Girder	8.50	2.00	2.0	78	2.0	-	92.50 in
2	78" Steel Plate Girder	8.50	2.00	2.0	78	2.0	2.5	95.00 in
3	78" Steel Plate Girder	8.50	2.00	2.0	78	2.0	-	92.50 in
4	78" Steel Plate Girder	8.50	2.00	2.0	78	2.0	2.5	95.00 in
5	78" Steel Plate Girder	8.50	2.00	2.0	78	2.0	-	92.50 in
6	78" Steel Plate Girder	8.50	2.00	2.0	78	2.0	-	92.50 in

VERTICAL CLEARANCE - SR 823 MAINLINE OVER NORFOLK SOUTHERN RAILROAD AND US-23 / RAMP D

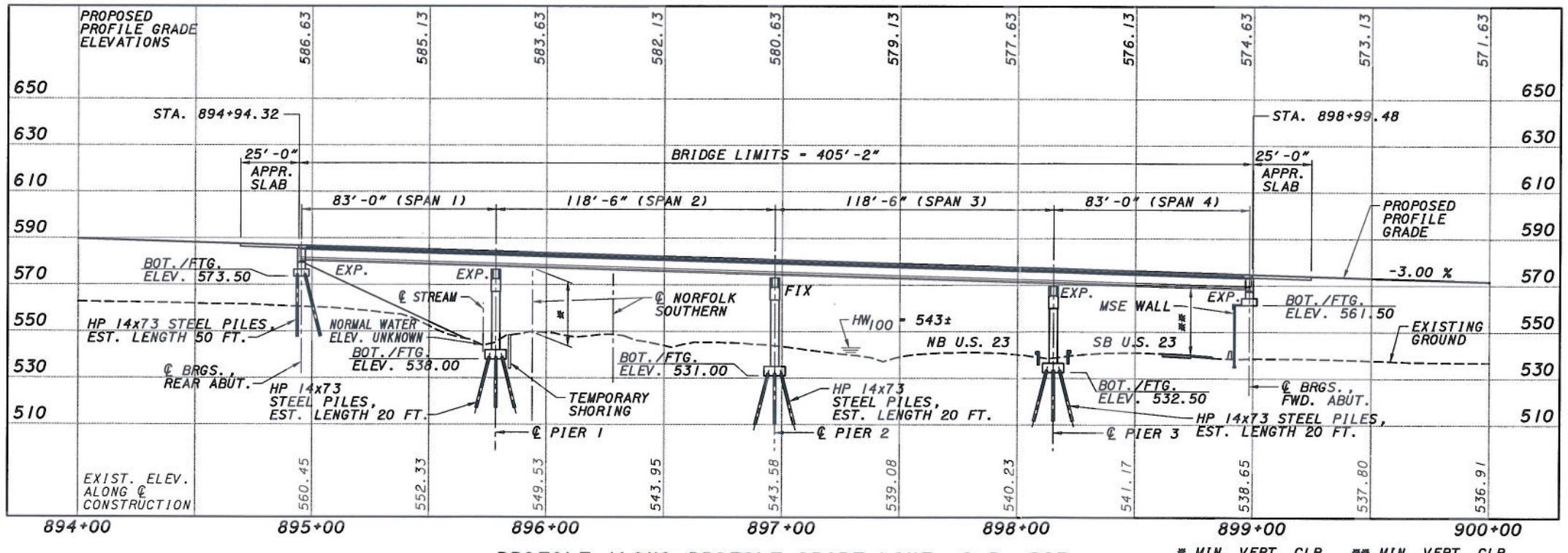
POINT	LOCATION	SR 823 MAINLINE - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. GIRDER ELEVATION	RR / RAMP D - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)		
1	LT. FASCIA GIRDER	583.53	92.500	575.83	550.53	**25.30**	OK	
2	LT. FASCIA GIRDER	582.67	95.000	574.76	549.22	**25.54**	OK	MINIMUM VERT.
3	RT. FASCIA GIRDER	582.79	92.500	575.08	550.40	**24.68**	OK	CLR = 23'-0"
4	RT. FASCIA GIRDER	581.93	95.000	574.01	548.98	**25.03**	OK	
5	RT. FASCIA GIRDER	574.67	92.500	566.96	540.74	**26.22**	OK	MINIMUM VERT.
6	RT. FASCIA GIRDER	574.40	92.500	566.69	540.41	**26.28**	OK	CLR = 17'-0"

APPENDIX D

Preliminary Structure Site Plans



PLAN

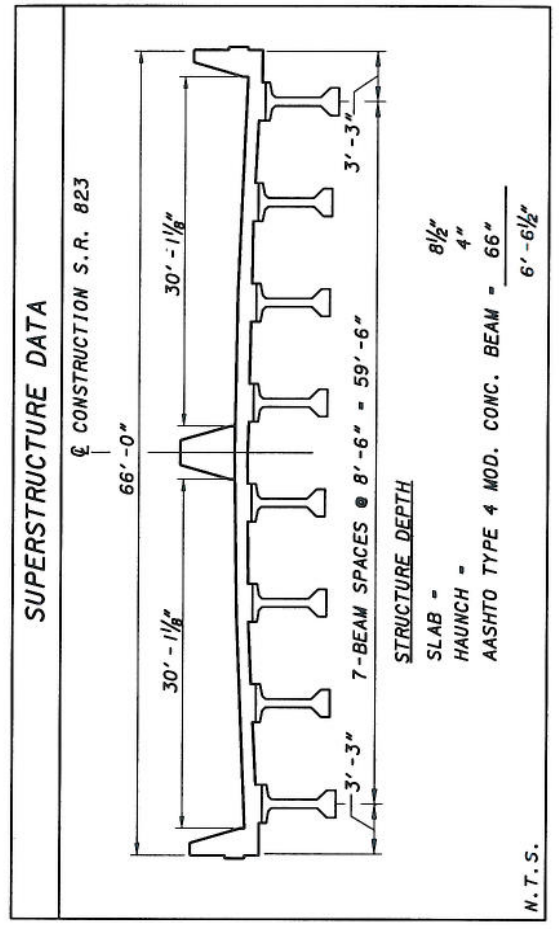


PROFILE ALONG PROFILE GRADE LINE, S.R. 823

* MIN. VERT. CLR. 25'-10" ACTUAL 23'-0" REQ'D.

** MIN. VERT. CLR. 27'-4" ACTUAL 17'-0" REQ'D.

SUPERSTRUCTURE DATA



PROPOSED STRUCTURE

TYPE: FOUR-SPAN COMPOSITE PRESTRESSED CONCRETE I-BEAMS WITH REINFORCED CONCRETE DECK ON SEMI-INTEGRAL ABUTMENTS WITH SIDE-BY-SIDE T-TYPE PIERS

LENGTH OF SPAN:

ROADWAY:

SIDEWALK:

DESIGN LOADING:

SKEW:

WEARING SURFACE:

APPROACH SLABS:

ALIGNMENT:

CROWN:

LATITUDE:

LONGITUDE:

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

DESIGNED	DRAWN	REVIEWED	DATE
WRT	MME	GAS	07/05
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

SCIOTO COUNTY
STA. 894+94.32
TO STA. 898+99.48

SCI-823-0.00

SITE PLAN

BRIDGE NO. SCI-823-1601

S.R. 823 OVER NORFOLK SOUTHERN & U.S. 23 - ALT. 1

-/-

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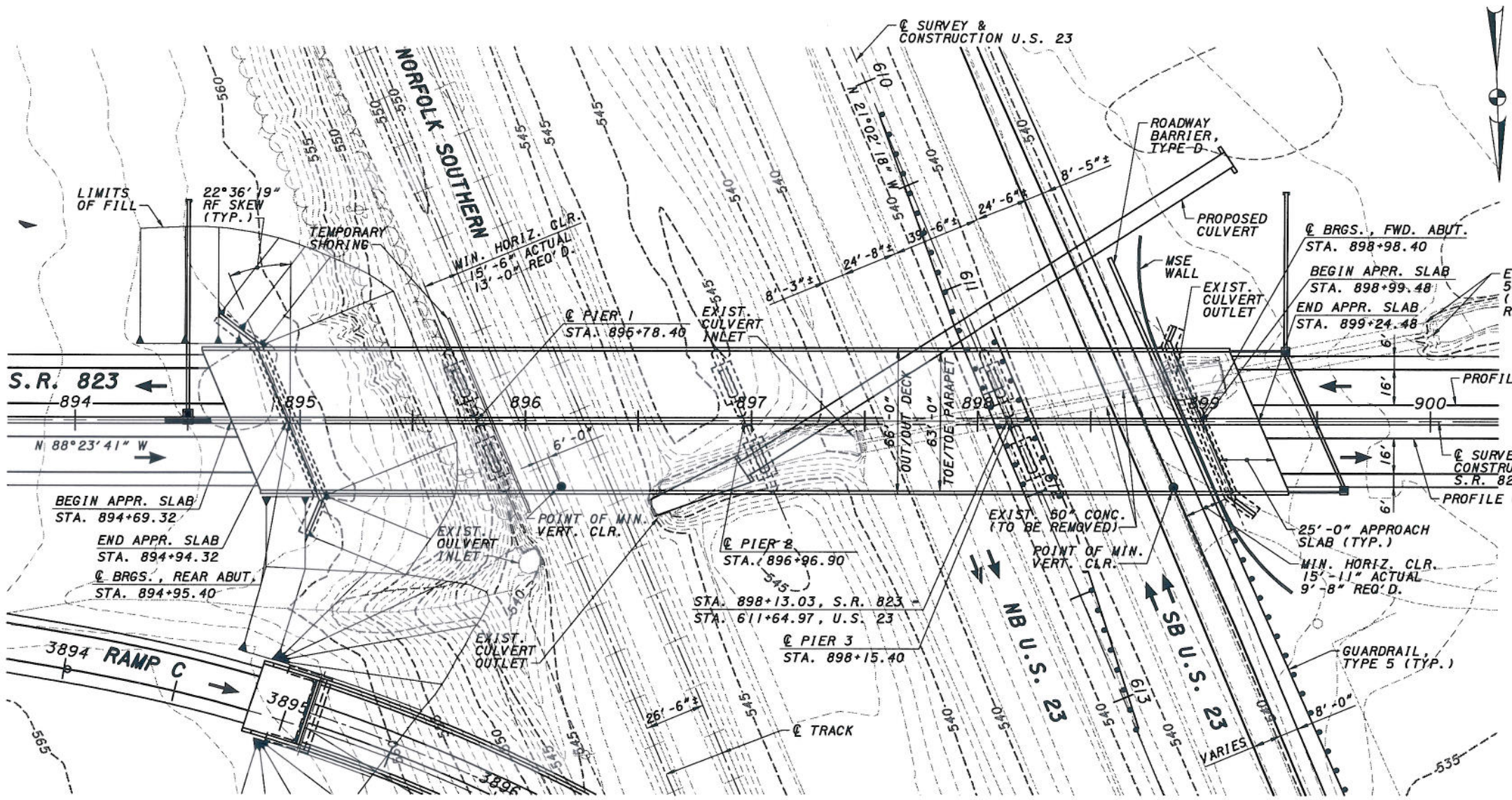
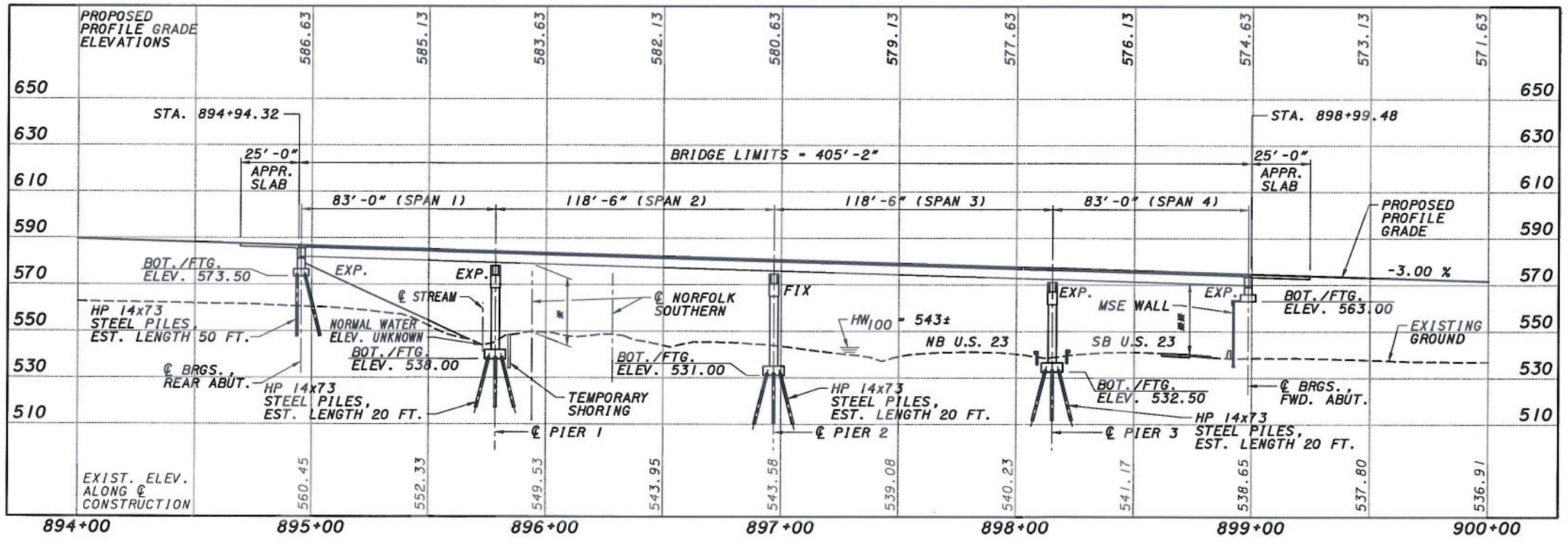


PLAN

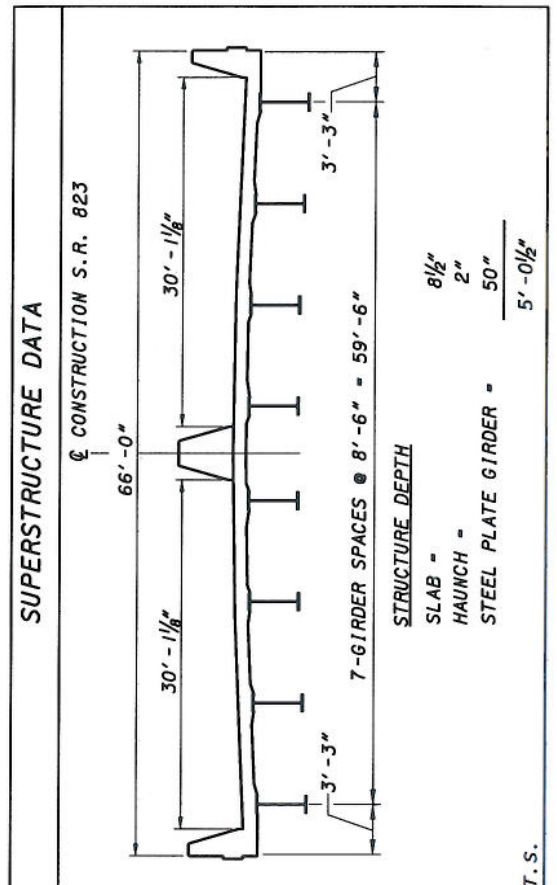


PROFILE ALONG PROFILE GRADE LINE, S.R. 823

* MIN. VERT. CLR. 27'-1" ACTUAL 23'-0" REQ'D.

** MIN. VERT. CLR. 28'-10" ACTUAL 17'-0" REQ'D.

SUPERSTRUCTURE DATA



STRUCTURE DEPTH

SLAB - 8½"

HAUNCH - 2"

STEEL PLATE GIRDER - 50" / 5'-0½"

PROPOSED STRUCTURE

TYPE: FOUR-SPAN COMPOSITE STEEL PLATE GIRDERS (NON-PAINTED ASTM A709, GR 50W) WITH REINFORCED CONCRETE DECK ON SEMI-INTEGRAL ABUTMENTS WITH SIDE-BY-SIDE T-TYPE PIERS

LENGTH OF SPAN:

ROADWAY:

SIDEWALK:

DESIGN LOADING:

SKEW:

WEARING SURFACE:

APPROACH SLABS:

ALIGNMENT:

CROWN:

LATITUDE:

LONGITUDE:

DESIGN AGENT
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

DRAWN	REVIEWED	DATE
MME	GAS	07/05
DESIGNED	REVISED	STRUCTURE FILE NUMBER
WRT		
CHECKED		
DGS		

SCIOTO COUNTY
STA. 894+94.32
TO STA. 898+99.48

SITE PLAN
BRIDGE NO. SCI-823-1601
S.R. 823 OVER NORFOLK SOUTHERN & U.S. 23 - ALT. 2

SCI-823-0.00

1 / 1

melben
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melben 07/14/2005
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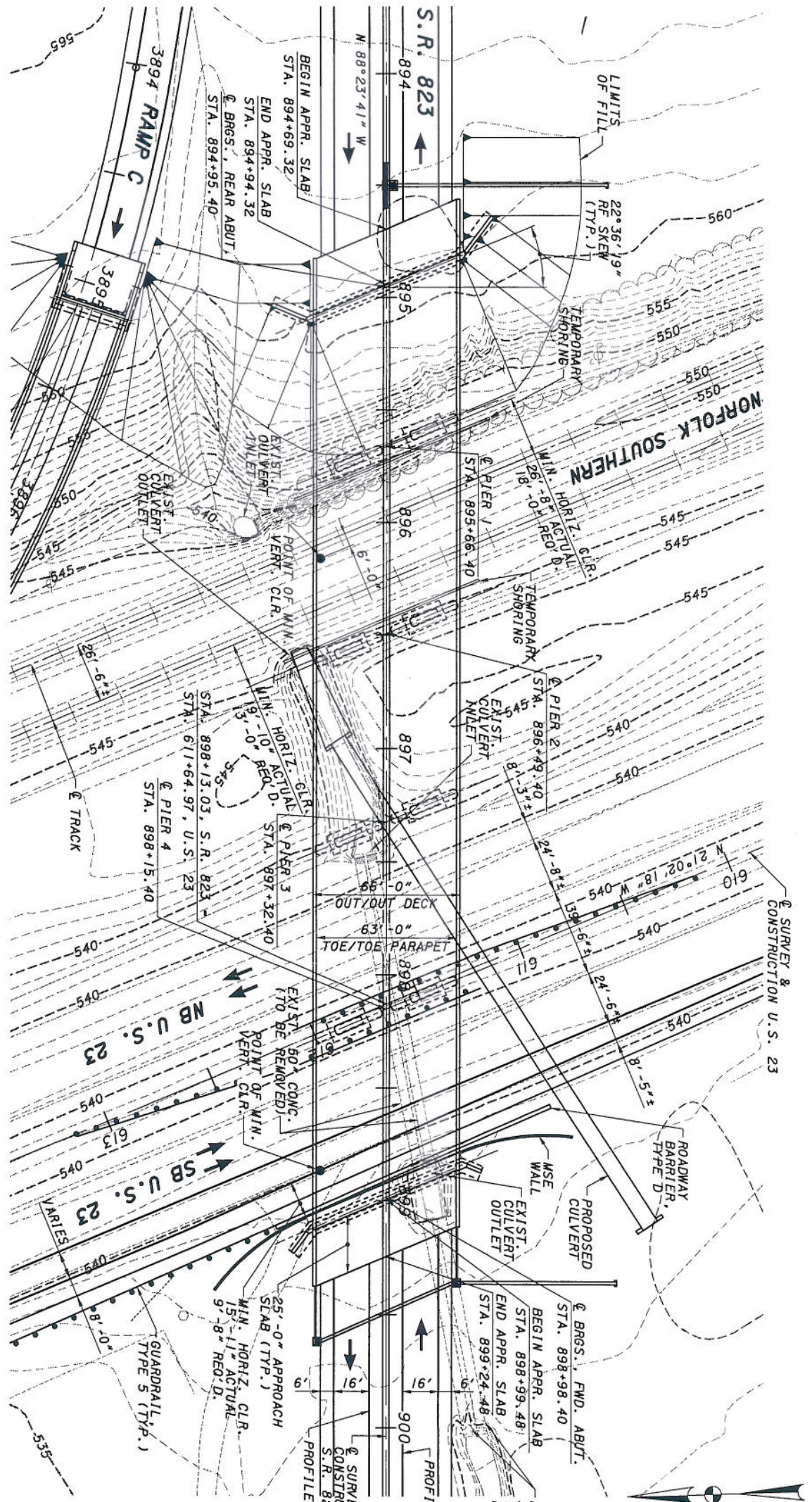
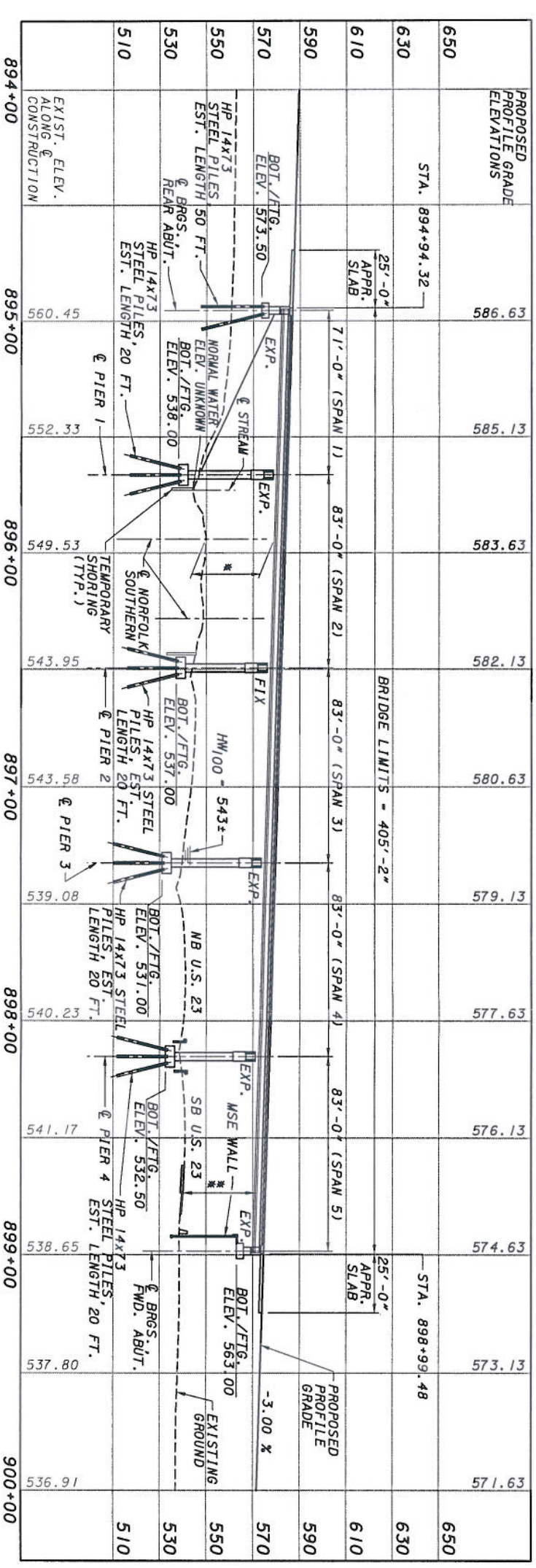


PLAN

PROFILE ALONG PROFILE LINE, S.R. 823



* MIN. VERT. CLR. 27'-7" ACTUAL 23'-0" REQ'D.

** MIN. VERT. CLR. 29'-1" ACTUAL 17'-0" REQ'D.

PROPOSED STRUCTURE

TYPE: FIVE-SPAN COMPOSITE PRESTRESSED CONCRETE I-BEAMS WITH REINFORCED CONCRETE DECK ON SEMI-INTEGRAL ABUTMENTS WITH SIDE-BY-SIDE T-TYPE PIERS

LENGTH OF SPAN: ROADWAY:

SIDEWALK:

DESIGN LOADING:

SKEW:

WEARING SURFACE:

APPROACH SLABS:

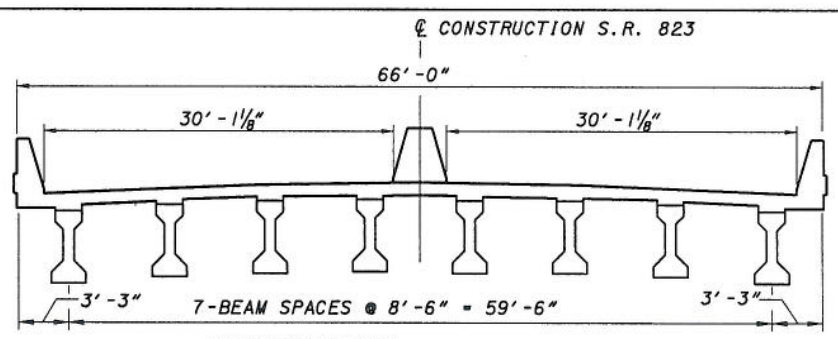
ALIGNMENT:

CROWN:

LATITUDE:

LONGITUDE:

SUPERSTRUCTURE DATA



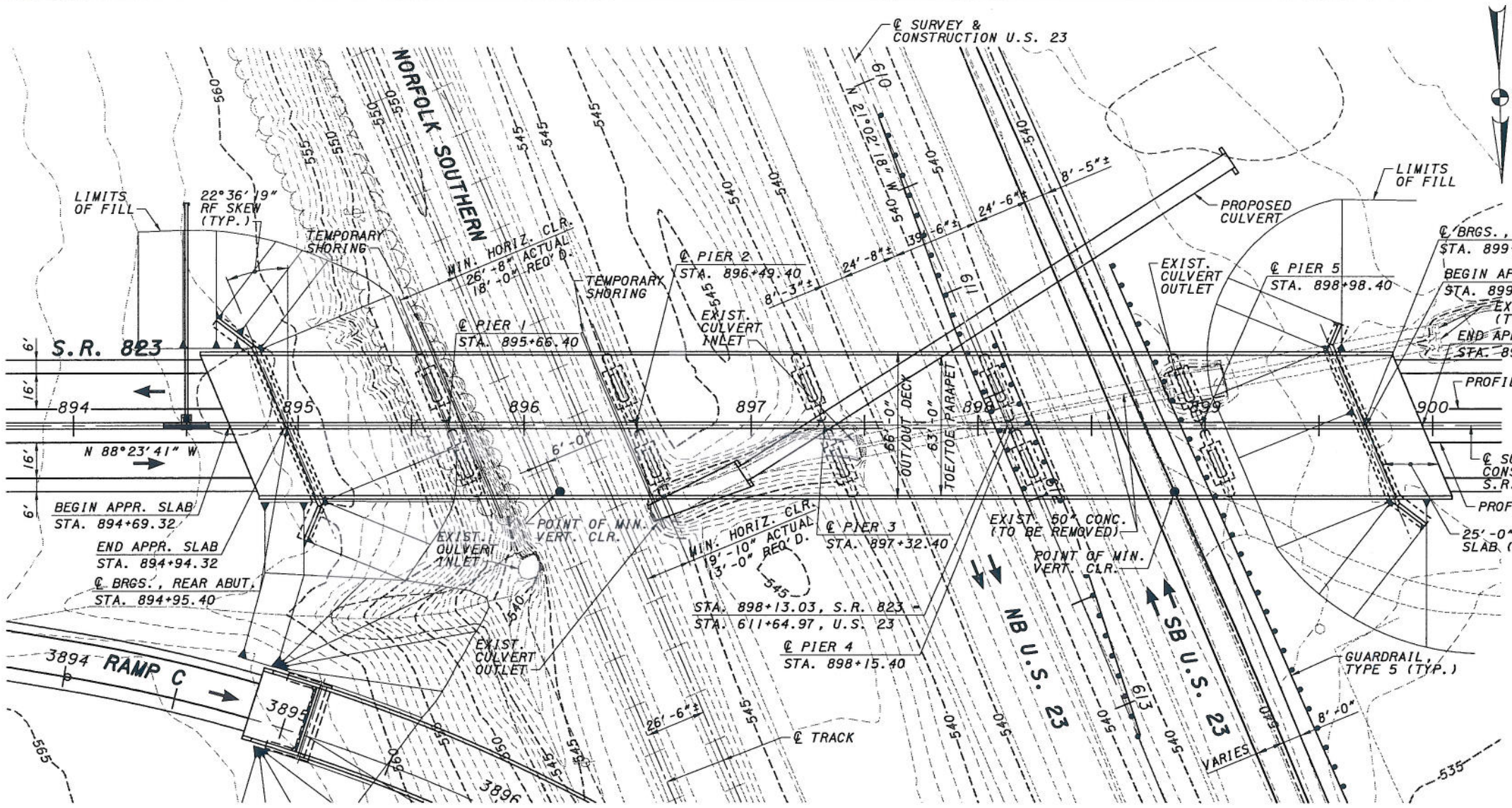
STRUCTURE DEPTH

SLAB =	8½"
HAUNCH =	4"
AASHTO TYPE 3 CONC. BEAM =	45"
	4'-9½"

N.T.S.

1/1	SCI-823-0.00	SITE PLAN BRIDGE NO. SCI-823-1601 S.R. 823 OVER NORFOLK SOUTHERN & U.S. 23 - ALT. 3	SCIOTO COUNTY STA. 894+94.32 TO STA. 898+99.48	DESIGNED WRT	DRAWN MME	REVIEWED GAS	DATE 07/05
				CHECKED DGS	REVISED	STRUCTURE FILE NUMBER	

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017



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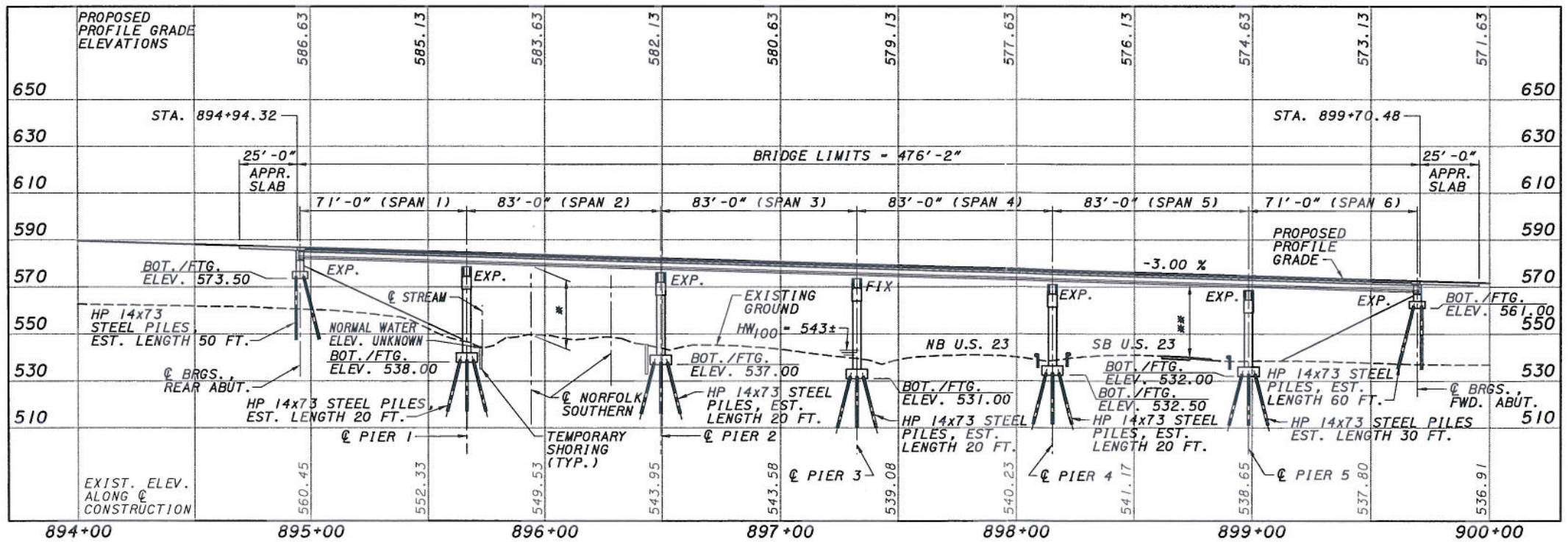
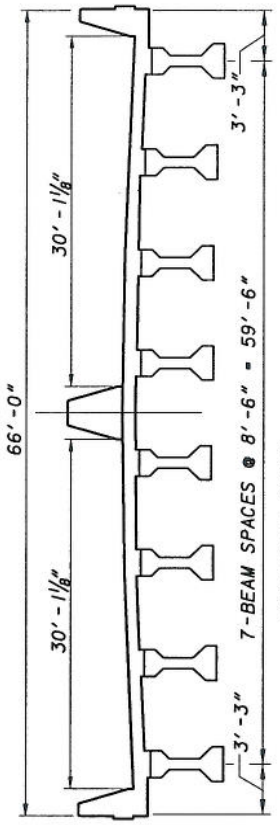


PROFILE ALONG PROFILE GRADE LINE, S.R. 823

* MIN. VERT. CLR. 27'-7" ACTUAL 23'-0" REQ'D.

** MIN. VERT. CLR. 29'-1" ACTUAL 17'-0" REQ'D.

SUPERSTRUCTURE DATA



STRUCTURE DEPTH

SLAB - 8½"

HAUNCH - 4"

AASHTO TYPE 3 CONC. BEAM - 45" / 4'-9½"

PROPOSED STRUCTURE

TYPE: SIX-SPAN COMPOSITE PRESTRESSED CONCRETE I-BEAMS WITH REINFORCED CONCRETE DECK ON SEMI-INTEGRAL ABUTMENTS WITH SIDE-BY-SIDE T-TYPE PIERS

LENGTH OF SPAN:

ROADWAY:

SIDEWALK:

DESIGN LOADING:

SKEW:

WEARING SURFACE:

APPROACH SLABS:

ALIGNMENT:

CROWN:

LATITUDE:

LONGITUDE:

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

DESIGNED	DRAWN	REVIEWED	DATE
WRT	MWE	GAS	07/05
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

SCIOTO COUNTY
STA. 894+94.32 TO STA. 899+70.48

SITE PLAN

BRIDGE NO. SCI-823-1601

S.R. 823 OVER NORFOLK SOUTHERN & U.S. 23 - ALT. 5

SCI-823-0.00

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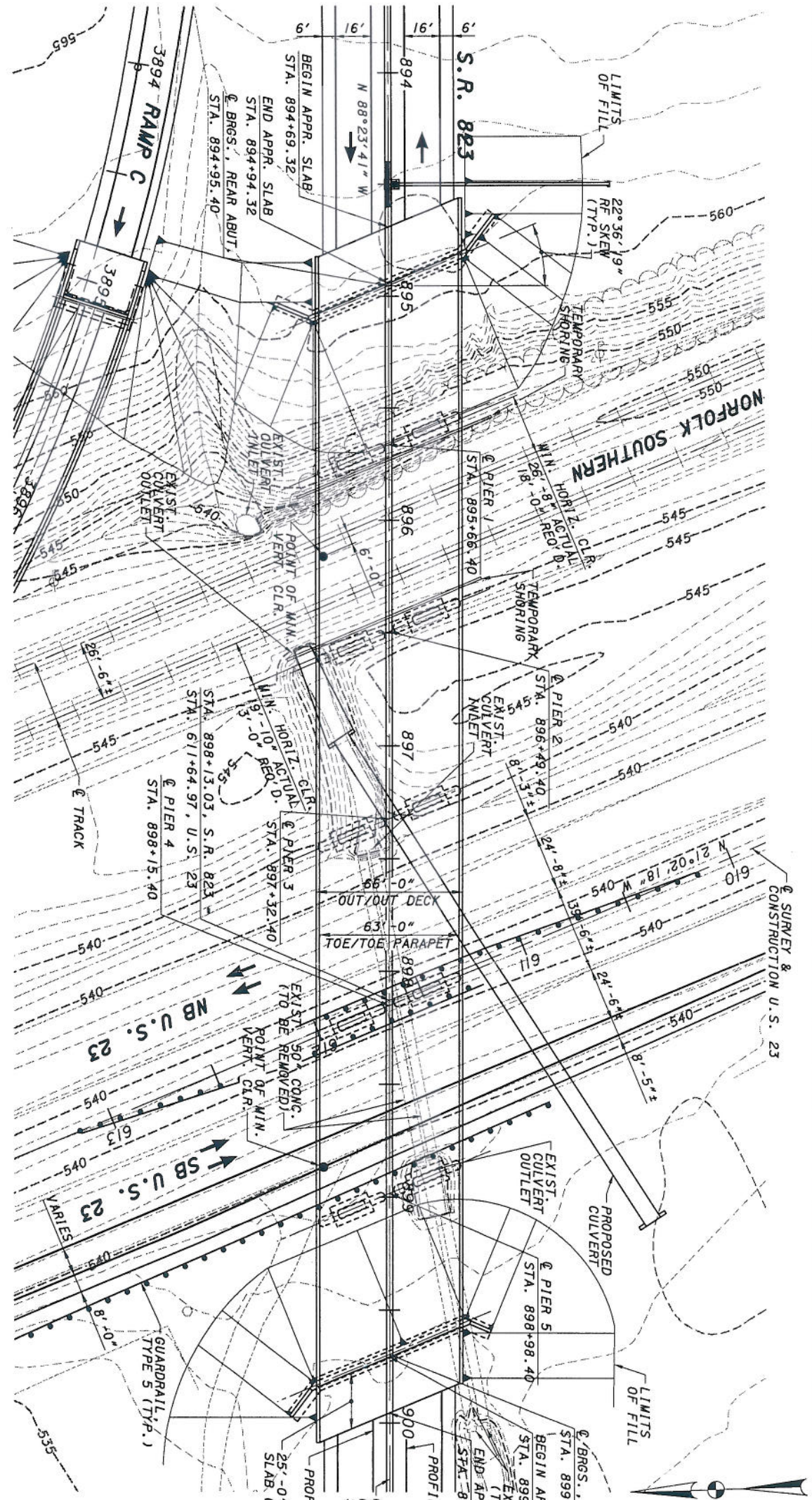


PLAN

PROFILE ALONG PROFILE GRADE LINE, S.R. 823

	894+00	895+00	896+00	897+00	898+00	899+00	900+00
PROPOSED PROFILE GRADE ELEVATIONS	650	630	610	590	570	550	530
	STA. 894+94.32						
	586.63	585.13	583.63	582.13	580.63	579.13	577.63
	576.13	574.63	573.13	571.63			
EXIST. ELEV. ALONG ℄ CONSTRUCTION	560.45	552.33	549.53	543.95	543.58	539.08	540.23
	541.17	538.65	537.80	536.91			
	510						

HP 14x73 STEEL PILES, EST. LENGTH 50 FT.
BOT./FTG. ELEV. 573.50
℄ REAR ABUT.
HP 14x73 STEEL PILES, EST. LENGTH 20 FT.
℄ PIER 1
NORMAL WATER ELEV. UNKNOWN
BOT./FTG. ELEV. 538.00
℄ STREAM
EXP.
25'-0" APPR. SLAB
71'-0" (SPAN 1)
83'-0" (SPAN 2)
℄ NORFOLK SOUTHERN
TEMPORARY SHORING (TYP.)
HP 14x73 STEEL PILES, EST. LENGTH 20 FT.
℄ PIER 2
BOT./FTG. ELEV. 537.00
HW 100 = 543±
EXISTING GROUND
℄ PIER 3
BOT./FTG. ELEV. 531.00
HP 14x73 STEEL PILES, EST. LENGTH 20 FT.
℄ PIER 4
BOT./FTG. ELEV. 532.50
HP 14x73 STEEL PILES, EST. LENGTH 20 FT.
℄ PIER 5
BOT./FTG. ELEV. 532.00
HP 14x73 STEEL PILES, EST. LENGTH 60 FT.
HP 14x73 STEEL PILES EST. LENGTH 30 FT.
BOT./FTG. ELEV. 561.00
℄ BRGS., FWD. ABUT.
83'-0" (SPAN 3)
BRIDGE LIMITS - 476'-2"
83'-0" (SPAN 4)
83'-0" (SPAN 5)
71'-0" (SPAN 6)
STA. 899+70.48
25'-0" APPR. SLAB
FIX
EXP.
NB U.S. 23
SB U.S. 23
-3.00 %
PROPOSED PROFILE GRADE

* MIN. VERT. CLR. 28'-9" ACTUAL 23'-0" REQ'D.
** MIN. VERT. CLR. 30'-3" ACTUAL 17'-0" REQ'D.

PROPOSED STRUCTURE

TYPE: SIX-SPAN COMPOSITE STEEL ROLLED BEAMS (NON-PAINTED ASTM A709, GR 50W) WITH REINFORCED CONCRETE DECK ON SEMI-INTEGRAL ABUTMENTS WITH SIDE-BY-SIDE T-TYPE PIERS

LENGTH OF SPAN:

ROADWAY:

SIDEWALK:

DESIGN LOADING:

SKEW:

WEARING SURFACE:

ALIGNMENT:

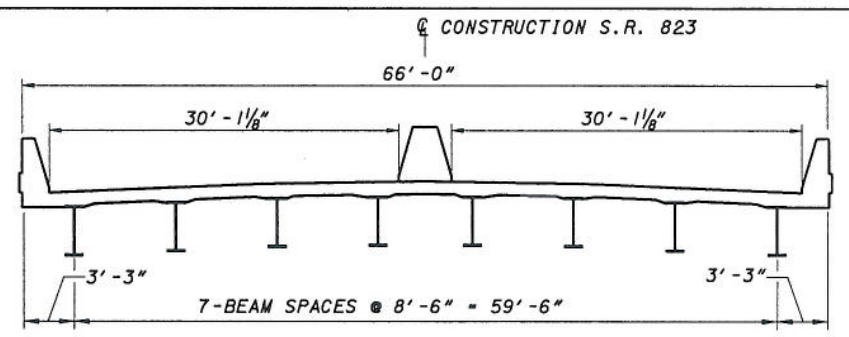
APPROACH SLABS:

CROWN:

LATITUDE:

LONGITUDE:

SUPERSTRUCTURE DATA

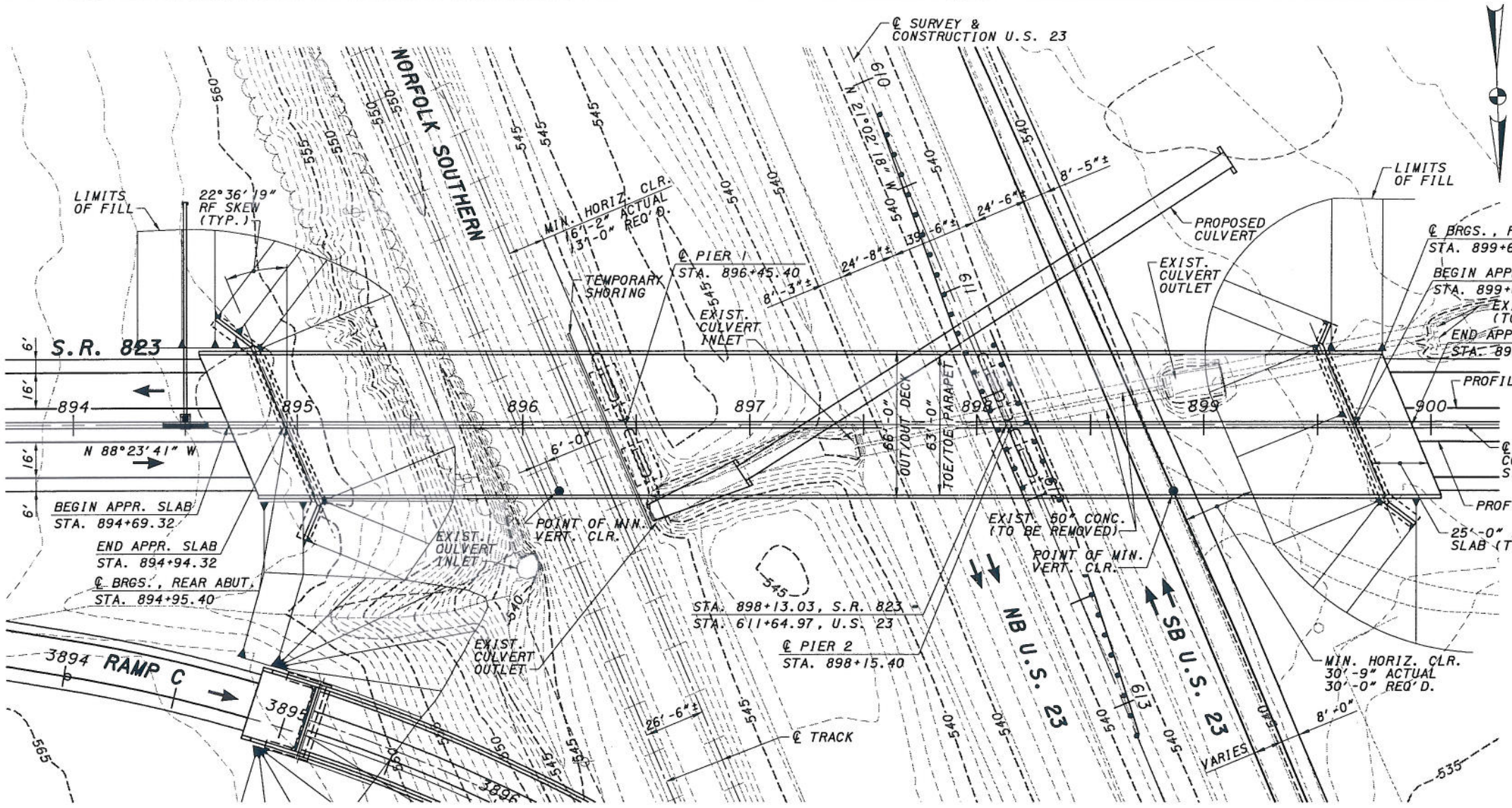


STRUCTURE DEPTH

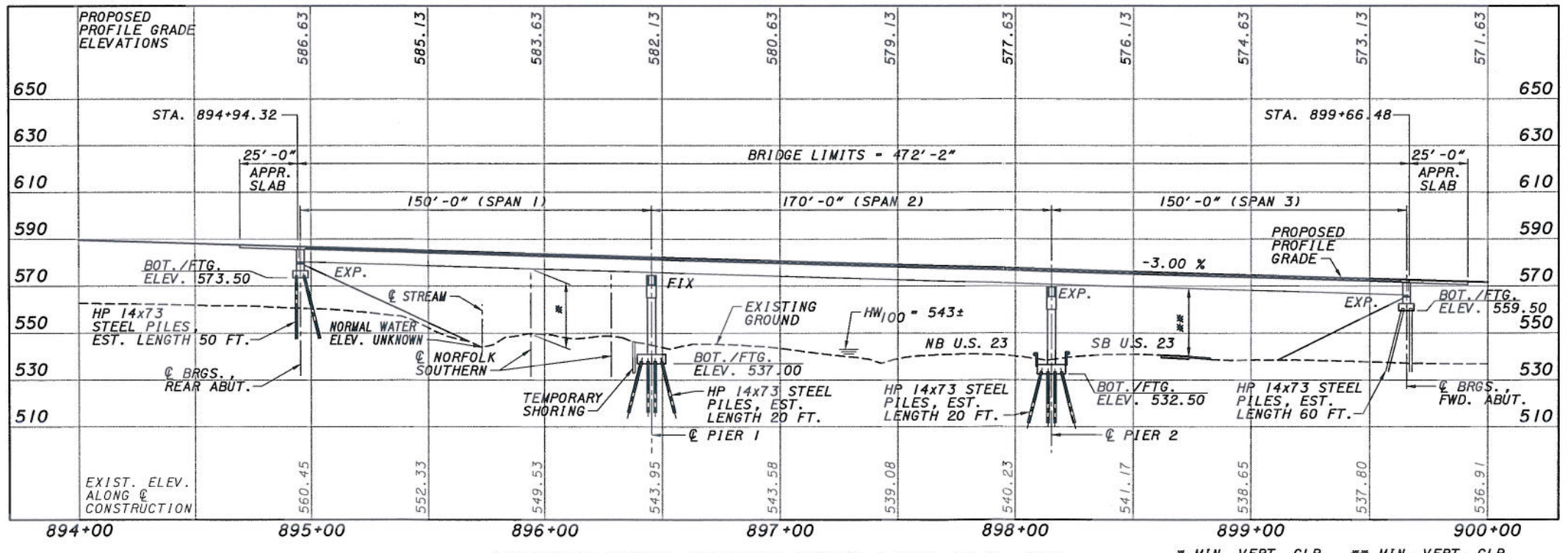
SLAB =	8½"
HAUNCH =	2"
W33 STEEL ROLLED BEAM =	33"
	3'-7½"

N.T.S.

1/1	SCI-823-0.00	SITE PLAN BRIDGE NO. SCI-823-1601 S.R. 823 OVER NORFOLK SOUTHERN & U.S. 23 - ALT. 6	SCIOTO COUNTY STA. 894+94.32 TO STA. 899+70.48	DESIGNED WRT / CHECKED DGS	DRAWN MME / REVISED	REVIEWED GAS / DATE 07/05 STRUCTURE FILE NUMBER	DESIGN AGENCY CH2MHILL 5775 Perimeter Drive, Suite 190 Dublin, Ohio 43017



PLAN



PROFILE ALONG PROFILE GRADE LINE, S.R. 823

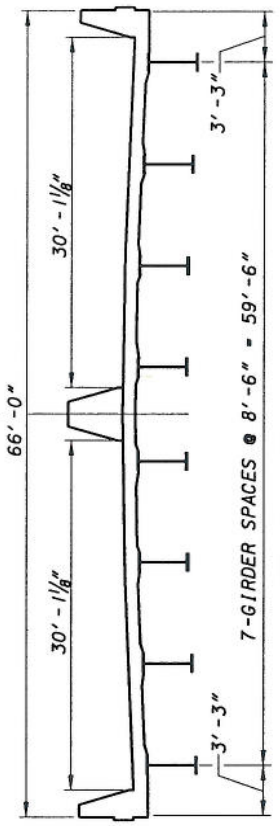
* MIN. VERT. CLR. 25'-9" ACTUAL 23'-0" REQ'D.

** MIN. VERT. CLR. 27'-3" ACTUAL 17'-0" REQ'D.

SUPERSTRUCTURE DATA

℄ CONSTRUCTION S.R. 823

66'-0"



STRUCTURE DEPTH

SLAB - 8½"

HAUNCH - 2"

STEEL PLATE GIRDER - 69" / 6'-7½"

N.T.S.

PROPOSED STRUCTURE

TYPE: THREE-SPAN COMPOSITE STEEL PLATE GIRDERS (NON-PAINTED ASTM A709, GR 50W) WITH REINFORCED CONCRETE DECK ON SEMI-INTEGRAL ABUTMENTS WITH SIDE-BY-SIDE T-TYPE PIERS

LENGTH OF SPAN:

ROADWAY:

SIDEWALK:

DESIGN LOADING:

SKEW:

WEARING SURFACE:

APPROACH SLABS:

ALIGNMENT:

CROWN:

LATITUDE:

LONGITUDE:

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

DESIGNED	DRAWN	REVIEWED	DATE
WAT	MME	GAS	07/05
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

SCIOTO COUNTY
STA. 894+94.32 TO STA. 899+66.48

SITE PLAN

BRIDGE NO. SCI-823-1601

S.R. 823 OVER NORFOLK SOUTHERN & U.S. 23 - ALT. 7

SCI-823-0.00

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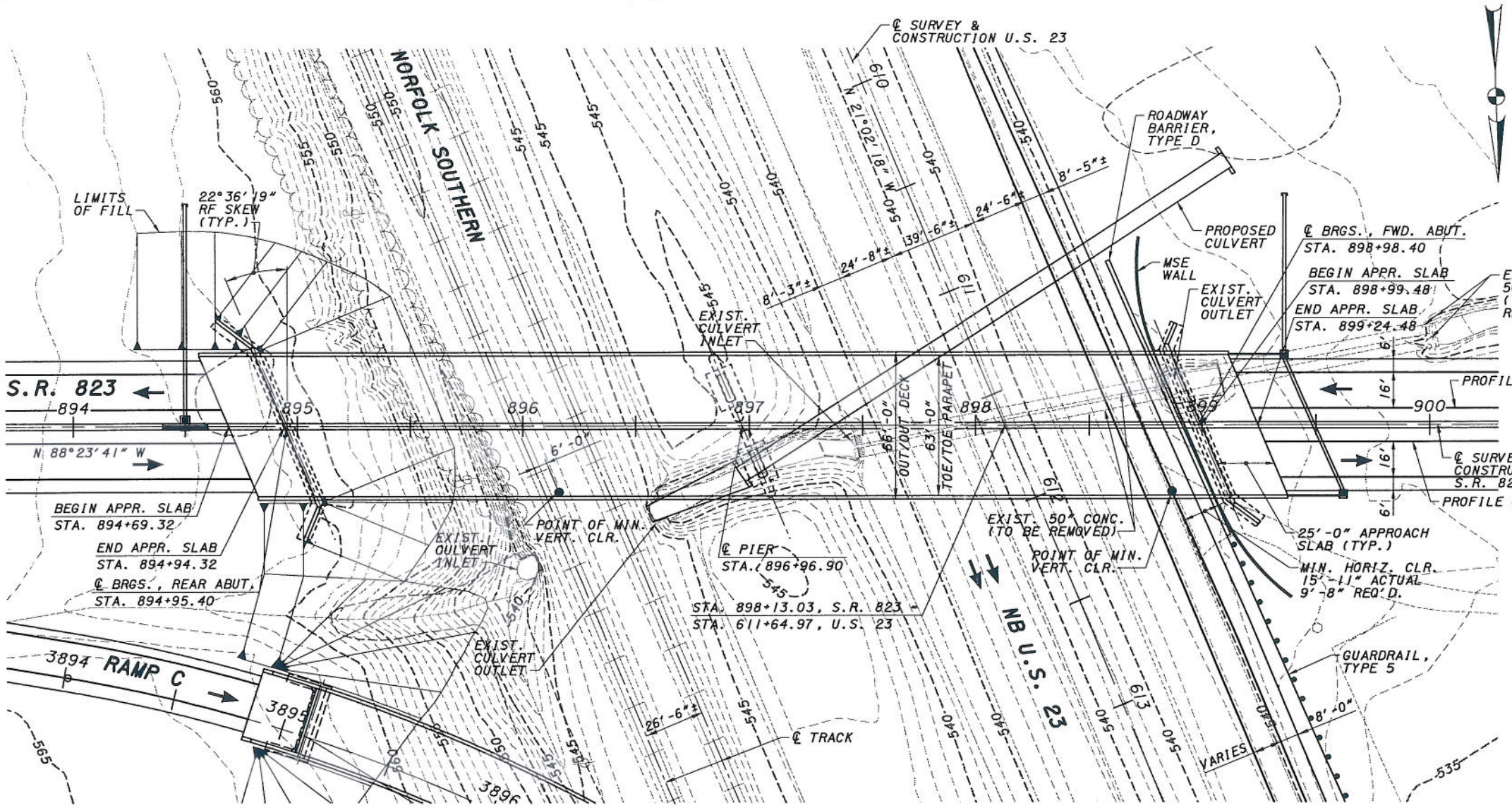

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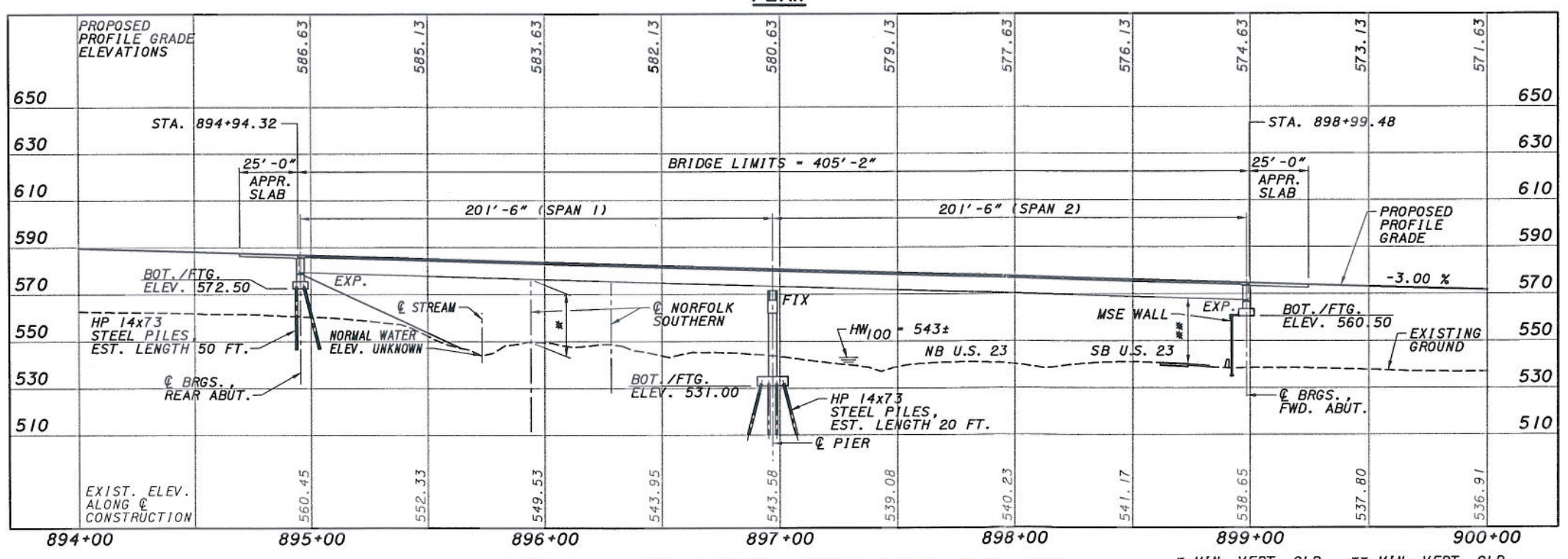

PROFILE ALONG PROFILE GRADE LINE, S.R. 823

* MIN. VERT. CLR. 24'-8" ACTUAL 23'-0" REQ'D.

** MIN. VERT. CLR. 26'-2" ACTUAL 17'-0" REQ'D.

PROPOSED STRUCTURE

TYPE: TWO-SPAN COMPOSITE STEEL PLATE GIRDERS (NON-PAINTED ASTM A709, GR 50W) WITH REINFORCED CONCRETE DECK ON SEMI-INTEGRAL ABUTMENTS WITH SIDE-BY-SIDE T-TYPE PIERS

LENGTH OF SPAN:

ROADWAY:

SIDEWALK:

DESIGN LOADING:

SKEW:

WEARING SURFACE:

APPROACH SLABS:

ALIGNMENT:

CROWN:

LATITUDE:

LONGITUDE:

SITE PLAN

BRIDGE NO. SCI-823-1601

S.R. 823 OVER NORFOLK SOUTHERN & U.S. 23 - ALT. 8

SCIOTO COUNTY
STA. 894+94.32
TO STA. 898+99.48

SCI-823-0.00

1 / 1

DESIGNED WRT
DRAWN MWE
CHECKED DGS
REVIEWED GAS
REVISED
DATE 07/05
STRUCTURE FILE NUMBER

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

APPENDIX E

Preliminary Foundation Recommendations

DLZ
ENGINEERS • ARCHITECTS • SCIENTISTS
PLANNERS • SURVEYORS

May 2, 2005

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

Re: **US 23 and SCI-823-0.00 Interchange**
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 structures at the US 23 and SCI-823-0.00 interchange to be located north of Lucasville, Ohio within the area of the Scioto County Fairgrounds. It is anticipated that six proposed bridges, and MSE walls along Ramps B and C, will be constructed as part of the interchange.

It is our understanding that the western portion of the interchange, Ramp A and Ramp D, will be constructed through earthwork and no structures will be constructed. The existing grade across the proposed interchange location is relatively flat with an elevation range between 530 and 570. Currently, the area has roadways for US 23 and Fairground Road (CR 55) as well as two sets of railroad tracks maintained by CSX Railroad. The area to the west of US 23 is primarily agricultural. It is anticipated that the SCI-823-0.00 mainline and majority of the interchange will require embankment construction with Ramps B and C requiring mostly mechanically stabilized earth (MSE) wall construction. At this time the embankment heights are unknown, however it is anticipated that as much as 50 feet of fill may be required in some areas of embankment and up to 25 feet of fill in areas of MSE wall construction.

The existing area of the proposed interchange is located within the Scioto River valley with the overburden being primarily composed of glacial and alluvial deposits. The following table briefly outlines the anticipated structures, and the attached plan indicated the location of the structures in proximity to existing features.

US 23 – SCI 823 Interchange Structures

Proposed Structure*	Approximate Location	Anticipated Number of Spans	Existing Grade Elevation**	Borings
Mainline Overpass #1	SCI-823 over Fairgrounds Rd	1	565 – 570	TR-55A, TR-56
Mainline Overpass #2	SCI-823 over US 23 & CSX RR.	3	533 – 555	TR-49A, TR-50A, TR-51, TR-52
Ramp B - #1	US 23 NB to SCI-823 over CSX RR	1	546 – 540	TR-60, TR-61
Ramp B - #2	US 23 NB to SCI-823 over Fairgrounds Rd.	2	564 – 570	TR-57, TR-58, TR-59A
Ramp C - #1	SCI-823 to US 23 NB over Fairgrounds Rd	1	565 – 568	TR-53A, TR-54
Ramp C - #2	SCI-823 to US 23 NB over CSX RR	2	543 – 550	TR-46, TR-47, TR-48

* As indicated on the attached plan.
** Established from established project topographic mapping.

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 sixteen structure borings, TR-46 through TR-48, TR-49A through TR-50A, TR-51, TR-52, TR-53, TR54A, TR-55A, TR-56 through TR-58, TR-59A, TR-60 and TR-61, were drilled at the proposed structures between March 14 and March 21, 2005. It should be noted that

five borings (TR-49, TR-50, TR-53, TR-55, and TR-59) were drilled during 2004, and were not used to prepare these preliminary foundation recommendations. These boring locations were moved due to an adjustment in the project coordinate system. The structure borings were drilled to depths between 25 and 45 feet below the ground surface. 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. Ground surface elevations at 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 a brief discussion of the subsurface conditions at each structure refer to the Conclusions and Recommendations section, or for more detailed information, please refer to the attached Boring Logs.

At the ground surface, topsoil was encountered to depths of 1 to 7 inches. Beneath the topsoil, subsurface materials encountered generally were interbedded granular and cohesive layers. The cohesive soils encountered ranged from sandy silt (A-4a) to silt and clay (A-6b), and ranged in consistency from medium stiff to very stiff. The granular soils encountered ranged from sandy silt (A-4a) to gravel with sand (A-1-b), and ranged in compactness form very loose to very dense. Natural moisture of the cohesive were generally damp to moist, and the granular layers were damp to wet.

Bedrock was encountered in all of the borings ranging in depth from 13.6 to 33.5 feet below the ground surface. The bedrock encountered was either shale that was very soft or soft, siltstone that was medium hard, or sandstone that was medium hard or hard, which was sometimes interbedded with the siltstone. Recovery of the core samples ranged from 70 to 100%, and RQD values ranged from 13 to 92% with an average RQD of 88%.

Seepage was detected in the majority of the borings ranging in depth from 13 to 30 feet below the ground surface. Seepage was generally detected within granular layers. No seepage was detected in Borings TR-53A, TR-54, and TR-56 through TR-58. Water levels recorded prior to coring ranged from dry to 26 feet below the ground surface, and at completion of drilling ranged from 3.5 to 19.0 feet below the ground surface. However, the final water levels include drilling water and may not be representative of the actual groundwater conditions. Groundwater levels may vary seasonally and will most likely be influenced by the Scioto River.

Conclusions and Recommendations

It appears that driven H-piles or drilled shafts on bedrock will be the best-suited foundation types for the support of the proposed structures. If high lateral or uplift loads are anticipated drilled shafts extending into bedrock may be needed. The actual design lengths, or rock sockets, will need to be designed based upon actual loading conditions. Spread footing foundations were evaluated for support of the structures. At the abutment locations, spread footing recommendations are based upon the assumption that the embankment fill will be properly placed and compacted in accordance with CMS Item 203: Roadway Excavation and Embankment. The following is a brief discussion of each structure.

Mainline Overpass - #1

Overpass #1 will be SCI-823-0.00 over Fairgrounds Road. Borings TR-55A, and TR-56 were drilled for this structure. Generally, these borings encountered cohesive soils at the ground surface consisting of silt and clay (A-6a), and silty clay (A-6b). These cohesive soils extended between 8.0 and 13.0 feet below the ground surface. Granular soils are located underlying the cohesive soils consisting of sandy silt (A-4a) and coarse and fine sand (A-3a). Bedrock was encountered at depths of 14.1 and 18.0 feet below the ground surface.

Due to the size of the structure, if H-piles are used, it is recommended that HP 14X73 H-pile sections, with a 95-ton capacity, be considered. H-piles should be driven to refusal to the top of bedrock. H-piles driven to refusal may be designed based on the full allowable capacity of the pile. An alternative to driven H-piles would be the use of drilled shafts extending to bedrock. It is anticipated that at the abutments, significant amounts of fill will be placed and spread footings within the embankment fills may be considered. It does not appear reasonable that spread footings extending to bedrock could be used at the abutments. The following table summarizes the site conditions and preliminary foundation recommendations.

Foundation Recommendations – Mainline Overpass - #1

Boring Number	Structural Element	Existing Ground Surface Elevation* (Feet)	Top of Rock Elevation* (Feet)	Estimated Drilled Shaft Tip Elevation* (Feet)	Allowable Bearing Capacity for Drilled Shafts (TSF)	Allowable Bearing Capacity for Spread Footings (TSF)**
TR-55A	Forward Abutment	565.5	547.5	543	15	1.5
TR-56	Rear Abutment	569.5	555.4	552	15	1.5

*Existing ground surface elevation was estimated from the established topographic mapping.
**Assuming spread footings founded on embankment fill.

Mainline Overpass - #2

Overpass #2 will SCI-823-0.00 over US 23 and CSX Railroad. Borings TR-49A through TR-52 were drilled for this structure. Topsoil was encountered at the ground surface ranging in depth between 1 and 2 inches, except at TR-49A, which did not encounter any topsoil. TR-50A encountered fill beneath the topsoil to a depth of 3.0 feet. Generally, beneath the topsoil the borings encountered cohesive soils at the ground surface consisting of silt and clay (A-6a), and silty clay (A-6b). ranging in consistency from stiff to hard. These cohesive soils extended between 8.0 and 20.5 feet below the ground surface. Granular soils are located underlying the cohesive soils ranging from sandy silt (A-4a) to gravel with sand (A-1-b). The granular soils were very loose to medium dense in compactness, with the majority of the layers being very loose of loose. Bedrock was encountered between depths of 24.5 and 33.5 feet below the ground surface. The bedrock encountered was shale and sandstone.

Due to the size of the structure, if H-piles are used, it is recommended that HP 14X73 H-pile sections, with a 95-ton capacity, be considered. H-piles should be driven to refusal to the top of bedrock. H-piles driven to refusal may be designed based on the full allowable capacity of the pile. An alternative to driven H-piles would be the use of drilled shafts extending to bedrock. It is anticipated that at the abutments, significant amounts of fill will be placed and spread footings within the embankment fills may be considered. It does not appear that spread footings extending to bedrock could be used at the abutment or pier locations. The following table summarizes the site conditions and preliminary foundation recommendations.

Foundation Recommendations – Mainline Overpass - #2

Boring Number	Structural Element	Existing Ground Surface Elevation* (Feet)	Top of Rock Elevation* (Feet)	Estimated Drilled Shaft Tip Elevation* (Feet)	Allowable Bearing Capacity for Drilled Shafts (TSF)	Allowable Bearing Capacity for Spread Footings (TSF)**
TR-49A	Forward Abutment	537.5	505.5	502	20	1.5
TR-50A	Pier 2	540.0	515.5	510	20	NA
TR-51	Pier 1	545.0	519.5	514	20	NA
TR-52	Rear Abutment	558.0	524.5	521	15	1.5

*Existing ground surface elevation was estimated from the established topographic mapping.
**Assuming spread footings founded on embankment fill.

Ramp B - #1

Ramp B-#1 will from US 23 northbound (NB) to SCI-823-0.00 over the CSX railroad. Borings TR-60 and TR-61 were drilled for this structure. A sandy silt (A-4a) fill was encountered at the ground surface in each boring and extended to depths of 3.0 and 5.5 feet below the ground surface. Beneath the fill, Boring TR-60 generally encountered granular soil ranging from sandy silt to coarse and fine sand (A-3a) in very loose to loose compactness to the top of rock at 28.0 feet. Boring TR-61 encountered a very stiff silt and clay (A-6a) to 10.5 feet, which was underlain by a very loose coarse to fine sand (A-3a). Bedrock was encountered at 23 feet below the ground surface. Bedrock encountered in borings was shale.

Due to the size of the structure, if H-piles are used, it is recommended that HP 14X73 H-pile sections, with a 95-ton capacity, be considered. H-piles should be driven to refusal to the top of bedrock. H-piles driven to refusal may be designed based on the full allowable capacity of the pile. An alternative to driven H-piles would be the use of drilled shafts extending bedrock. It does not appear reasonable that spread footings extending to bedrock could be used at either abutment due to the depth to bedrock. However, it is anticipated that at the abutments, significant amounts of fill will be placed and spread footings within the embankment fills may be considered. The following table summarizes the site conditions and preliminary foundation recommendations.

Foundation Recommendations – Ramp B - #1

Boring Number	Structural Element	Existing Ground Surface Elevation* (Feet)	Top of Rock Elevation* (Feet)	Estimated Drilled Shaft Tip Elevation* (Feet)	Allowable Bearing Capacity for Drilled Shafts (TSF)	Allowable Bearing Capacity for Spread Footings (TSF)**
TR-60	Forward Abutment	554	526	522	15	1.5
TR-61	Rear Abutment	547	524	520	15	1.5

*Existing ground surface elevation was estimated from the established topographic mapping.
**Assuming spread footings founded on embankment fill.

Ramp B - #2

Ramp B-#2 will be from US 23 northbound (NB) to SCI-823-0.00 over Fairground Road. Borings TR-57 through TR-59A were drilled for this structure. Borings TR-57 and TR-58 encountered cohesive soils at the ground surface consisting silt and clay (A-6a) ranging in consistency from stiff to hard. These cohesive soils extended between 14.0 and 8.0 feet below the ground surface, respectively. Granular soils are located underlying the cohesive soils, and at the ground surface at TR-59A, consisting of sandy silt (A-4a) and coarse and fine sand (A-3a). Generally, the granular soils were very loose to medium dense in compactness. Bedrock was encountered between depths of 14.0 and 21.5 feet below the ground surface.

Due to the size of the structure, if H-piles are used, it is recommended that HP 14X73 H-pile sections, with a 95-ton capacity, be considered. H-piles should be driven to refusal to the top of bedrock. H-piles driven to refusal may be designed based on the full allowable capacity of the pile. An alternative to driven H-piles would be the use of drilled shafts extending to bedrock. Spread footings founded on bedrock can be considered at the pier location, if no significant amounts of fill are to be placed. It is anticipated that at the abutments, significant amounts of fill will be placed and spread footings within the embankment fills may be considered. It does not appear reasonable that spread footings extending to bedrock could be used at the abutments. The following table summarizes the site conditions and preliminary foundation recommendations.

Foundation Recommendations – Ramp B - #2

Boring Number	Structural Element	Existing Ground Surface Elevation* (Feet)	Top of Rock Elevation* (Feet)	Estimated Drilled Shaft Tip Elevation*	Allowable Bearing Capacity for Drilled Shafts (TSF)	Estimated Spread Footing Elevation*	Allowable Bearing Capacity for Spread Footings (TSF)
TR-57	Forward Abutment	569.5	555.5	552	15	Unknown	1.5**
TR-58	Pier	567.0	553.0	549	15	551.0	12
TR-59A	Rear Abutment	564.5	543.0	538	15	Unknown	1.5**

*Existing ground surface elevation was estimated from the established topographic mapping. The Embankment heights at the abutment locations is not know at this time.
**Assuming spread footings founded on embankment fill.

Ramp C - #1

Ramp C-#1 is from SCI-823-00 northbound (NB) to US 23 NB over Fairground Road. Borings TR-53A and TR-54 were drilled for this structure. Generally, these borings encountered cohesive soils at the ground surface consisting of sandy silt (A-4a) and silt and clay (A-6a) ranging in consistency from stiff to hard. These cohesive soils extended between 5.5 and 10.5 feet below the ground surface. Coarse and fine sand (A-3a) granular soils are located underlying the cohesive soils, which range from very loose to loose in compactness. Shale bedrock was encountered at depths of 13.6 and 20.5 feet below the ground surface.

Due to the size of the structure, if H-piles are used, it is recommended that HP 14X73 H-pile sections, with a 95-ton capacity, be recommended. H-piles should be driven to refusal to the top of bedrock. H-piles driven to refusal may be designed based on the full allowable capacity of the pile. An alternative to driven H-piles would be the use of drilled shafts extending to bedrock. It is anticipated that at the abutments, significant amounts of fill will be placed and spread footings within the embankment fills may be considered. It does not appear reasonable that spread footings extending to bedrock could be used at the abutments due to the depth to bedrock. The following table summarizes the site conditions and preliminary foundation recommendations.

Foundation Recommendations – Ramp C - #1

Boring Number	Structural Element	Existing Ground Surface Elevation* (Feet)	Top of Rock Elevation* (Feet)	Estimated Drilled Shaft Tip Elevation*	Allowable Bearing Capacity for Drilled Shafts (TSF)	Allowable Bearing Capacity for Spread Footings (TSF)**
TR-53A	Forward Abutment	565.5	545.0	541	15	1.5
TR-54	Rear Abutment	567.5	553.9	550	15	1.5

*Existing ground surface elevation was estimated from the established topographic mapping.
**Assuming spread footings founded on embankment fill.

Ramp C - #2

Ramp C-#2 will be from SCI-823-0.00 northbound (NB) to US 23 NB over the CSX railroad. Borings TR-46 through TR-48 were drilled for this structure. Generally, these borings encountered inter-layered cohesive soils and granular soils. Cohesive layers encountered consisted of sandy silt (A-4a), silt and clay (A-6a), and clay (A-7-6). These layers ranged in consistency from stiff to very stiff. Granular soils encountered consisted of sandy silt (A-4a), coarse and fine sand (A-3a), gravel with sand and silt (A-2-4), and gravel with sand (A-1-b). These layers ranged in compactness from very loose to dense. Shale and sandstone bedrock was encountered at depths of 23.5 and 26.5 feet below the ground surface.

Due to the size of the structure, if H-piles are used, it is recommended that HP 14X73 H-pile sections, with a 95-ton capacity, be recommended. H-piles should be driven to refusal to the top of bedrock. H-piles driven to refusal may be designed based on the full allowable capacity of the pile. An alternative to driven H-piles would be the use of drilled shafts extending to bedrock. It is anticipated that at the abutments, significant amounts of fill will be placed and spread footings within the embankment fills may be considered. It does not appear reasonable that spread footings extending to bedrock could be used at the abutments due to the depth to bedrock. The following table summarizes the site conditions and preliminary foundation recommendations.

Foundation Recommendations – Ramp C - #2

Boring Number	Structural Element	Existing Ground Surface Elevation* (Feet)	Top of Rock Elevation* (Feet)	Estimated Drilled Shaft Tip Elevation*	Allowable Bearing Capacity for Drilled Shafts (TSF)	Allowable Bearing Capacity for Spread Footings (TSF)**
TR-46	Forward Abutment	543.0	517.0	513	20	1.5
TR-47	Pier	542.0	519.0	514	20	NR
TR-48	Rear Abutment	542.0	523.5	520	15	1.5

*Existing ground surface elevation was estimated from the established topographic mapping.
**Assuming spread footings founded on embankment fill.

MSE Wall Stability

Several MSE walls are proposed within the interchange, mainly along Ramps B and C. Based upon the borings drilled across the proposed interchange, it appears that global stability will not be an issue for the anticipated wall height. This is based on an assumption of a maximum wall height of 25 feet. Once the wall designs have been finalized the geometries of each wall will need to be evaluated for the global stability, sliding, overturning, and bearing capacity at each location. It should be noted that some settlement may be anticipated at some of the MSE wall locations, and wire-faced MSE walls may be considered if significant settlements are anticipated.

General Information

Minor amounts of settlement occurring within the very loose to loose granular soils are anticipated during construction of the embankments. Due to the granular nature of the soils, it is assumed that the settlement will occur during the earthwork activities, and will have been completed by the time the full height of the embankment has been constructed.

Because of the many geotechnical factors across the anticipated structure locations, and the design unknowns at this time, a detailed evaluation of all geotechnical parameters will need to be considered for the final design. It is strongly recommended that we discuss the proposed foundation design after TranSystems has had a chance to review these recommendations.

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PLANNERS • SURVEYORS

Closing

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

Sincerely,

DLZ OHIO, INC.

P. Paul Painter

P. Paul Painter
Engineering Geologist

Dorothy A. Adams for

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

Attachments: General Information – Drilling Procedures and Logs of Borings
Legend – Boring Log Terminology
Boring Location Plan
Boring Logs TR-46 through TR-61

cc: File

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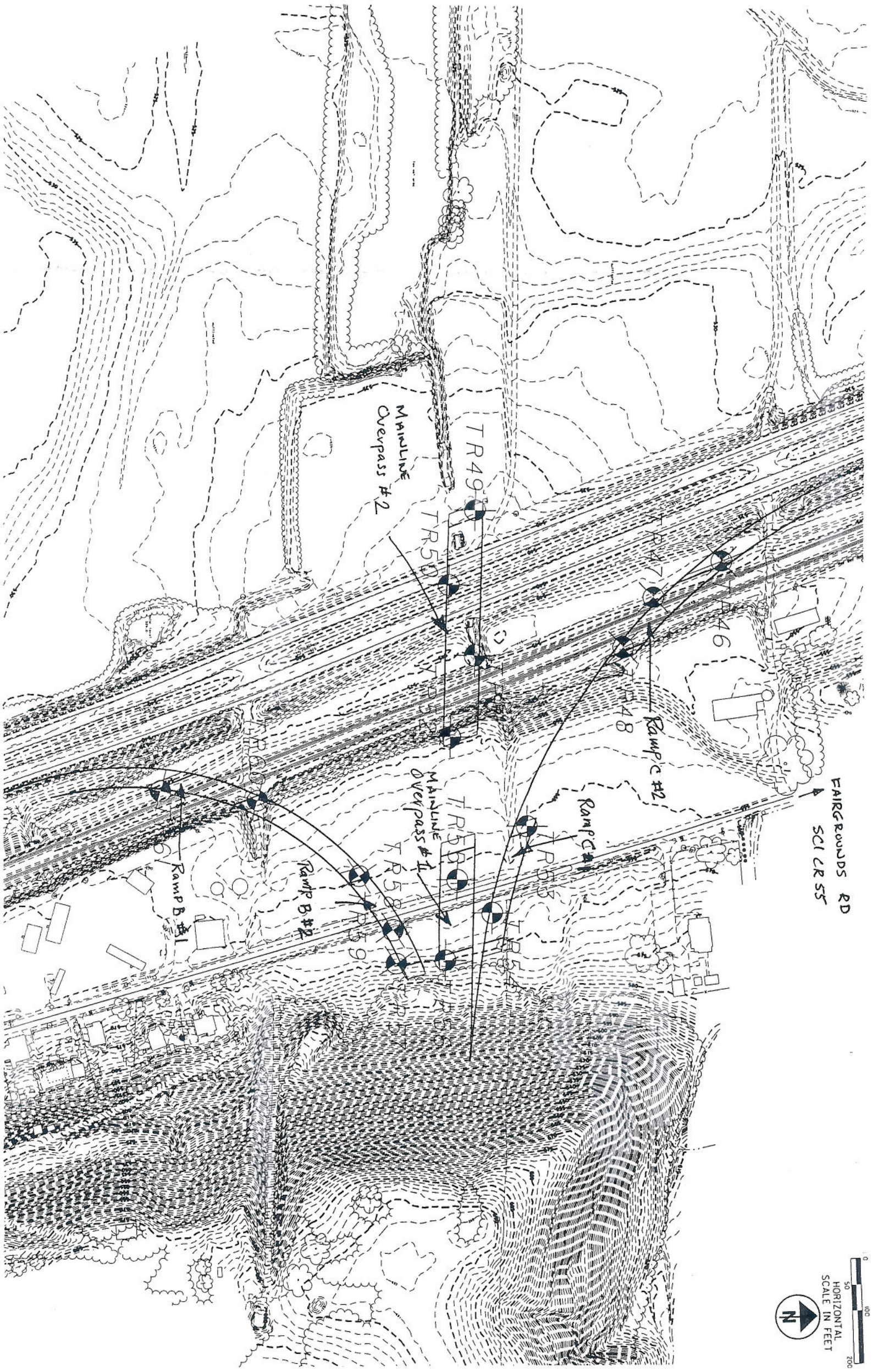

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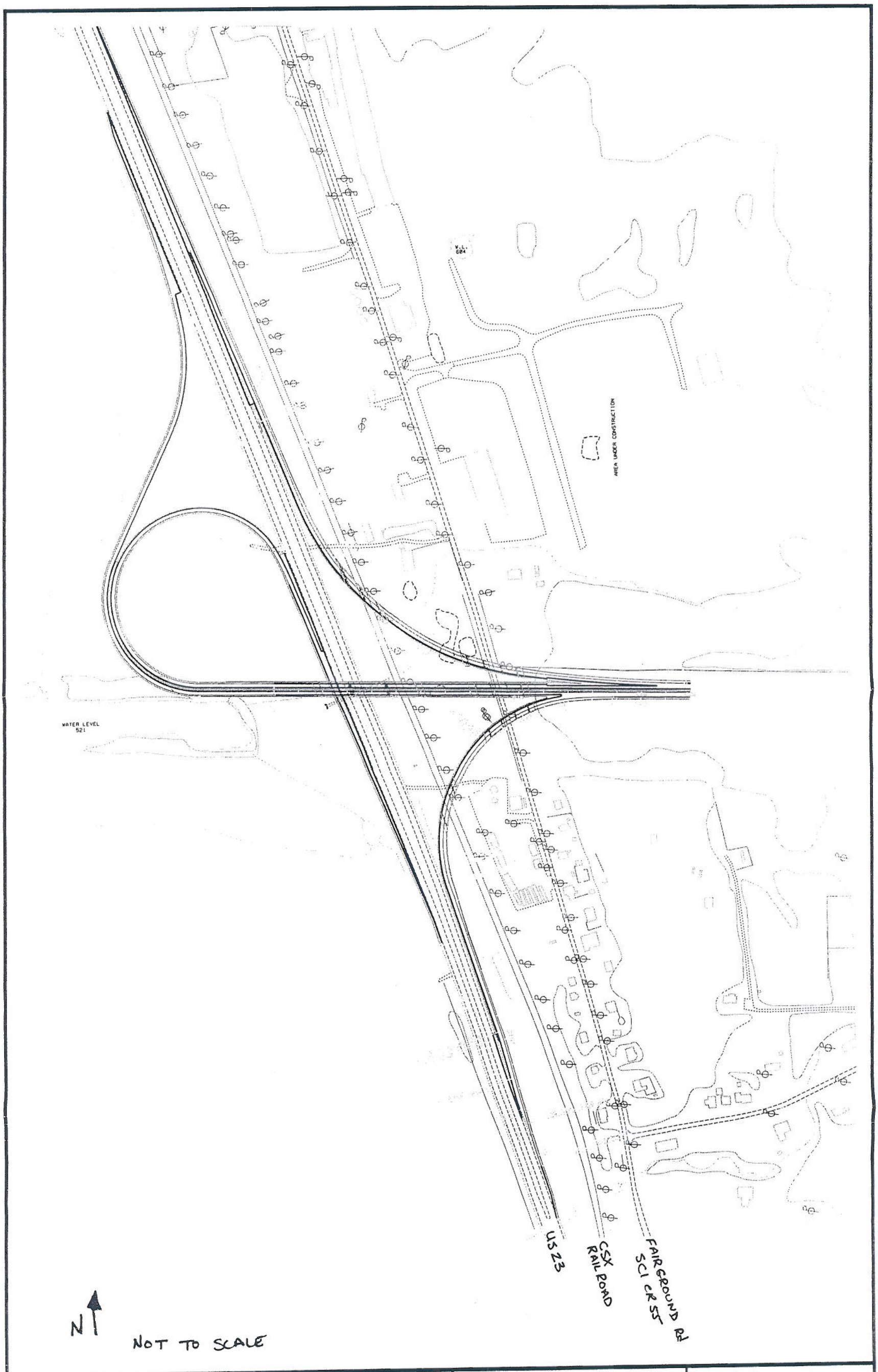
Boring Location Plan



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Ramp Layout

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

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.

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

LOG OF: Boring TR-46 | Location: Forward Abutment - Ramp C - #2 | Date Drilled: 03/17/05

WATER OBSERVATIONS: Water seepage at: 13.5'-19.0'
Water level at completion: 6.0' (Prior to coring)
5.0' (Including 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	STANDARD PENETRATION (N) / Natural Moisture Content, % / PL — LL / Blows per foot
0.1	543.0 / 542.9						Topsoil - 1"							
		2 1 1	2	1			FILL: Very loose brown and black GRAVEL WITH SAND (A-1-b), some silty clay; contains roots; damp.							
5		2 2 2	4	2				44	19	--	13	16	8	
5.5	537.5	3 3 3	18	3		2.0	Stiff brown SILT AND CLAY (A-6a), little fine to coarse gravel, trace fine to coarse sand; damp to moist.							
8.5	534.5	2 6 6	12	4			Medium dense brown and gray GRAVEL WITH SAND (A-1-b), little silty clay; moist.							
10		2 11 7	11	5				56	15	--	9	16	4	Non-Plastic
13.5	529.5	3 4 3	8	6			Loose brown GRAVEL WITH SAND (A-1-b), trace silt, trace clay; wet.							
15		5 4 4	12	7			@ 18.0', heaving sand.	33	31	--	13	20	3	Non-Plastic
19.0	524.0	16 15 20	14	8			Dense light brown GRAVEL WITH SAND AND SILT (A-2-4), trace clay, trace fine to coarse gravel; moist to wet.							
20		14 19 20	8	9										
		5 5 12	14	10			@ 23.0', gray.	30	11	--	24	25	9	
25														
26.0	517.0	50/3	3	11			Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, laminated to medium bedded, slightly fractured.							
							@ 29.4', very thin clay seam.							
30							@ 29.8', 30.8', thin clay seam.							

FILE: 0121-3070-01 [5/2/2005 3:15 PM]

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

LOG OF: Boring TR-46 | Location: Forward Abutment - Ramp C - #2 | Date Drilled: 03/17/05

WATER OBSERVATIONS: Water seepage at: 13.5'-19.0'
Water level at completion: 6.0' (Prior to coring)
5.0' (Including drill water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION
30	513.0						
		Core 120"	Rec 118"	RQD 83%	R1		Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, laminated to medium bedded, slightly fractured. @ 31.4', very thin clay seam. @ 31.6'-32.0', broken zone with clay and rock fragments. @ 33.4'-33.7', clay layer. @ 33.7'-34.2', cross bedded. @ 35.9', very thin clay seam.
35							
37.0	506.0						Bottom of Boring - 37.0'
40							
45							
50							
55							
60							

GRADATION: % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay

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

FILE: 0121-3070-03 [5/2/2005 3:15 PM]

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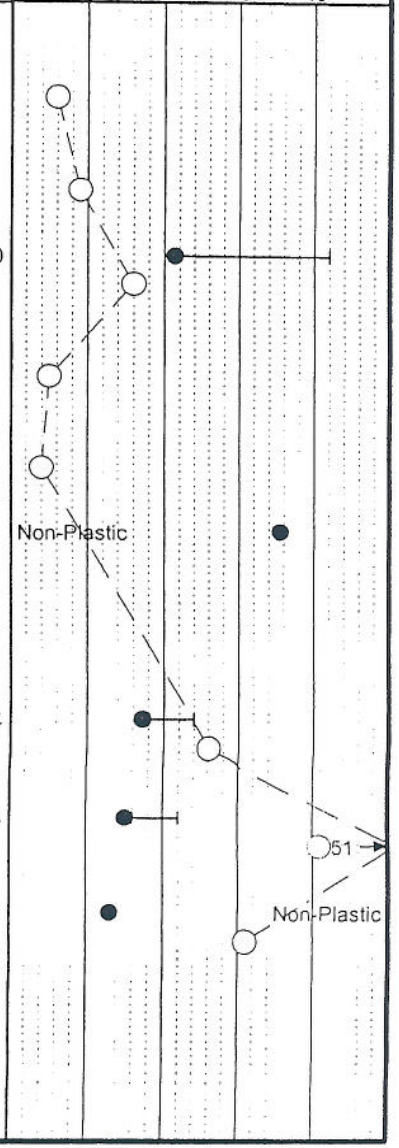
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-47 | Location: Pier location - Ramp C - #2 | Date Drilled: 03/17/05

WATER OBSERVATIONS: Water seepage at: 13.0'-18.0'
Water level at completion: 18.0' (Prior to coring)
9.0' (Including 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	542.0												
0.1	541.9						Topsoil - 1"						
		1 2 4	10	1		1.5	Stiff brown and gray CLAY (A-7-6), trace fine sand; slightly organic; moist.						
							@ 3.0', very stiff.						
5		2 4 5	13	2		2.5							
							@ 6.0', hard.						
7.0	535.0	4 6 10	15	3		4.5							
							Medium stiff brown SANDY SILT (A-4a), trace gravel, trace clay; moist to wet.	0	0	--	2	48	50
		1 3 2	10	4		0.5							
10													
		2 2 2	7	5		--							
13.0	529.0												
		WOH WOH WOH	18	6			Very loose brown COARSE AND FINE SAND (A-3a), trace clay; wet.	1	2	--	83	15	
15													
		WOH WOH 1	18	7									
18.0	524.0												
		11 14 12	10	8		1.5	Stiff brown SANDY SILT (A-4a), some gravel; moist.	30	11	--	24	22	14
20													
21.0	521.0	42 34 17	12	9		--	Very stiff to hard dark gray SANDY SILT (A-4a), little clay; moist.	15	9	--	35	26	15
23.0	519.0												
		4 10 21	11	10		--	Very soft black SHALE; highly weathered, carbonaceous, laminated, broken, contains silt filled high angle fracture.	29	23	--	31	12	5
25													
26.5	515.5	50/4	4	11									
							Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, laminated to medium bedded, slightly fractured. @ 26.7'-28.4',30.0'-30.2', vertical healed fracture.						
30													

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



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

LOG OF: Boring TR-47 | Location: Pier location - Ramp C - #2 | Date Drilled: 03/17/05

WATER OBSERVATIONS: Water seepage at: 13.0'-18.0'
Water level at completion: 18.0' (Prior to coring)
9.0' (Including 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	STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ⊢—⊣ LL Blows per foot - ○ 10 20 30 40
30	512.0	Core 120"	Rec 120"	RQD 74%	R1		Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, laminated to medium bedded, slightly fractured. @ 30.2'-32.4', 34.7'-35.4', high angle bedding. @ 31.8'-32.4, broken zone with thin clay seam. @ 33.1'-33.6', low angle healed fracture. @ 33.1'-33.6', high angle healed fracture. @ 33.7'-34.0', very argillaceous. @ 33.7', Highly weathered fracture.							
35														
36.5	505.5						Bottom of Boring - 36.5'							
40														
45														
50														
55														
60														

FILE: 0121-3070-03 [5/2/2005 3:15 PM]

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

LOG OF: Boring TR-48 | Location: Rear Abutment - Ramp C - #2 | Date Drilled: 3/21/05

WATER OBSERVATIONS: Water seepage at: 13.0'-18.0'
Water level at completion: 8.0' measured inside of augers

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	STANDARD PENETRATION (N)
0	547.0	2 2 3	14	1			FILL: Loose brown GRAVEL WITH SAND (A-1-b); contains mostly coal fragments and cinders; dry to damp.							
3.0	544.0	WOH WOH WOH	1	2			FILL: Very loose brown SILT AND CLAY (A-6a), little fine to coarse sand; contains roots, coal and cinder fragments; damp.							
6.5	540.5	WOH 2 3	16	3		2.5	Very stiff brown and gray SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; damp to moist.							
10		2 5 7	17	4		3.5		0	0	--	2	43	55	
		2 5 6	15	5		3.5								
13.0	534.0	1 2 2	5	6			Very loose brown COARSE AND FINE SAND (A-3a), little to some gravel, trace clay; wet.							
15		1 1 1	8	7				37	27	--	17	20		Non-Plastic
18.0	529.0	6 6 7	10	8			Medium dense brown SANDY SILT (A-4a), some gravel, little clay; moist.	52	14	--	15	12	7	Non-Plastic
20		2 7 30	15	9			@ 21.0', trace gravel and trace clay.							
23.5	523.5	20 15 50	12	10			Soft to medium hard black SHALE; very fine grained, slightly weathered, very thinly bedded, highly fractured. @ 25.3'-25.6', 26.0'-26.4', broken 27.15'-27.2', sandstone seam.							65 →
25														
30		Core 120"	Rec 120"	RQD 97%	R1									

PL ⊢ LL
Natural Moisture Content, % - ●
Blows per foot - ○
10 20 30 40

FILE: 0121-3070.03 [5/2/2005 3:15 PM]

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

LOG OF: Boring TR-48 | Location: Rear Abutment - Ramp C - #2 | Date Drilled: 3/21/05

WATER OBSERVATIONS: Water seepage at: 13.0'-18.0'
Water level at completion: 8.0' measured inside of augers

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
0.0	517.0												
29.9	517.1						Hard gray SANDSTONE; fine grained, slightly weathered, thinly bedded. @ 32.9' fracture						
35.0	512.0						Bottom of Boring - 35.0'						

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

FILE: 0121-3070-03 [5/2/2005 3:15 PM]

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

LOG OF: Boring TR-49A | Location: Forward Abutment - Mainline Overpass # 2 | Date Drilled: 3/21/05

WATER OBSERVATIONS: Water seepage at: 18.0'-28.0'
Water level at completion: 14.0' measured inside of augers

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	537.5	4 5 7	17	1		4.5+	Hard brown SILT AND CLAY (A-6a), little fine to coarse sand, trace gravel; damp.						
		3 4 4	16	2		4.0							
5		3 5 5	16	3		1.5	@ 6.0', stiff; moist.						
		2 2 3	17	4		1.0							
10		3 4 5	18	5		1.5	@ 11.0', little gravel.	23	16	--	9	30	22
13.0	524.5	WOH 2 2	18	6			Loose brown SANDY SILT (A-4a), trace to little gravel, trace clay; moist.	0	5	--	16	54	25
15													
15.5	522.0	1 2 3	18	7			Loose brown SILT (A-4b); moist.	0	0	--	1	67	33
18.0	519.5	WOH WOH WOH	3	8			Very loose brown GRAVEL WITH SAND (A-1-b), trace to little clay; moist to wet.						
20		5 9 18	12	9			@ 21.0', medium dense.	62	16	--	8	14	
		2 2 6	18	10									
25		6 5 8	13	11									
		10 43 50/4	18	12			@ 29.0', possible broken sandstone.						
30													

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

Non-Plastic

FILE: 0121-3070-03 [5/2/2005 3:15 PM]

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-49A | Location: Forward Abutment - Mainline Overpass # 2 | Date Drilled: 3/21/05

WATER OBSERVATIONS: Water seepage at: 18.0'-28.0'
Water level at completion: 14.0' measured inside of augers

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
30	507.5						Very loose brown GRAVEL WITH SAND (A-1-b), trace to little clay (possible broken sandstone); moist to wet.						
32.0	505.5						Medium hard gray SANDSTONE; fine grained, slightly weathered, argillaceous, broken, multiple clay seams, low and high angled fractures.						
		50/2	1	13									
35													
		Core 120"	Rec 84"	RQD 13%	R1								
40													
45.0	492.5						Bottom of Boring - 45.0'						
50													
55													
60													

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

FILE: 0121-3070-03 [5/2/2005 3:15 PM]

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-50A | Location: Pier # 2 - Mainline Overpass # 2 | Date Drilled: 3/22/05

WATER OBSERVATIONS: Water seepage at: 18.0'-25.0'
Water level at completion: 18.0' measured inside of augers

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	540.0												
0.1	539.9						Topsoil -1"						
		3 2 3	10	1			FILL: Loose dark brown SANDY SILT (A-4a), trace gravel; contains roots; damp.						
3.0	537.0												
		2 1 2	8	2		1.0	Stiff brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; moist.						
5													
		2 3 3	13	3		2.0	@ 6.0'-7.5', little to some gravel.						
		1 2 3	16	4		1.5		1	4	--	7	57	33
10													
10.5	529.5												
		1 2 3	18	5		1.25	Stiff brown SILTY CLAY (A-6b), little gravel, trace fine to coarse sand; moist to wet.	32	20	--	12	18	18
		WOH 2 3	18	6		1.5							
15													
		1 1 2	18	7		1.25	@ 16.0', trace gravel and some fine to coarse sand.						
18.0	522.0												
		WOH 1 3	16	8			Very loose to loose brown COARSE AND FINE SAND (A-3a), trace clay, trace gravel; wet.	15	40	--	23	21	
20													
21.0	519.0												
		2 5 11	16	9			Medium dense brown GRAVEL WITH SAND (A-1-b), trace clay; wet.	42	24	--	20	14	
		2 7 50	18	10									
24.5	515.5						Medium hard brownish gray SANDSTONE; highly weathered.						
25													
		25 37 50/4	10	11									
27.5	512.5						Hard gray SANDSTONE; fine grained, slightly weathered, argillaceous, medium bedded. @ 28.1',-28.7', 29.0'-29.1' clay seams						
30													

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

Non-Plastic
Non-Plastic
57 →
87 →

FILE: 0121-3070-03 [5/2/2005 3:15 PM]

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-50A | Location: Pier # 2 - Mainline Overpass # 2 | Date Drilled: 3/22/05

WATER OBSERVATIONS: Water seepage at: 18.0'-25.0'
Water level at completion: 18.0' measured inside of augers

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	STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ⊢——⊣ LL Blows per foot - ○ 10 20 30 40
30	510.0													
		Core 120"	Rec 117"	RQD 68%	R1		Hard gray SANDSTONE; fine grained, slightly weathered, argillaceous, medium bedded. @ 33.3', 34.3'-34.4', 36.2', 37. 2', clay seams @ 30.8'-32.1', high angle fracture.							
35														
37.5	502.5						Bottom of Boring - 37.5'							
40														
45														
50														
55														
60														

FILE: 0121-3070-03 (5/2/2005 3:15 PM)

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-51 | Location: Pier # 1 - Mainline Overpass # 2 | Date Drilled: 03/17/05

WATER OBSERVATIONS: Water seepage at: 13.0'-18.0'
Water level at completion: 21.0' (Prior to coring)
13.0' (Including 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	STANDARD PENETRATION (N) / Natural Moisture Content, % / PL — LL / Blows per foot
0.1	545.0 / 544.9						Topsoil - 2"							
		1 2 1	7	1		2.0	Stiff dark brown SILT AND CLAY (A-6a), little fine to coarse sand, trace fine to coarse gravel; damp to moist.							
5		1 2 3	13	2		1.0								
5.5	539.5						Very stiff brown SILTY CLAY (A-6b), trace fine to coarse sand, trace fine to coarse gravel; damp.							
		2 3 6	8	3		3.5								
8.0	537.0						Very loose to loose brown GRAVEL WITH SAND (A-1-b); damp.							
		3 3 4	10	4		2.0								
10							@ 11.0', moist.							
		1 1 1	7	5		1.5		43	28	--	11	7	11	Non-Plastic
13.0	532.0						Very loose brown COARSE AND FINE SAND (A-3a), trace fine to coarse gravel, trace clay; wet.							
		WOH WOH WOH	18	6				12	28	--	45	15		Non-Plastic
15		WOH WOH WOH	18	7										
18.0	527.0						Medium dense reddish brown SANDY SILT (A-4a), little gravel; damp to moist.							
		16 7 8	18	8										
20														
		7 14 11	14	9				19	19	--	30	24	8	Non-Plastic
23.0	522.0						Stiff gray CLAY (A-7-6); moist.							
		1 3 5	11	10		1.5		0	0	--	1	43	55	
25														
25.5	519.5						Medium hard black SHALE; moderately weathered, pyritic, laminated, broken.							
		20 50/3	8	11										
28.6	516.4						@ 28.1'-28.2', gray.							
30							Hard gray SANDSTONE							

FILE: 0121-3070-03 [5/2/2005 3:15 PM]

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-51 | Location: Pier # 1 - Mainline Overpass # 2 | Date Drilled: 03/17/05

WATER OBSERVATIONS: Water seepage at: 13.0'-18.0'
Water level at completion: 21.0' (Prior to coring)
13.0' (Including drill water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press /Core	Hand Penetro-meter (tsf)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N) / Natural Moisture Content, % - ● / PL ⊢⊣ LL / Blows per foot - ○
30	515.0	Core 120"	Rec 116"	RQD 71%	R1		Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, very thinly bedded to medium bedded. @ 28.7'-28.8', pyritic. @ 31.8', very thin clay seam. @ 33.1'-33.3', clay and gravel seam. @ 33.5', fracture. @ 34.5', very thin clay seam. @ 35.5'-36.2', broken zone with clay infilling. @ 36.6'-36.8', highly weathered.							10 20 30 40
35														
37.5	507.5						Bottom of Boring - 37.5'							
40														
45														
50														
55														
60														

FILE: 0121-3070-03 [5/2/2005 3:15 PM]

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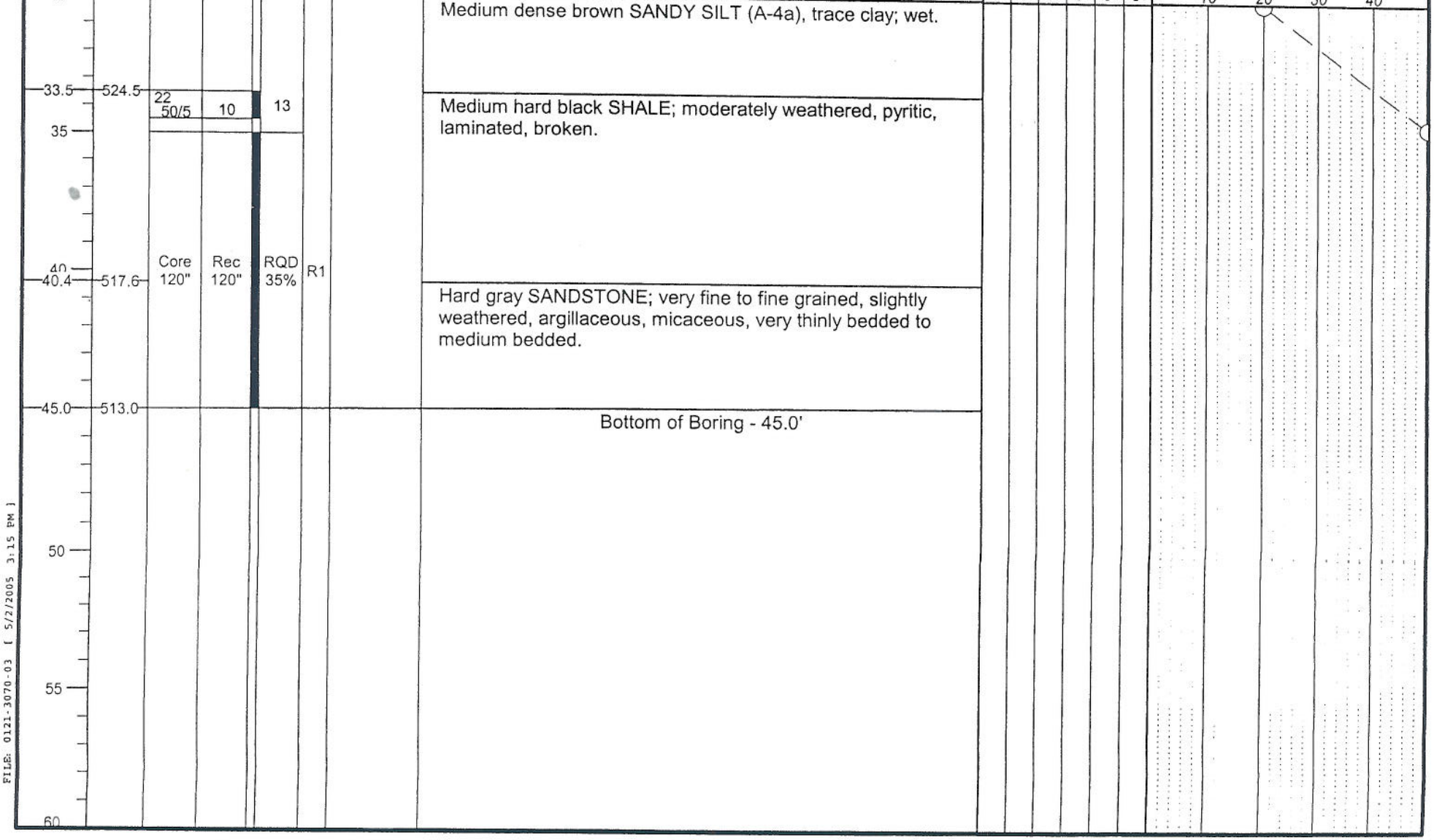
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-52 | Location: Rear Abutment - Mainline Overpass # 2 | Date Drilled: 03/15/05

WATER OBSERVATIONS: Water seepage at: 23.0'-30.0'
Water level at completion: 27.0' (Prior to coring)
6.0' (Including 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
30	528.0						Medium dense brown SANDY SILT (A-4a), trace clay; wet.						
33.5	524.5	22 50/5	10	13			Medium hard black SHALE; moderately weathered, pyritic, laminated, broken.						
40		Core 120"	Rec 120"	RQD 35%	R1								
40.4	517.6						Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, very thinly bedded to medium bedded.						
45.0	513.0						Bottom of Boring - 45.0'						
50													
55													
60													

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



FILE: 0121-3070-03 [5/2/2005 3:15 PM]

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

LOG OF: Boring TR-54 | Location: Rear Abutment - Ramp C - #1 | Date Drilled: 3-16-05

WATER OBSERVATIONS: Water seepage at: None
Water level at completion: Dry (Prior to coring)
11.0' (Including 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	STANDARD PENETRATION (N) / Natural Moisture Content, % / PL — LL / Blows per foot
0	567.5													
0.2	567.3						Topsoil - 3"							
		2 2 2	14	1		1.0	Stiff to very stiff brown SILT AND CLAY (A-6a), trace fine to coarse sand; damp. @ 0.0'-2.5', contains roots.							
5		2 5 6	17	2		3.5		0	0	--	4	61	35	
5.5	562.0						Very stiff brown SANDY SILT (A-4a), trace clay; damp.							
		3 5 6	18	3		2.25		0	0	--	12	67	21	
		1 3 2	11	4		2.0								
10														
10.5	557.0						Loose dark brown COARSE AND FINE SAND (A-3a), trace to little clay, trace gravel; damp.							
		1 2 3	13	5				8	38	--	37	18		Non-Plastic
13.6	553.9						Soft gray SHALE; moderately weathered.							
		7 35 50/4	14	6										85
15.0	552.5						Medium hard gray SHALE; fine grained, moderately weathered, laminated. @ 15.0'-17.3', broken with high angles fractures and thin clay seams. @ 18.9'-19.0', 20.6'-20.9', high angle fractures.							
20		Core 120"	Rec 120"	RQD 83%	R-1									
22.6	544.9						Hard gray SILTSTONE; very fine to fine grained, slightly weathered, argillaceous, medium bedded, slightly fractured.							
23.5	544.0						Hard gray SHALE; slightly weathered, argillaceous, very thinly bedded.							
25.0	542.5						Bottom of Boring - 25.0'							
30														

GRADATION

FILE: 0121-3070-03 [5/2/2005 3:15 PM]

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-55A | Location: Forward Abutment - Mainline Overpass #1 | Date Drilled: 3-15-05

WATER OBSERVATIONS: Water seepage at: 13.0'-18.0'
Water level at completion: 18.0' (Prior to coring)
18.0' (Including 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	STANDARD PENETRATION (N) / Natural Moisture Content, % / PL — LL / Blows per foot
0	565.5	3 5 5	10	1		4.5+	Hard gray SILTY CLAY (A-6b); damp.							
3.0	562.5	6 7 7	9	2		4.5+	Hard brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; damp.							
5		11 11 9	12	3		4.5+		22	15	--	23	21	19	
8.0	557.5	4 5 4	14	4		3.5	Very stiff to hard brown SANDY SILT (A-4a), trace gravel; damp.	5	25	--	39	16	16	Non-Plastic
10		5 4 3	12	5		4.5+	@ 11.0', hard.							
13.0	552.5	2 2 2	15	6			Loose brown COARSE AND FINE SAND (A-3a), trace gravel; wet.	9	38	--	41	13		Non-Plastic
15		1 2 2	7	7										
18.0	547.5	35 50/5	12	8			Hard gray SHALE interbedded with SANDSTONE; fine grained, highly weathered, very thinly bedded, highly fractured. @ 20.0'-22.0', 26.7'-27.5', 28.3'-28.5', 29.3'-29.6', highly fractured with clay seams. @ 21.0'-21.3', 21.7'-21.9', 26.5'-26.7', 26.9'-22.0', Hard brown sandstone; slightly weathered laminated.							
20														
25		Core 120"		RQD 64%	R-1									
30.0	535.5						Bottom of Boring - 30.0'							

FILE: 0121-3070-03 [5/2/2005 3:15 PM]

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-55A | Location: Forward Abutment - Mainline Overpass #1 | Date Drilled: 3-15-05

WATER OBSERVATIONS: Water seepage at: 13.0'-18.0'
Water level at completion: 18.0' (Prior to coring)
18.0' (Including drill water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press /Core	Hand Penetro-meter (tsf)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ⊢—⊣ LL Blows per foot - ○ 10 20 30 40
30	535.5													
35														
40														
45														
50														
55														
60														

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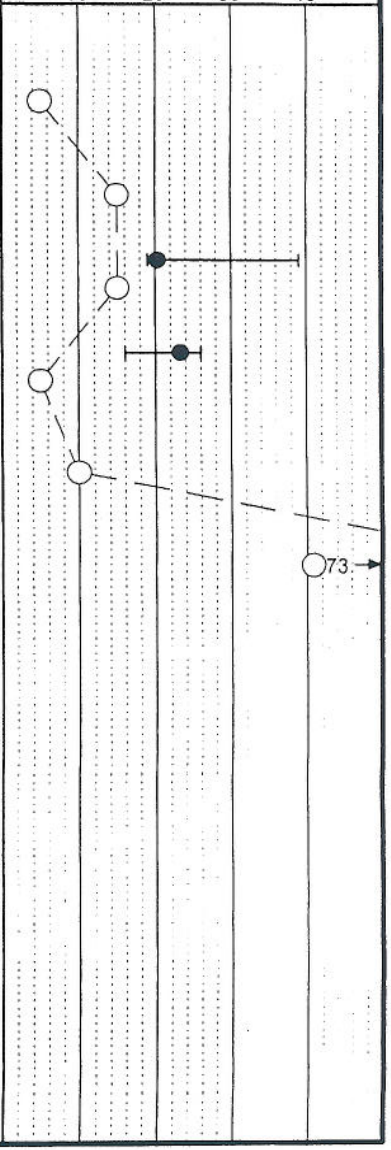
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-56 | Location: Rear Abutment - Mainline Overpass # 1 | Date Drilled: 3-16-05

WATER OBSERVATIONS: Water seepage at: None
Water level at completion: Dry (Prior to coring)
7.5' (Including 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	569.5												
0.2	569.3						Topsoil -3"						
		2 2 3	15	1		2.5	Very stiff brown SANDY SILT (A-4a), trace clay, trace gravel; damp to moist.						
3.0	566.5												
		4 6 9	17	2		4.5+	Hard brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; damp.						
5													
		4 6 9	16	3		4.25		0	0	--	2	58	41
8.0	561.5												
		2 2 3	18	4			Loose brown and gray SANDY SILT (A-4a), trace clay; damp to moist.	0	1	--	19	55	25
10													
		2 6 4	9	5									
14.1	555.4	8 23 50/4	15	6			Medium hard grayish brown SILTSTONE interbedded with SHALE; very fine to fine grained, slightly weathered, argillaceous, thinly bedded, highly fractured. @ 16.4'-17.2', high angle fracture and clay seam. @ 17.2', gray. @ 19.2'-19.7', clay seam. @ 20.4'-20.8', highly broken, clay seam.						
15													
		Core 120"	Rec 120"	RQD 68%	R-1								
20													
25.0	544.5						Bottom of Boring - 25.0'						
30													

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



FILE: 0121-3070-03 [5/2/2005 3:15 PM]

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-57 | Location: Rear Abutment - Ramp B - #2 | Date Drilled: 3-16-04

WATER OBSERVATIONS: Water seepage at: None
Water level at completion: Dry (Prior to coring)
3.5' (Including 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	569.5												
0.3	569.2						Topsoil -4"						
		2 3 4	14	1		4.0	Very stiff to hard brown SILT AND CLAY (A-6a), trace fine to coarse sand; damp.						
		3 5 7	12	2		4.5							
5													
		4 5 6	17	3		3.5		0	0	--	1	64	35
8.0	561.5												
		1 2 2	18	4		1.0	Stiff brown SILT AND CLAY (A-6a), little fine to coarse sand; damp to moist.	0	0	--	10	67	23
10													
10.5	559.0						Medium dense brown SANDY SILT (A-4a), little gravel, trace clay; damp.						
		2 5 5	14	5				23	15	--	19	26	17
14.0	555.5	12 27 50/3	13	6			Soft to medium hard gray SHALE; moderately weathered, laminated.	0	2	--	4	64	31
15							@ 15.8'-16.3', 19.1'-19.5', clay seams						
20		Core 120"	Rec 120"	RQD 90%	R-1								
20.9	548.6						Hard gray SILTSTONE interbedded with SHALE; slightly weathered, laminated.						
22.9	546.6						@ 22.7'-22.9' high angle fracture						
							Hard gray SHALE; slightly weathered, laminated, slightly fractured.						
25.0	544.5						Bottom of Boring - 25.0'						
30													

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○
10 20 30 40
77

FILE: 0121-3070-03 [5/2/2005 3:15 PM]

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

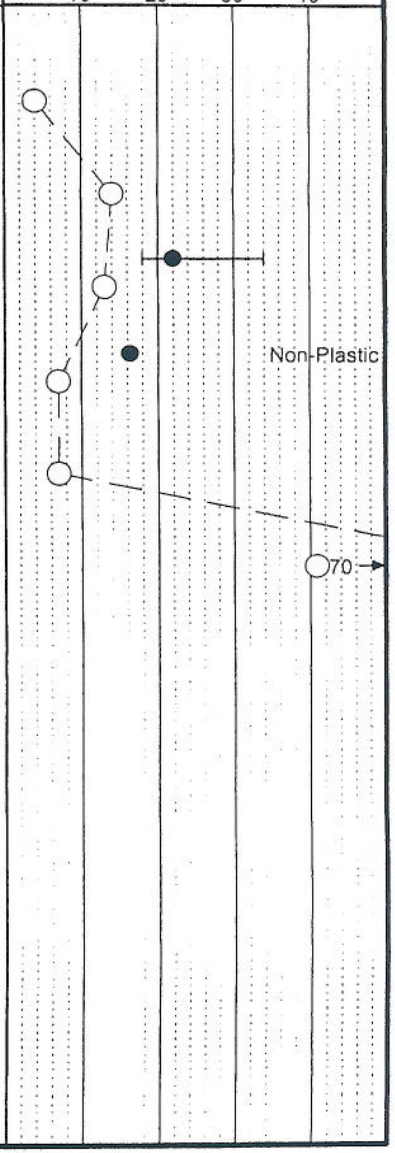
LOG OF: Boring TR-58 | Location: Pier # 1 - Ramp B - #2 | Date Drilled: 3-16-05

WATER OBSERVATIONS: Water seepage at: None
Water level at completion: Dry (Prior to coring)
4.0' (Including drill 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	567.0												
0.3	566.7						Topsoil -4"						
		1 2 2	16	1		--	Soft brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; damp to moist. @ 0.0'-2.5', contains roots. @ 3.5', very stiff to hard, damp.						
		3 6 8	15	2		4.25							
5		5 6 7	18	3		3.5		0	0	--	6	65	29
8.0	559.0												
		2 4 3	16	4			Loose dark brown COARSE AND FINE SAND (A-3a), trace to little clay, trace gravel; damp.	7	34	--	40	19	
10		4 4 3	15	5									
14.0	553.0	2 20 50/5	16	6			Soft to medium hard gray SHALE; moderately weathered, argillaceous, thinly bedded, slightly fractured. @ 15.0'-16.7', broken with clay seams and high angle fractures @ 17.5'-17.8', 19.5'-20.1', clay seams with high angle fractures @ 20.9'-21.0', clay seam. @ 24.2' and 24.4', very thin clay seam.						
15													
20		Core 120"	Rec 120"	RQD 82%	R-1								
25.0	542.0						Bottom of Boring - 25.0'						
30													

GRADATION

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



FILE: 0121-3070-03 [5/2/2005 3:15 PM]

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-59A | Location: Forward Abutment - Ramp B - #2 | Date Drilled: 3-14-05

WATER OBSERVATIONS: Water seepage at: 19'-21.5'
Water level at completion: Dry (Prior to coring)
17.0' (Including 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	564.5												
		3 3 3	14	1			Loose dark gray SANDY SILT (A-4a), trace clay, trace gravel; damp.						
		2 2 2	12	2			@ 3.5', brown; Moist.	7	13	--	26	32	22
5													
5.5	559.0	2 2 3	15	3			Very loose to loose brown COARSE AND FINE SAND (A-3a), trace clay, trace silt; moist.	15	36	--	37	12	
		2 2 1	13	4									
10													
10.5	554.0	2 2 2	16	5			Loose brown SANDY SILT (A-4a), little gravel, trace clay; damp to moist.	14	25	--	31	9	21
		1 2 3	15	6									
15													
		2 3 3	12	7			@ 16.0', little to some clay.						
		0 1 1	14	8			@ 19.0'-21.5', wet.						
20													
21.5	543.0	1 36 50	12	9			Medium hard gray SHALE; slightly weathered.						
		32 50/3	9	10									
25.0	539.5						Medium hard to hard gray SILTSTONE interbedded with SHALE; very fine to fine grained, slightly weathered, argillaceous, thinly bedded, slightly fractured. @ 25.4'-25.7', 28.5', 29.6', clay seams @ 25.9', 26.5-26.7', 27.8', high angle fractures @ 28.6'-29.6', moderately weathered SHALE.						
30		Core 120"	Rec 119"	RQD 65%	R-1								

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

Non-Plastic

86

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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-59A | Location: Forward Abutment - Ramp B - #2 | Date Drilled: 3-14-05

WATER OBSERVATIONS: Water seepage at: 19'-21.5'
Water level at completion: Dry (Prior to coring)
17.0' (Including drill water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press /Core	Hand Penetrometer (tsf)	DESCRIPTION
30	534.5						Medium hard to hard gray SILTSTONE interbedded with SHALE; very fine to fine grained, slightly weathered, argillaceous, thinly bedded, slightly fractured.
33.0	531.5						@ 31.4'-31.7', clay seams with high angle fractures
35.0	529.5						Hard black SHALE; fine grained, slightly weathered, carbonaceous, thinly bedded.
							@ 33.8'-34.0', high angle fractures and broken.
							Bottom of Boring - 35.0'
40							
45							
50							
55							
60							

GRADATION: % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay

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

FILE: 0121-3070-03 [5/2/2005 3:15 PM]

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-60 | Location: Rear Abutment - Ramp B - #1 | Date Drilled: 3-14-05

WATER OBSERVATIONS: Water seepage at: 18'-28'
Water level at completion: 26.0' (Prior to coring)
19.0' (Including drill water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press /Core	Hand Penetro-meter (tsf)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N) / Natural Moisture Content, % / Blows per foot
0	554.0													
0.1	553.9						Topsoil -1"							
		4 8 7	12	1			FILL: Medium dense brown SANDY SILT (A-4a), little gravel, trace clay; damp.							
3.0	551.0													
		4 4 4	12	2			Loose brown COARSE AND FINE SAND (A-3a), little gravel, trace clay; damp.	33	43	--	11	13		Non-Plastic
5		3 2 2	9	3										
		3 2 3	13	4										
10														
10.5	543.5													
		3 3 3	14	5			Loose brown SANDY SILT (A-4a), little gravel, trace clay; damp.	50	20	--	9	17	4	Non-Plastic
		3 3 4	1	6			@ 13.5', moist.							
15														
		2 3 3	14	7										
18.0	536.0													
		1 1 2	17	8			Very loose to loose brown COARSE AND FINE SAND (A-3a), trace clay, trace gravel; wet.	10	53	--	20	17		Non-Plastic
20														
		4 3 3	16	9										
23.0	531.0													
		7 4 4	18	10		--	Stiff brown SILT AND CLAY (A-6a), little to some gravel, little fine to coarse sand; wet.	31	27	--	12	18	12	
25														
25.5	528.5						Loose reddish brown FINE SAND (A-3), trace clay; wet.							
		3 6 4	18	11				7	14	--	59	21		Non-Plastic
28.0	526.0													
		50/4	4	12			Soft black SHALE; highly weathered.							
30														

FILE: 0121-3070-03 [5/2/2005 3:15 PM]

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-60 | Location: Rear Abutment - Ramp B - #1 | Date Drilled: 3-14-05

WATER OBSERVATIONS: Water seepage at: 18'-28'
Water level at completion: 26.0' (Prior to coring)
19.0' (Including drill water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press /Core	Hand Penetro-meter (tsf)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ⊢—⊣ LL Blows per foot - ○ 10 20 30 40
30	524.0						Medium hard black SHALE; moderately weathered, carbonaceous, laminated, highly fractured.							
							@ 30.0'-32.3', clay seam.							
							@ 32.3' hard.							
							@ 33.2', 38.0'-38.2', clay seams.							
35		Core 120"	Rec 119"	RQD 79%	R-1		@ 39.4'-39.8', high angle fracture.							
							@ 39.9', Hard gray SANDSTONE.							
40.0	514.0						Bottom of Boring - 40.0'							
45														
50														
55														
60														

FILE: 0121-3070.03 [5/2/2005 3:15 PM]

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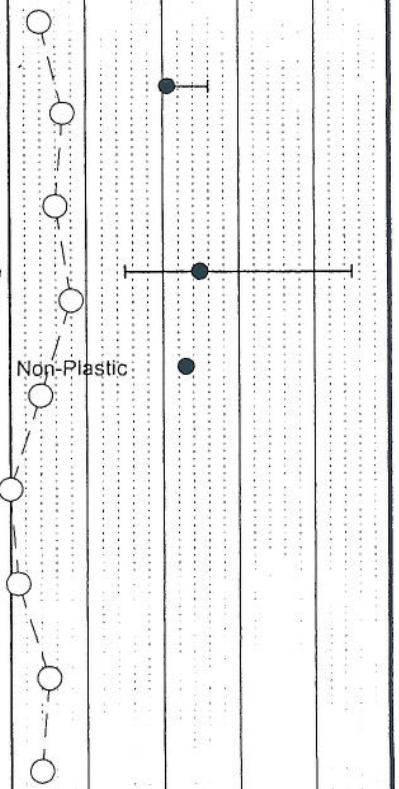
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-61 | Location: Forward Abutment - Ramp B - #1 | Date Drilled: 3-16-05

WATER OBSERVATIONS: Water seepage at: 13.5'-23.0'
Water level at completion: 14.0' Prior to coring
9.0' Measured from inside the augers after coring

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	547.0	2 2 2	2	1			FILL: Loose black SANDY SILT (A-4a), little gravel; organic; dry to damp.						
5		3 4 3	1	2				14	20	--	26	28	12
5.5	541.5	2 3 3	16	3		2.5	Very stiff light brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; damp.						
10		1 3 5	12	4		2.25	@ 8.5', brown.	8	12	--	12	29	39
10.5	536.5	1 2 2	13	5			Very loose brown COARSE AND FINE SAND (A-3a); moist. @ 10.5'-12.5', little clay	9	47	--	32	13	Non-Plastic
15		0 0 0	16	6			@ 13.5', wet.						
		0 0 1	18	7									
20		1 3 2	18	8			@ 18.0', very loose to loose.						
		1 1 3	18	9									
23.0	524.0	50/3	3	10			Medium hard black SHALE; moderately weathered.						
25.0	522.0						Hard black SHALE; fine grained, moderately weathered, carbonaceous, thinly bedded, moderately fractured, fissile. @ 25.0'-25.2', 27.5'-27.6', 28.1'-28.2', 29.3'-30.0', high angle fractures						
30		Core 120"	Rec 114"	RQD 92%	R-1								

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



FILE: 0121-3070-03 [5/2/2005 3:15 PM]

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-61 | Location: Forward Abutment - Ramp B - #1 | Date Drilled: 3-16-05

WATER OBSERVATIONS:
Water seepage at: 13.5'-23.0'
Water level at completion: 14.0' Prior to coring
9.0' Measured from inside the augers after coring

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	STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL — LL Blows per foot - ○ 10 20 30 40
30	517.0													
30.5	516.5						Hard gray SANDSTONE; fine to medium grained, slightly weathered, thinly to medium bedded. @ 31.2'-31.6', high angle fracture. 33.7'-33.9', clay seam.							
35.0	512.0						Bottom of Boring - 35.0'							
40														
45														
50														
55														
60														

FILE: 0121-3070-03 [5/2/2005 3:15 PM]