Structure Type Study

Ramp B over Norfolk Southern Railway

SCI-823-0.00
PID No. 19415

Prepared for

Ohio Department of Transportation

July 2005

CH2MHILL

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1. Introduction

Two (2) alternatives for construction of the proposed Ramp B bridge over Norfolk Southern (NS) Railway have been evaluated in this study, and are designated (in no particular order) Alternatives 1 and 2. Alternative 1 is a two-span layout, while Alternative 2 is a single span layout. 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 railroad. 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. According to the Department's 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. The floodwaters are expected to impact the rear abutment only. It is anticipated that MSE walls at this location may require specialized fill material, rip-rap, or other means to protect against scour. Final selection of MSE wall details and abutment foundation details should consider the results of the hydraulic analysis.

Each alternative was 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 latest version of the Ohio Department of Transportation Bridge Design Manual, the 2002 AASHTO Standard Specifications for Highway Bridges, 17^{th} edition, and the 2003 AASHTO Guide Specifications for Horizontally Curved Steel Girder Highway Bridges. 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, Ramp B follows an 11°15'00" horizontal curve (509.30-foot radius) to the right. The proposed section consists of one 16-foot lane, a 6-foot left shoulder, and an 8-foot right shoulder. With two 1'-6" wide single slope outside deflector parapets, the out-to-out deck width is a constant 33'-0" for all alternatives. The Ramp B bridge will be superelevated at a constant 8.3 percent for the entire structure length.

The proposed Ramp B vertical alignment over NS Railway consists of a +5.80 percent slope at the rear approach, followed by a 200-foot crest vertical curve to a +2.20 percent slope at the forward approach.

The existing railroad section consists of two tangent tracks on approximately 26′-6″ centers, proceeding north on an approximate 0.3% downgrade. Ramp B crosses the railway at a skew angle of approximately 50° (actual skew varies somewhat due to the curvature of Ramp B). No modifications to the existing railroad are anticipated as part of the project.

4. Proposed Maintenance of Traffic Solution

The proposed Ramp B alignment will carry traffic exiting northbound US-23 onto eastbound SR-823. Because the Ramp B alignment is new construction over railway, there are no maintenance of highway traffic concerns.

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 girders). 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 has been set to provide adequate vertical clearance over the railroad (23′-0″ above top of high rail) for a superstructure depth equal to 8′-6″. For alternatives where the superstructure depth is significantly less than 8′-6″, the roadway cost savings associated with lowering the profile have been estimated and subtracted from the total bridge cost. 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. Bridge substructures were also located to preserve the existing drive which approaches from the East and proceeds under the proposed bridge at a private railroad grade crossing. Piers and abutment spill-through slopes have been placed clear of this driveway. The ramp horizontal alignment was optimized, within the constraints of the overall interchange geometry, to minimize the skew and the span length over the tracks. The resulting 50° skew, 26'-6" track centers, and railroad horizontal clearance considerations require a clear span (face-to-face of abutments) of approximately 133 feet along the construction baseline. 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.

The possible superstructure types are limited by the site characteristics. Given the minimum clear span length of 133 feet, the degree of curvature, and the preference to use conventional deck overhangs (less than 4'-0"), the girders must be horizontally curved. Possible structure types include curved box girders (prestressed concrete or steel) and curved plate girders. The falsework required for a cast-in-place box is not compatible with maintaining railroad traffic, and the bridge size and site conditions do not permit segmental concrete construction to be competitive, so those two alternatives can be dismissed without further investigation. Of the two remaining superstructure types, experience suggests that steel box girders are advantageous for a very tight radius and are sometimes considered aesthetically superior, but tend to be more expensive than plate girders. Because this case does not involve a particularly tight radius, and a subtle aesthetic advantage is not an overriding consideration for this railroad crossing, curved steel plate girders are the obvious choice. Unpainted weathering steel is selected in lieu of coated steel, to minimize initial construction and future maintenance costs.

Substructure types are also somewhat limited by the site characteristics. The portion of Ramp B behind of the bridge will be partially or totally retained by MSE walls, as dictated by the proximity of the railroad and the adjacent northbound US-23. Therefore, an MSE type abutment is a logical choice for the rear abutment. A retained-fill type and a spill-through type are both feasible options for the forward abutment. However, placement of the forward abutment must preserve the existing private drive, in order to prevent relocation or modifications to the existing railroad grade crossing and the considerable costs associated with railroad interference. At either location, 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, abutment walls within 25 feet of the track centerline are not considered in this 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. It is anticipated that MSE walls at the rear 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 MSE wall details and abutment foundation details at the rear abutment. Because of the horizontally curved superstructure, integral and semi-integral abutments are not feasible options; each abutment will require a deck joint.

Site horizontal geometry constraints effectively limit the number of feasible span arrangements. The alternatives selected for investigation are intended to represent the optimum layouts for one and two spans. While other arrangements are possible, the alternatives presented here are expected to capture the most economical solutions.

Alternative 1

Alternative 1 is a curved steel plate girder bridge with spans of 152′-9″ and 95′-0″ center-to-center of bearings along the construction baseline. The seat-type rear abutment is on piles behind a three-sided MSE wall. The seat-type forward abutment is on piles behind a spill-through 2:1 slope, with U-back wingwalls. The single hammerhead pier rests on a pile-supported rectangular footing. All piles will be driven to bedrock. The superstructure consists of four curved high-strength steel plate girders with 60-inch webs spaced at 9′-0″ on center.

The rear abutment is located to provide 25′-0″ clear between the MSE wall and nearest track centerline. The pier is located to provide adequate horizontal railroad clearance to the footing on the west side and allow room to relocate the existing roadway ditch on the east side in the vicinity of the pier. The forward abutment is located such that the spill-through slope would not encroach upon the existing private drive and its northern drainage ditch. The placement also ensures that Span 2 is at least 60% of Span 1, so that net uplift due to live load effects is not anticipated at any bearing. All substructure units are set radial to the Ramp B baseline. Using radial substructures has the disadvantage of increasing the overall deck area required. However, the following advantages are simultaneously realized: substructures and MSE walls with smaller widths and right angles are less expensive; a smaller pier cap permits use of a hammerhead pier, and the small pier footprint allows placement for more balanced spans; regular bridge geometry facilitates repeatability in design, detailing, and construction.

The initial bridge construction cost for Alternative 1 is estimated to be $1,573,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $415,000, resulting in a total estimated ownership cost of $1,988,000 in year 2008 dollars.

Alternative 2

Alternative 2 is a curved steel plate girder bridge with a single span of 152′-6″ center-to-center of bearings along the construction baseline. Both rear and forward abutments are of the seat type and are supported on piles behind a three-sided MSE wall, with faces parallel to the railroad centerline. All piles will be driven to bedrock. The superstructure consists of four curved high-strength steel plate girders with 66-inch webs spaced at 9′-0″ on center.

The rear abutment is located to provide 25′-0″ clear between the MSE wall and nearest track centerline. The skew at the rear abutment is approximately 60 degrees from the radial (left forward) at the centerline of bearing. The forward abutment is located to prevent encroachment upon the existing private drive and its northern drainage ditch. The MSE wingwalls on the east and west sides extend back to catch the same spill slope defined in Alternative 1, in order to prevent encroachment of fill upon the railroad and private drive drainage ditches, respectively. As with Alternative 1, part of the existing driveway ditch will need to be relocated. The skew at the forward abutment is approximately 52 degrees from the radial (left forward) at the centerline of bearing. These heavy skews tend to complicate the MSE wall design and construction. Consideration should be given to the potential for conflict between piles and the dense soil reinforcing typically required at the acute wall corner.

The initial bridge construction cost for Alternative 2 is estimated to be $1,947,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $292,000, resulting in a total estimated ownership cost of $2,239,000 in year 2008 dollars.

6. Recommended Alternative

Two structural solutions for the construction of the proposed Ramp B over NS Railway have been evaluated in this Structure Type Study. Both alternatives provide comparable operational characteristics and meet minimum horizontal and vertical clearance requirements. Alternative 1 offers the following advantages over Alternative 2:

- Lower initial construction cost
- Lower total ownership costs
- Avoidance of excessive skew
- Lower roadway profile
- Regular geometry

Based on the foregoing advantages, **CH2M HILL recommends that the two-span bridge of ALTERNATIVE 1 be constructed for the bridge carrying Ramp B over Norfolk Southern Railway.**

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 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.

Two borings at the Ramp B bridge over Norfolk Southern Railway were taken during the first mobilization. Based on these initial borings, geotechnical subconsultant DLZ has made preliminary foundation recommendations for the Ramp B bridge over NS Railway. A copy of the preliminary report is included with this submission.

The recommended alternative has a seat-type rear abutment behind a three-sided MSE wall, and a seat-type forward abutment behind a spill-through 2:1 slope. Both abutments are assumed to be supported on HP14x73 piles driven to bedrock. The forward abutment will utilize battered piles in the front row to resist horizontal loads. The rear abutment will rely on the MSE wall to resist horizontal loads. Here, reinforcing straps will be attached to the backwall and footing, at which location the wall must be designed to resist horizontal forces from the abutment. It is envisioned that piles will be separated from the wall fill by using pile sleeves or other suitable means. The final pile arrangement should consider avoiding potential conflicts with typical MSE reinforcing strap patterns. Although a spread footing resting directly on the MSE select granular fill would avoid such pile conflicts, the magnitude of the bearing reactions at the forward abutment makes that option impractical. Each pier is assumed to be supported on HP14x73 piles driven to bedrock, with the outer pile rows 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

Ramp B Over NS Railway

STRUCTURE TYPE STUDY

Filename: C:\Documents and Settings\NBROWN3\Local Settings\Temporary Internet Files\OLK3E\[1598C Cost Comp.xls]Alternative Summary

By: WRT Date: 6/23/2005

Checked: SKT Date: 6/23/2005

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 Alternative Construction Cost	Superstructure Life Cycle Maintenance Cost	Total Relative Ownership Cost
1	2	152.75 - 95.00	4 ~ Curved Steel Plate Girders	60" Web - Grade 50W	$808,000	$365,000	$1,573,000	$415,000	**$1,988,000**
2	1	152.5	4 ~ Curved Steel Plate Girders	66" Web - Grade 50W	$534,000	$871,000	$1,947,000	$292,000	**$2,239,000**

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ALTERNATIVE COST SUMMARY

Alternative No.	Span Arrangement No. Spans	Span Arrangement Lengths	Total Span Length (ft.)	Framing Alternative	Proposed Stringer Section	Subtotal Superstructure Cost	Subtotal Substructure Cost	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	2	152.75 - 95.00	247.75	4 ~ Curved Steel Plate Girders	60" Web - Grade 50W	$808,000	$365,000	0.0	$0	-$60,000	$188,000	$272,200	$0	$1,573,000	$415,000	$1,988,000
2	1	152.50	152.50	4 ~ Curved Steel Plate Girders	66" Web - Grade 50W	$534,000	$871,000	95.25	$24,000	-$40,000	$225,000	$326,000	$7,000	$1,947,000	$292,000	$2,239,000

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	33.00 ft.	33.00 ft.	33.00 ft.
Alt. 2	33.00 ft.	33.00 ft.	33.00 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. The roadway profile has been set to provide adequate vertical clearance over the railroad for a superstructure depth of up to 8'-6".
   Profile adjustment costs reflect the cost savings in ramp construction due to optimum lowering of the profile for each alternative.

Alternative	Vertical Clearance Provided (ft.)	Profile Adjustment Permitted (ft.)	Change in MSE Wall Area (sq. ft.)	Year 2008 Unit Cost	Profile Adjustment Cost
Alt. 1	25.14	-1.50	-950	$62.00	-$60,000
Alt. 2	24.64	-1.00	-650	$62.00	-$40,000

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SUPERSTRUCTURE

Alternative No.	Span Arrangement No. Spans	Span Arrangement 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	2	152.75 - 95.00	247.75	249.75	8,200	317	$189,700	$79,400	$30,300	4 ~ Curved Steel Plate Girders	60" Web - Grade 50W	369000.0	$508,100	$0	**$808,000**
2	1	152.5	152.50	154.50	5,100	196	$117,300	$49,100	$30,300	4 ~ Curved Steel Plate Girders	66" Web - Grade 50W	244800.0	$337,100	$0	**$534,000**

Deck Cross-Sectional Area:

Parapets:

	No.	Individual Area (sq. ft.)	Parapet Area (sq. ft.)
Parapets	2	4.26	8.52
Median	0	9.29	0.00

Slab:

	T (ft.)	Ave. W (ft.)	Slab Area	Haunch & Overhang Area	Total Concrete Area (sq. ft.)
Alt. 1	0.71	33.00	23.4	2.3	34.2
Alt. 2	0.71	33.00	23.4	2.3	34.2

Note: Deck width measured as average width.
10% of deck area allowed for haunches and overhangs.

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

	Year 2004	Annual Escalation	Year 2008
Deck	$491.00	3.5%	$563.00
Parapets	$615.00	3.5%	$706.00
Weighted Average =			$599.00

Based on parapet and slab percentages of total concrete area

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

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

Structural Steel
Unit Costs ($/lb.):

	Cost Ratio	Year 2004	Annual Escalation	Year 2008
Rolled Beams - Grade 50	n/a	$0.74	3.5%	$0.85
Plate Girders - Grade 50	n/a	$1.20	3.5%	$1.38
Hybrid Plate Girders - Grade 50/70W	1.10	$1.32	3.5%	$1.51

Note - structural steel weight is estimated at 45 pounds per each square foot of bridge deck area for Alt. 1.
and 48 pounds per each square foot of bridge deck area for Alt. 2.

Reinforced Concrete Approach Slabs (T=15")
Unit Cost ($/sq. yd.):
Length = 25 ft. Ave. Width = 33.00 ft
Area = 92 sq. yd.

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

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SUBSTRUCTURE

Alternative No.	Span Arrangement No. Spans	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	2	152.75 - 95.00	4 ~ Curved Steel Plate Girders	60" Web - Grade 50W	$50,200	$11,400	$79,800	$13,100	$78,500	$131,900	$0	**$365,000**
2	1	152.5	4 ~ Curved Steel Plate Girders	66" Web - Grade 50W	$0	$0	$109,600	$18,000	$58,000	$685,400	$0	**$871,000**

Pier QC/QA Concrete, Class QSC1 Cost:

Alt. 1

Component	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost	
Cap	38.0	$421.00	3.5%	$483.00	$18,350	
Columns	34.0	$421.00	3.5%	$483.00	$16,420	
Footings	32.0	$421.00	3.5%	$483.00	$15,460	
Total Pier Cost					$50,200	Each Pier

Abutment QC/QA Concrete, Class QSC1 Cost:

Alt. 1

Component	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Abutment					
Rear	61.0	$421.00	3.5%	$483.00	$29,500
Forward	73.0	$421.00	3.5%	$483.00	$35,300
Wingwalls					
Rear	0.0	$421.00	3.5%	$483.00	$0
Forward	31.0	$421.00	3.5%	$483.00	$15,000

Alt. 2

Component	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Abutment					
Rear	139.0	$421.00	3.5%	$483.00	$67,100
Forward	88.0	$421.00	3.5%	$483.00	$42,500
Wingwalls					
Rear	0.0	$421.00	3.5%	$483.00	$0
Forward	0.0	$421.00	3.5%	$483.00	$0

Epoxy Coated Reinforcing Steel

Unit Cost ($/lb):

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

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

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

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

	Rear Abutment Area (sq. ft.)	Forward Abutment Area (sq. ft.)	Total Cost
Alt. 1	2,127	0	$131,900
Alt. 2	4,874	6,181	$685,400

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

Pile Foundation Unit Cost ($/ft.): HP14 x 73 Steel Piles, Furnished & Driven

Pier Piles:

	Number	Top Elev.	Bottom Elev.	Length per Pile	Total Pile Length	Total Cost
Alt. 1	24	545.0	522.0	25	600	$24,800
Alt. 2	0	0.0	0.0	0	0	$0

Abutment Piles:

	Number Rear	Number Forward	Top Elevation Rear	Top Elevation Forward	Bottom Elevation Rear	Bottom Elevation Forward	Length per Pile Rear	Length per Pile Forward	Total Pile Length	Total Cost
Alt. 1	11	15	568.5	574.5	520.0	526.0	50	50	1,300	$53,700
Alt. 2	16	11	568.0	574.5	520.0	522.0	50	55	1,405	$58,000

HP14 x 73 Steel Piles, Furnished & Driven

	Year 2004 Unit Cost	Annual Escalation	Year 2008
Furnished	$24.41	3.5%	$28.00
Driven	$11.57	3.5%	$13.30
Total			$41.30

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	0	0	$0
Alt. 2	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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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	2	152.75 - 95.00	4 ~ Curved Steel Plate Girders	$0	0	$0	$0	0	$0	$0	0	$0
2	1	152.5	4 ~ Curved Steel Plate Girders	$0	0	$0	$0	0	$0	$1,600	7	$11,200

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 Alternative Construction Cost	Total Relative Ownership Cost
1	2	152.75 - 95.00	4 ~ Curved Steel Plate Girders	$24,900	$30,100	$4,500	1	$59,500	$189,700	$79,400	$18,000	$67,900	1	$355,000	**$415,000**	**$1,573,000**	**$1,988,000**
2	1	152.5	4 ~ Curved Steel Plate Girders	$15,500	$18,700	$7,500	1	$41,700	$117,300	$49,100	$30,000	$42,200	1	$238,600	**$292,000**	**$1,947,000**	**$2,239,000**

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. 1			247.75		0	20%	0
Alt. 2			152.50		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:

	No. Stringers	Total Span Length (ft.)	Nominal Exposed Beam Area (sq. ft.)	Secondary Member Allowance	Total Exposed Concrete Area (sq. yd.)
Alt. 1			0	10%	0
Alt. 2			0	10%	0

Sealing Cost per sq. yd.:

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

Bridge Redecking:
Bridge Deck Joint Cost per foot:

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

	Ave. Joint Length	No. Joints
Alt. 1	33.00	2
Alt. 2	55.00	2

Bridge Deck Removal Cost:

	Deck Area (3) (sq. ft.)	Year 2008	Deck Removal Cost
Alt. 1	8,200	$8.28	$67,900
Alt. 2	5,100	$8.28	$42,200

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	8,200	911	23	21
Alt. 2	5,100	567	14	13

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. Single strip seal deck joints will be required at each abutment.
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

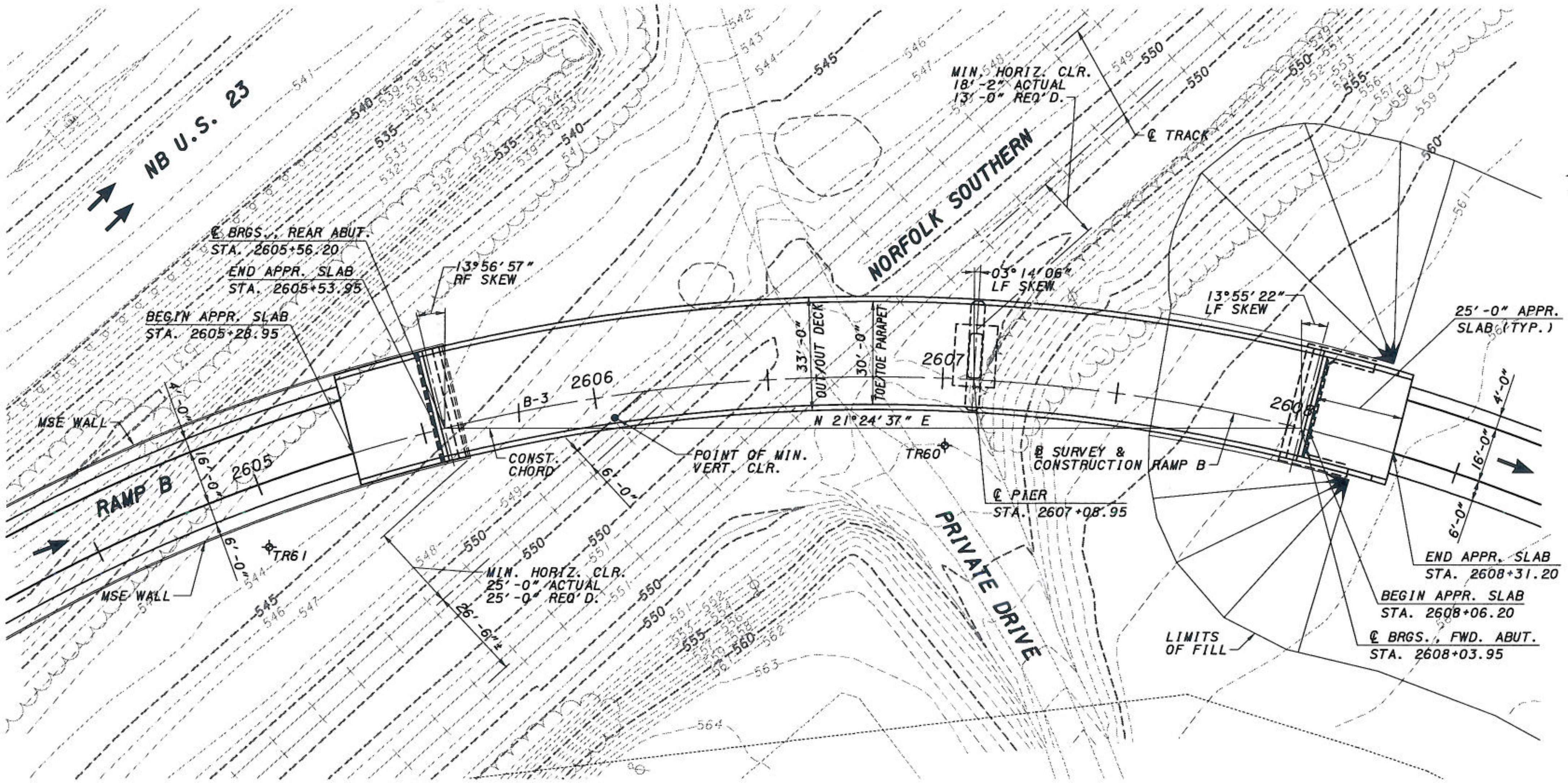
Asphalt Resurfacing Costs:

	Approach Roadway Length (ft.) (4)	Approach Roadway Width (ft.)	Resurfacing Area (sq. yd.)	Wearing Course Thickness (in.)	Wearing Course Volume (cu. yd.)
Alt. 1	0.0	33.0	0	1.50	0.0
Alt. 2	95.25	33.0	349	1.50	14.6

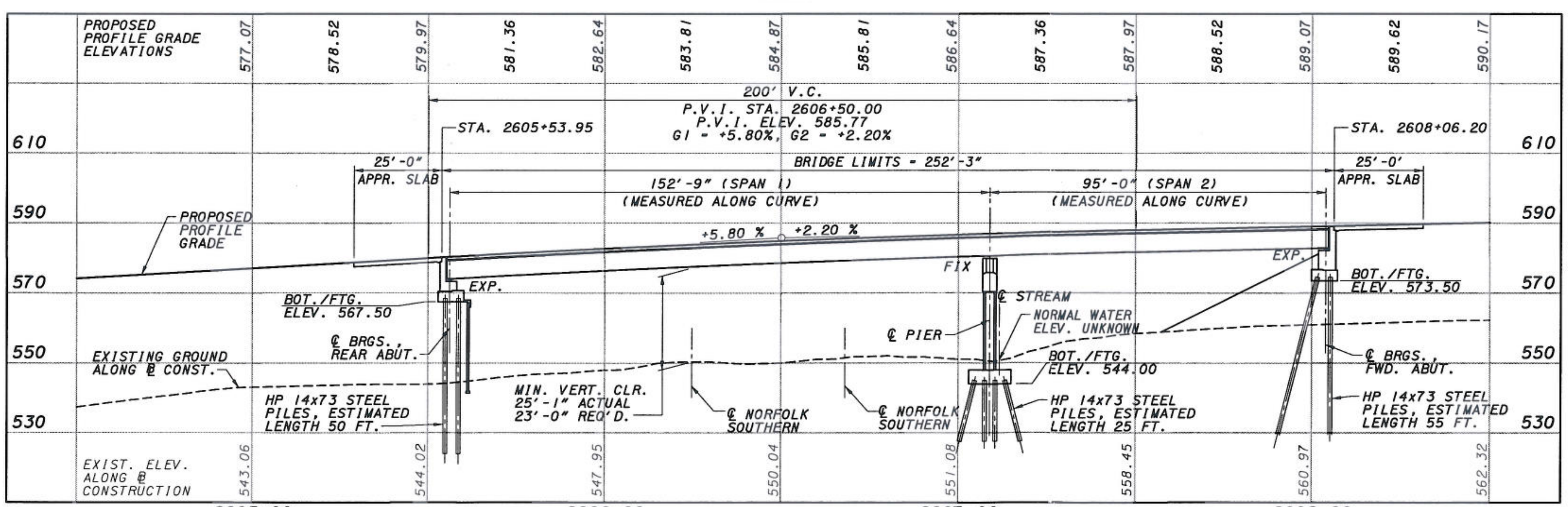
APPENDIX B

Preferred Alternative Site Plan and Details

BENCHMARKS



PLAN



PROFILE ALONG ℄ SURVEY AND CONSTRUCTION, RAMP B

CURVE B-3
P.I. STA. = 2609+69.36
Δ = 102°45'15" (RT.)
Dc = 11°15'00"
R = 509.30'
T = 637.46'
L = 913.37'
E = 306.63'
e_{max} = 0.076

TRAFFIC DATA
CURRENT ADT (2010) = 2700
DESIGN ADT (2030) = 3600
DESIGN ADTT = 500

LEGEND
⌖ DENOTES SOIL BORING LOCATION

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

PROPOSED STRUCTURE

TYPE: TWO SPAN COMPOSITE CURVED STEEL PLATE GIRDERS (NON-PAINTED ASTM A709, GR 50W) WITH REINFORCED CONCRETE DECK ON JOINTED STUB ABUTMENT ON MSE WALL (REAR) AND JOINTED STUB ABUTMENT (FWD.) WITH T-TYPE PIER
LENGTH OF SPAN: 152'-9", 95'-0", MEASURED ℄ ABUTMENT BRGS. - ℄ PIER BRGS. - ℄ ABUTMENT BRGS.
ROADWAY: 30'-0" TOE/TOE PARAPETS
SIDEWALK: NONE
DESIGN LOADING: HS25 (CASE II) AND THE ALTERNATE MILITARY LOADING, FWS = 60 LB/FT²
SKEW: 13°56'57" RF (REAR ABUTMENT), 03°14'06" LF (PIER), 13°55'22" LF (FORWARD ABUTMENT), MEASURED FROM THE NORMAL TO THE CONSTRUCTION CHORD
WEARING SURFACE: MONOLITHIC CONCRETE
APPROACH SLABS: AS-1-81 (25'-0" LONG)
ALIGNMENT: HORIZONTALLY CURVED (℄ RADIUS = 509.30 FT.)
CROWN: 0.083 FT/FT
LATITUDE: N 38°53'28"
LONGITUDE: W 82°59'54"

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

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

SCIOTO COUNTY
STA. 2605+53.95 TO STA. 2608+06.20

SITE PLAN
BRIDGE NO. SCI-823-1598
RAMP B OVER NORFOLK SOUTHERN - ALT. 1

SCI-823-0.00

1 / 3

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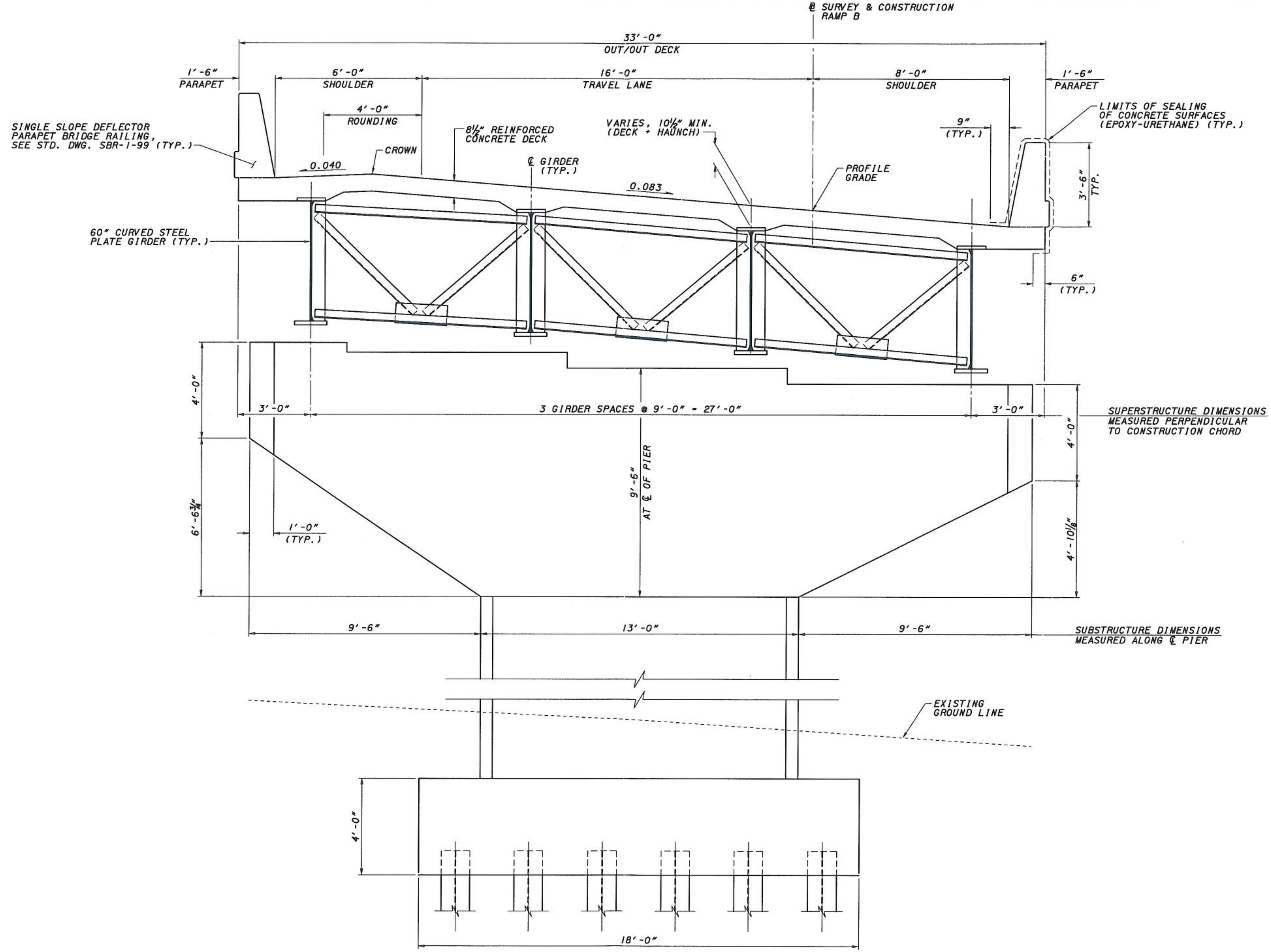

TYPICAL TRANSVERSE SECTION

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

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

TYPICAL TRANSVERSE SECTION
BRIDGE NO. SCI-823-1598
RAMP B OVER NORFOLK SOUTHERN - ALT. 1

SCI-823-0.00

2/3

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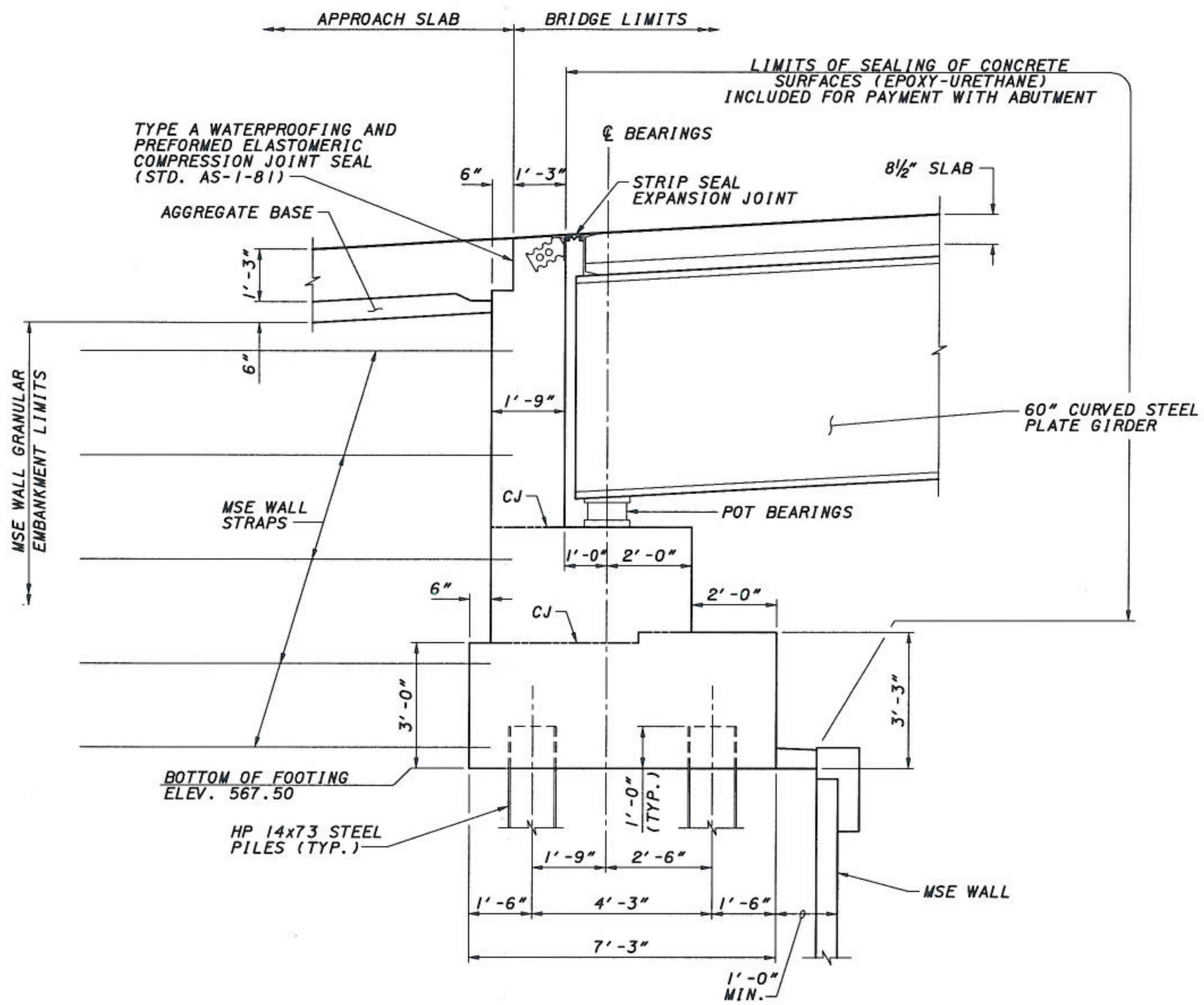
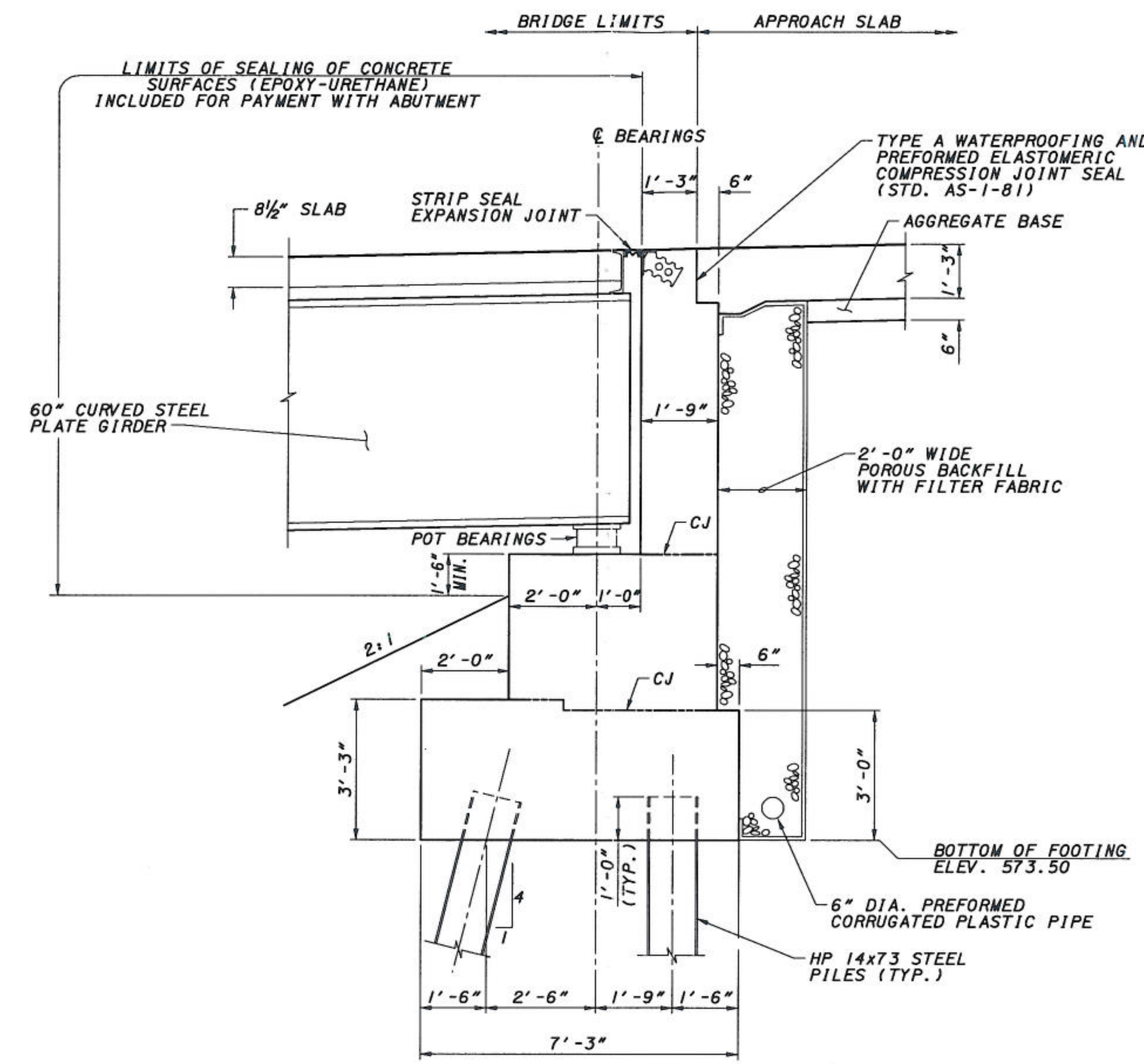
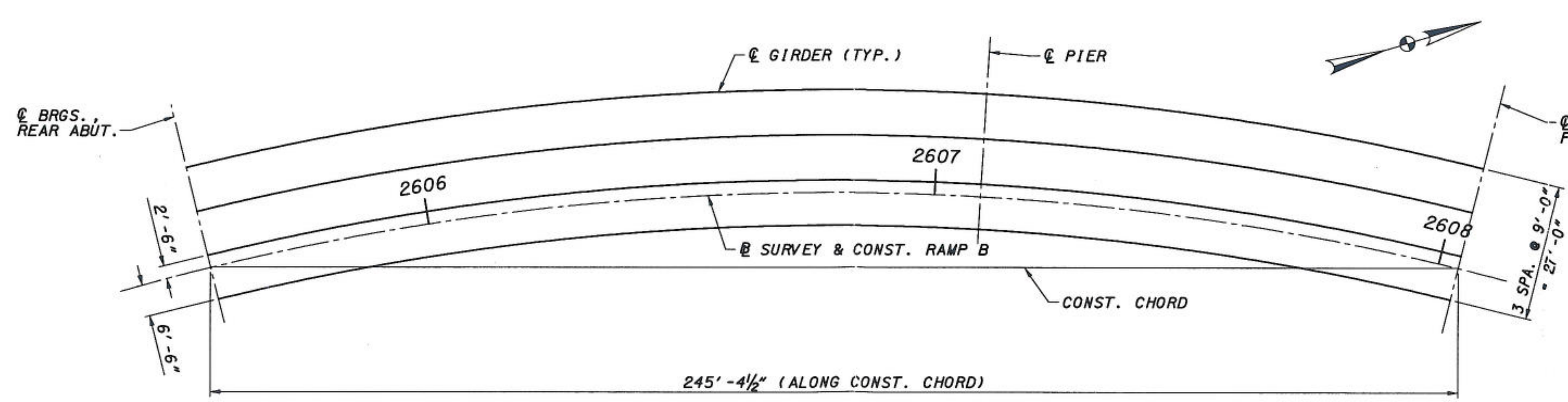


REAR ABUTMENT SECTION



FORWARD ABUTMENT SECTION



FRAMING PLAN

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

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

ABUTMENT SECTION AND FRAMING PLAN
BRIDGE NO. SCI-823-1598
RAMP B OVER NORFOLK SOUTHERN - ALT. 1

SCI-823-0.00

3/3

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APPENDIX C

Vertical Clearance Calculations

SCI-823-0.00
RAMP B OVER NORFOLK SOUTHERN
VERTICAL CLEARANCES

Filename: \\aries\proj\TranSystems\319861\19415\structures documents\Step 7 - Type Study\Bridge SCI823-1598C Ramp B over Railroad\[RampB_Vert_Clr.xls]Alternative 2

By: WRT　　Date: 06/19/2005

Checked: SKT　　Date:

LEGEND:

User Input - Not Critical

User Input - Critical to Output

Alternative 1 - 60" Curved Steel Plate Girders

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	NORFOLK SOUTHERN RAILWAY		RAILWAY STATION	NORFOLK SOUTHERN - EXISTING ELEV. @ POINT
1	Top/Rail East	NB	n/a	551.99
2	Top/Rail West	NB	n/a	551.94
3	Top/Rail East	SB	n/a	550.84
4	Top/Rail West	SB	n/a	551.00

PROFILE DATA - RAMP B

Linear:
- PVT Sta. 2601+50.00
- PVT Elev. 556.77
- g 5.80%
- PVC Sta. 2605+50.00
- PVC Elev. 579.97

Vertical Curve:
- PVC Sta. 2605+50.00
- PVC Elev. 579.97
- g1 5.80%
- g2 2.20%
- LVC 200
- PVI Sta. 2606+50.00
- PVI Elev. 585.77
- PVT Sta. 2607+50.00
- PVT Elev. 587.97

Superelevation Data:

Station	Left Shoulder	Pavement	Right Shoulder
2605+00.00	-4.0%	8.3%	-8.3%
2608+00.00	-4.0%	8.3%	-8.3%

POINT	RAMP B LOCATION DESCRIPTION	STA.	OFF.*	RAMP B PG ELEV.	LT. SHOULDER X-SLOPE	PVMT X-SLOPE	RT. SHOULDER X-SLOPE	RAMP B - FINISHED GRADE @ POINT
1	RT. FASCIA GIRDER	2606+69.22	6.50	585.61	-4.0%	8.3%	-8.3%	585.07
2	RT. FASCIA GIRDER	2606+50.34	6.50	584.88	-4.0%	8.3%	-8.3%	584.34
3	RT. FASCIA GIRDER	2606+26.01	6.50	583.86	-4.0%	8.3%	-8.3%	583.32
4	RT. FASCIA GIRDER	2606+04.90	6.50	582.88	-4.0%	8.3%	-8.3%	582.34

* For Offsets allow positive (+) to denote an offset to the right of the baseline and negative (-) to denote an offset to the left of the baseline

STRUCTURE DEPTH　　Haunch + Max. Top Flange = 4 in

POINT	GIRDER DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total	
1	60" PLATE GIRDER	8.50	2.00	2.0	60	2.0	2.5	77.00	in
2	60" PLATE GIRDER	8.50	2.00	2.0	60	2.0	2.5	77.00	in
3	60" PLATE GIRDER	8.50	2.00	2.0	60	2.0	-	74.50	in
4	60" PLATE GIRDER	8.50	2.00	2.0	60	2.0	-	74.50	in

VERTICAL CLEARANCE - RAMP B OVER NORFOLK SOUTHERN

POINT	LOCATION	RAMP B - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. GIRDER ELEVATION	NORFOLK SOUTHERN - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)	
1	RT. FASCIA GIRDER	585.07	77.000	578.65	551.99	**26.66**	OK
2	RT. FASCIA GIRDER	584.34	77.000	577.93	551.94	**25.99**	OK
3	RT. FASCIA GIRDER	583.32	74.500	577.11	550.84	**26.27**	OK
4	RT. FASCIA GIRDER	582.34	74.500	576.14	551.00	**25.14**	OK

SCI-823-0.00
RAMP B OVER NORFOLK SOUTHERN
VERTICAL CLEARANCES

Filename: \\aries\proj\TranSystems\319861\19415\structures documents\Step 7 - Type Study\Bridge SCI823-1598C Ramp B over Railroad\[RampB_Vert_Clr.xls]Alternative 2

By: WRT | Date: 06/19/2005

Checked: SKT | Date:

LEGEND:
User Input - Not Critical
User Input - Critical to Output

Alternative 2 - 66" Curved Steel Plate Girders

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	NORFOLK SOUTHERN RAILWAY		RAILWAY STATION	NORFOLK SOUTHERN - EXISTING ELEV. @ POINT
1	Top/Rail East	NB	n/a	551.99
2	Top/Rail West	NB	n/a	551.94
3	Top/Rail East	SB	n/a	550.84
4	Top/Rail West	SB	n/a	551.00

PROFILE DATA - RAMP B

Linear:
- PVT Sta. 2601+50.00; PVT Elev. 556.77; g 5.80%
- PVC Sta. 2605+50.00; PVC Elev. 579.97

Vertical Curve:
- PVC Sta. 2605+50.00; PVC Elev. 579.97; g1 5.80%; g2 2.20%; LVC 200
- PVI Sta. 2606+50.00; PVI Elev. 585.77
- PVT Sta. 2607+50.00; PVT Elev. 587.97

Superelevation Data:

Station	Left Shoulder	Pavement	Right Shoulder
2605+00.00	-4.0%	8.3%	-8.3%
2608+00.00	-4.0%	8.3%	-8.3%

POINT	RAMP B LOCATION DESCRIPTION	STA.	OFF.*	RAMP B PG ELEV.	LT. SHOULDER X-SLOPE	PVMT X-SLOPE	RT. SHOULDER X-SLOPE	RAMP B - FINISHED GRADE @ POINT
1	RT. FASCIA GIRDER	2606+69.22	6.50	585.61	-4.0%	8.3%	-8.3%	585.07
2	RT. FASCIA GIRDER	2606+50.34	6.50	584.88	-4.0%	8.3%	-8.3%	584.34
3	RT. FASCIA GIRDER	2606+26.01	6.50	583.86	-4.0%	8.3%	-8.3%	583.32
4	RT. FASCIA GIRDER	2606+04.90	6.50	582.88	-4.0%	8.3%	-8.3%	582.34

* For Offsets allow positive (+) to denote an offset to the right of the baseline and negative (-) to denote an offset to the left of the baseline

STRUCTURE DEPTH Haunch + Max. Top Flange = 4 in

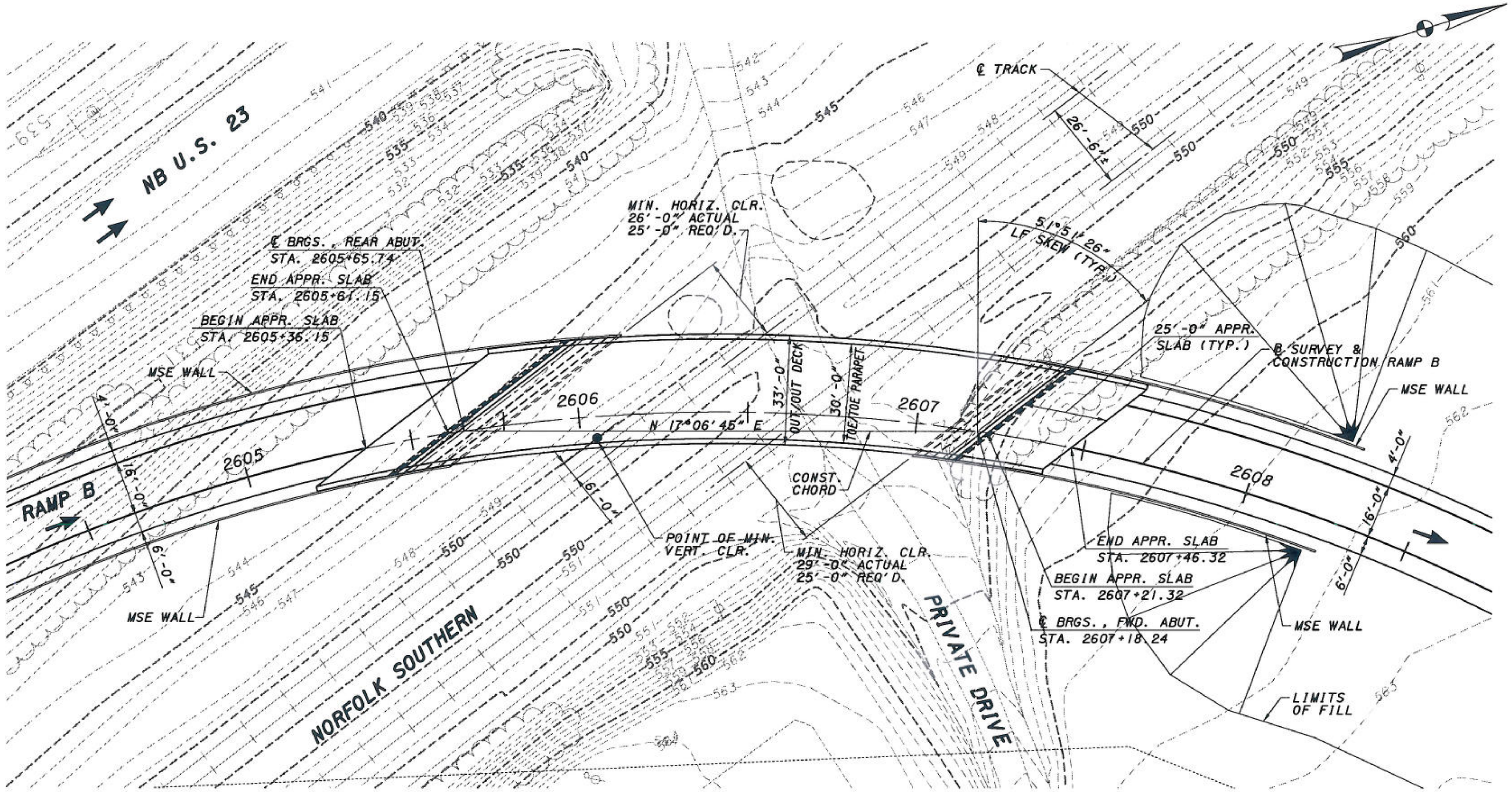
POINT	GIRDER DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total	
1	66" PLATE GIRDER	8.50	2.00	2.0	66	2.0	2.5	83.00	in
2	66" PLATE GIRDER	8.50	2.00	2.0	66	2.0	2.5	83.00	in
3	66" PLATE GIRDER	8.50	2.00	2.0	66	2.0	-	80.50	in
4	66" PLATE GIRDER	8.50	2.00	2.0	66	2.0	-	80.50	in

VERTICAL CLEARANCE - RAMP B OVER NORFOLK SOUTHERN

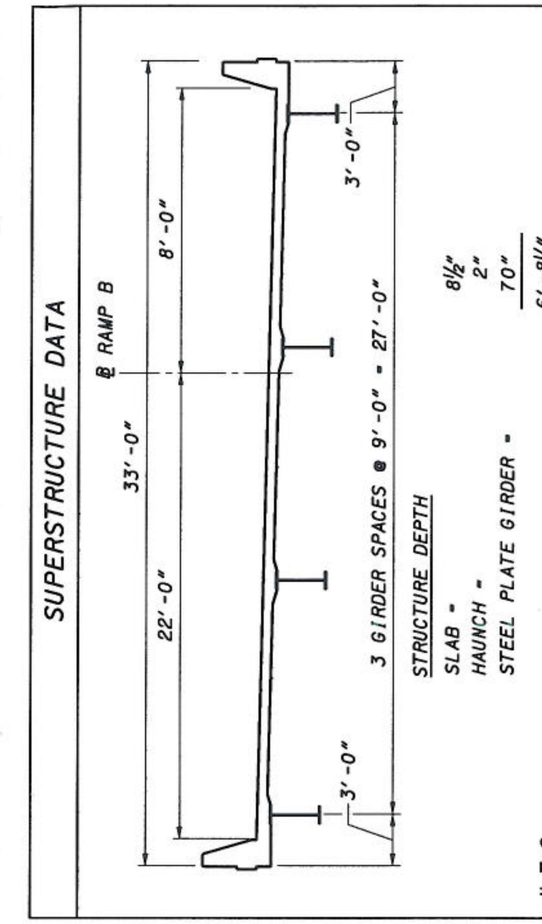
POINT	LOCATION	RAMP B - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. GIRDER ELEVATION	NORFOLK SOUTHERN - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)	
1	RT. FASCIA GIRDER	585.07	83.000	578.15	551.99	**26.16**	OK
2	RT. FASCIA GIRDER	584.34	83.000	577.43	551.94	**25.49**	OK
3	RT. FASCIA GIRDER	583.32	80.500	576.61	550.84	**25.77**	OK
4	RT. FASCIA GIRDER	582.34	80.500	575.64	551.00	**24.64**	OK

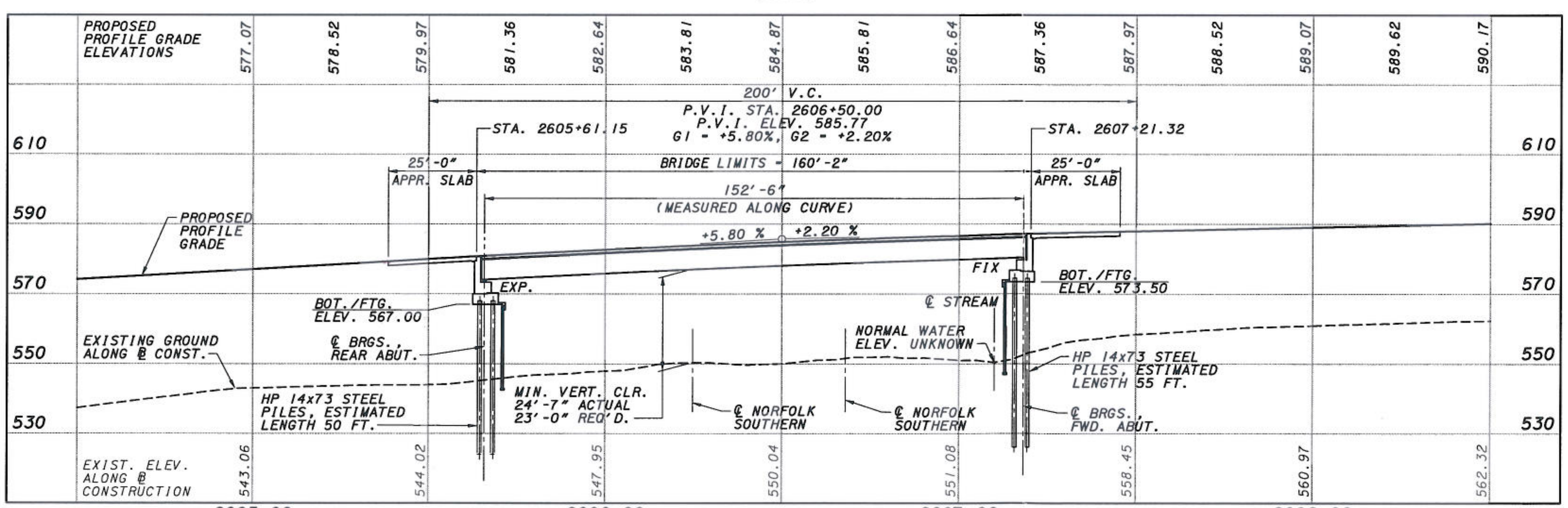
APPENDIX D

Preliminary Structure Site Plans



PLAN





PROFILE ALONG ℄ SURVEY AND CONSTRUCTION, RAMP B

PROPOSED STRUCTURE

TYPE: SINGLE SPAN COMPOSITE CURVED STEEL PLATE GIRDERS (NON-PAINTED ASTM A709, GR 50W) WITH REINFORCED CONCRETE DECK AND JOINTED STUB ABUTMENTS ON MSE WALLS

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
REVIEWED GAS	DATE 07/05
STRUCTURE FILE NUMBER	
DESIGNED WRT	DRAWN MME
CHECKED DGS	REVISED
SCIOTO COUNTY	STA. 2605+61.15 TO STA. 2607+21.32

SITE PLAN

BRIDGE NO. SCI-823-1598
RAMP B OVER NORFOLK SOUTHERN - ALT. 2

SCI-823-0.00

1/1

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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.

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ENGINEERS • ARCHITECTS • SCIENTISTS
PLANNERS • SURVEYORS

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.

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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.

<u>Ramp B - #2</u>

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.

Closing

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

Sincerely,

DLZ OHIO, INC.

P. Paul Painter

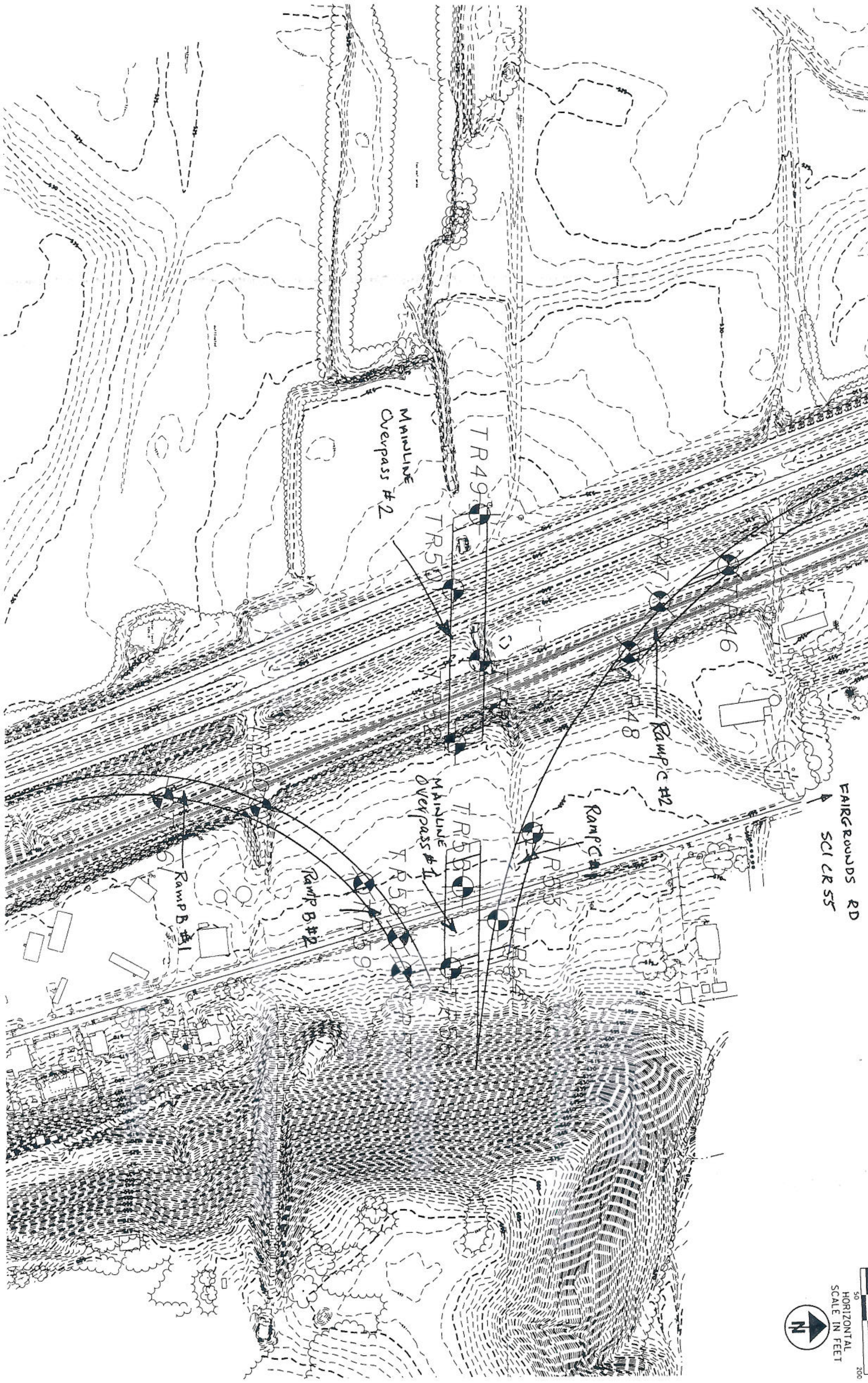
P. Paul Painter
Engineering Geologist

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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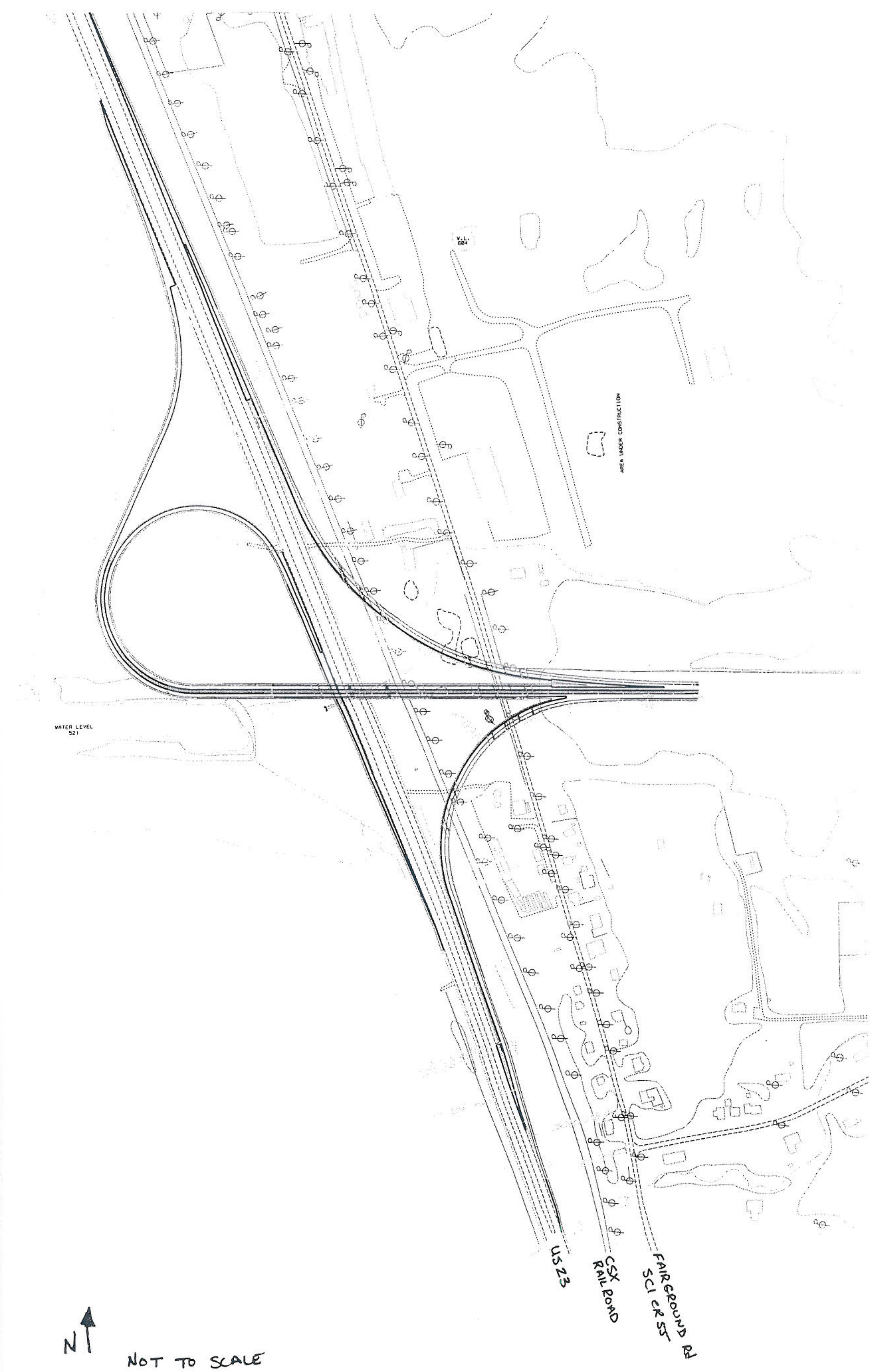

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Ramp Layout

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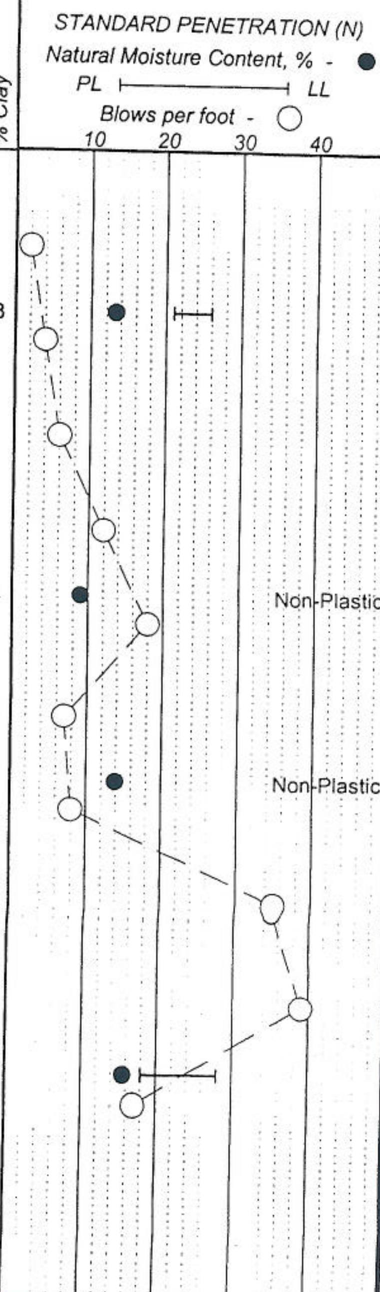
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

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	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
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
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
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			@ 23.0', gray.						
25		5 5 12	14	10				30	11	--	24	25	9
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. @ 29.8', 30.8', thin clay seam.						
30													



Client: TranSystems, Inc.

Project: SCI-823-0.00

LOG OF: Boring TR-46

Location: Forward Abutment - Ramp C - #2

Job No. 0121-3070.03

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	% 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	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.							
37.0	506.0						Bottom of Boring - 37.0'							

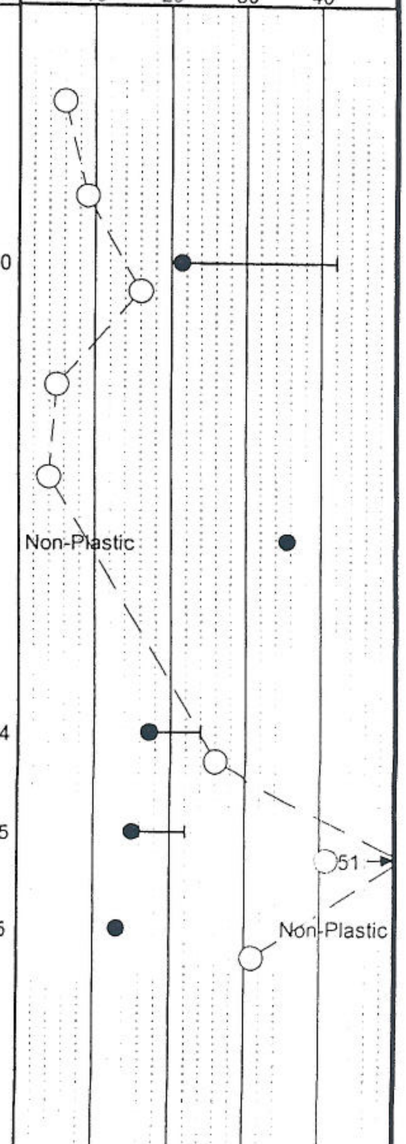
Depth scale: 30, 35, 40, 45, 50, 55, 60

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	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.0 – 0.1	542.0 – 541.9						Topsoil - 1"						
0.1 – 7.0	541.9 – 535.0	1 2 4	10	1		1.5	Stiff brown and gray CLAY (A-7-6), trace fine sand; slightly organic; moist.						
		2 4 5	13	2		2.5	@ 3.0', very stiff.						
		4 6 10	15	3		4.5	@ 6.0', hard.	0	0	--	2	48	50
7.0 – 13.0	535.0 – 529.0	1 3 2	10	4		0.5	Medium stiff brown SANDY SILT (A-4a), trace gravel, trace clay; moist to wet.						
		2 2 2	7	5		--							
13.0 – 18.0	529.0 – 524.0	WOH WOH WOH	18	6			Very loose brown COARSE AND FINE SAND (A-3a), trace clay; wet.	1	2	--	83	15	
		WOH WOH 1	18	7									
18.0 – 21.0	524.0 – 521.0	11 14 12	10	8		1.5	Stiff brown SANDY SILT (A-4a), some gravel; moist.	30	11	--	24	22	14
21.0 – 23.0	521.0 – 519.0	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 – 26.5	519.0 – 515.5	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
		50/4	4	11									
26.5 – 30	515.5 –						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.						



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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	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N)
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.							
36.5	505.5						Bottom of Boring - 36.5'							

Depth scale: 30, 35, 40, 45, 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]

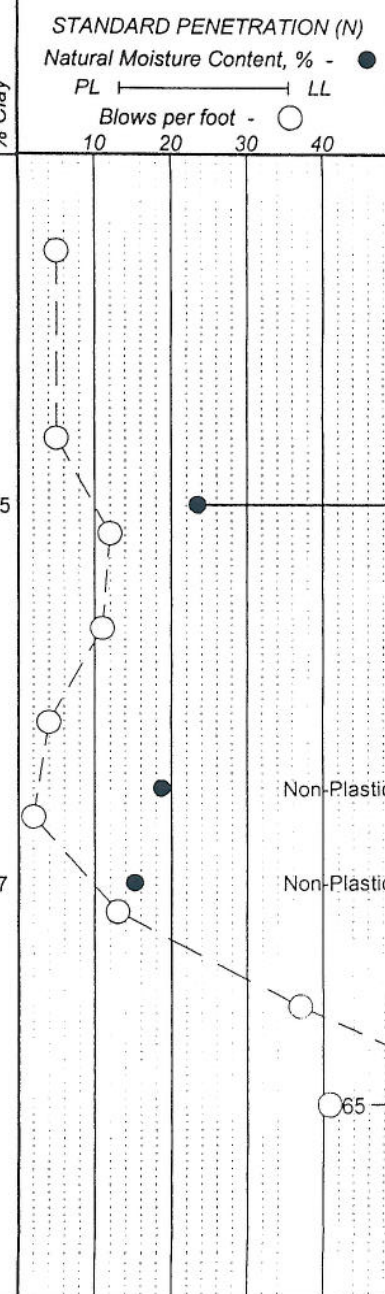
DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

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

LOG OF: Boring TR-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	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
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.						
		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.						
		1 1 1	8	7				37	27	--	17	20	
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
		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.						
30		Core 120"	Rec 120"	RQD 97%	R1								



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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 Penetro-meter (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N)
29.9	517.0 / 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 - ○; scale 10, 20, 30, 40

Depth scale: 40, 45, 50, 55, 60

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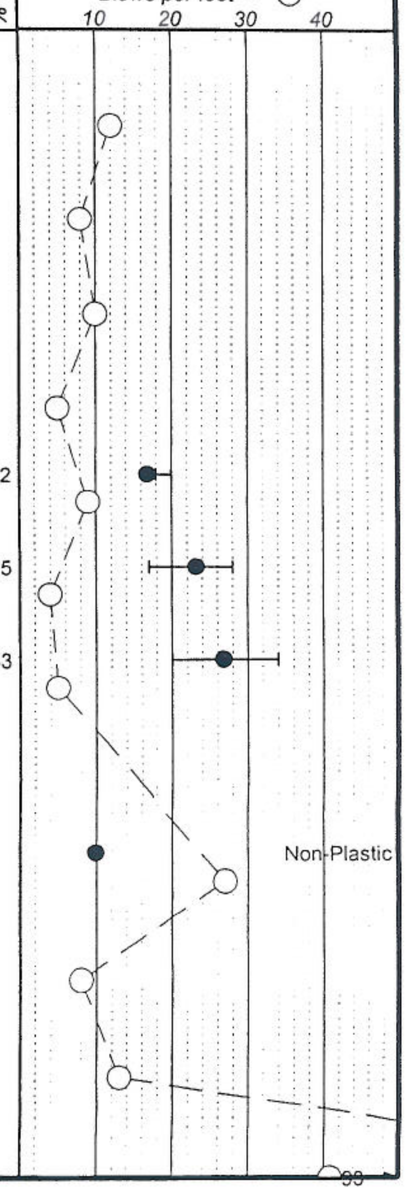
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-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	% 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.						
5		3 4 4	16	2		4.0							
		3 5 5	16	3		1.5	@ 6.0', stiff; moist.						
10		2 2 3	17	4		1.0							
		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
15.5	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	
25		2 2 6	18	10									
		6 5 8	13	11									
30		10 43 50/4	18	12			@ 29.0', possible broken sandstone.						

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



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

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

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
30	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	50/2	1	13			Medium hard gray SANDSTONE; fine grained, slightly weathered, argillaceous, broken, multiple clay seams, low and high angled fractures.						
35–45		Core 120"	Rec 84"	RQD 13%	R1								
45.0	492.5						Bottom of Boring - 45.0'						
50													
55													
60													

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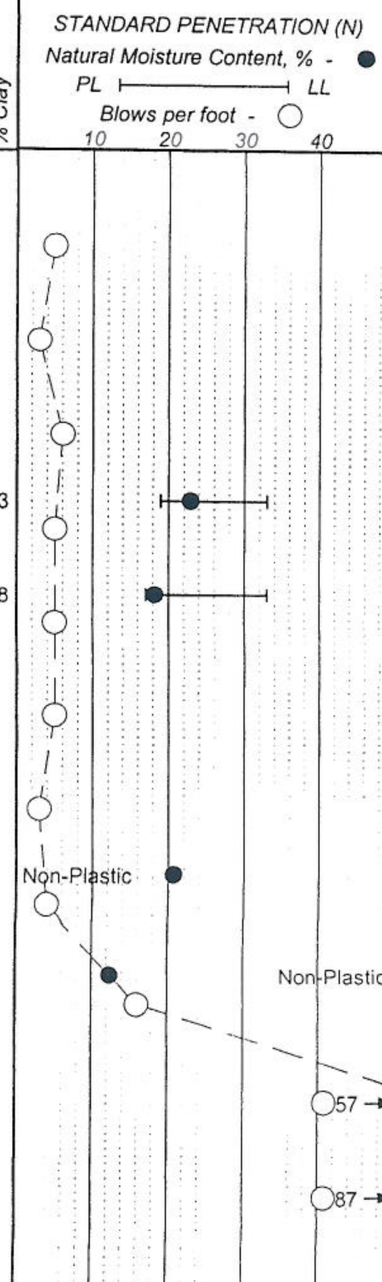
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

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 Penetro-meter (tsf)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.1	540.0 / 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.						
10		1 2 3	16	4		1.5		1	4	--	7	57	33
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
15		WOH 2 3	18	6		1.5							
		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	
24.5 / 25	515.5	2 7 50	18	10			Medium hard brownish gray SANDSTONE; highly weathered.						
27.5	512.5	25 37 50/4	10	11			Hard gray SANDSTONE; fine grained, slightly weathered, argillaceous, medium bedded. @ 28.1'-28.7', 29.0'-29.1' clay seams						
30													



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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	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														

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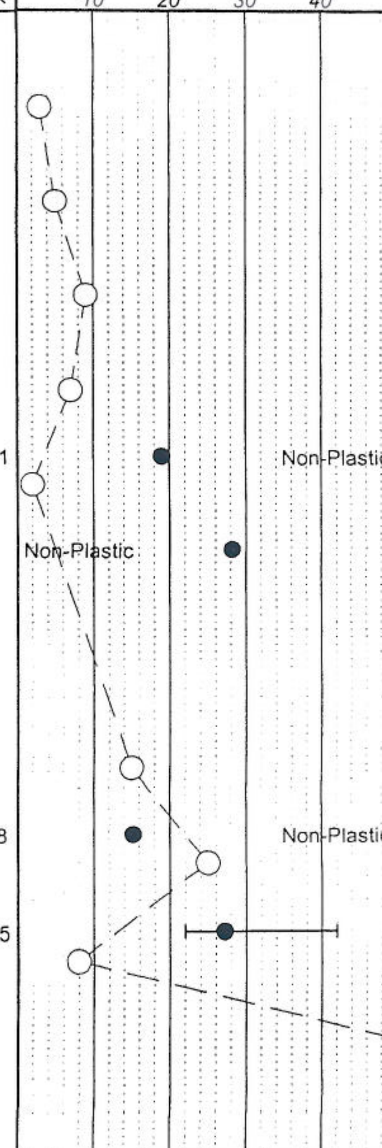
Client: TranSystems, Inc. | *Project:* SCI-823-0.00 | *Job No.* 0121-3070.03

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	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
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	2 3 6	8	3		3.5	Very stiff brown SILTY CLAY (A-6b), trace fine to coarse sand, trace fine to coarse gravel; damp.						
8.0	537.0	3 3 4	10	4		2.0	Very loose to loose brown GRAVEL WITH SAND (A-1-b); damp.						
10		1 1 1	7	5		1.5	@ 11.0', moist.	43	28	--	11	7	11
13.0	532.0	WOH WOH WOH	18	6			Very loose brown COARSE AND FINE SAND (A-3a), trace fine to coarse gravel, trace clay; wet.	12	28	--	45	15	
15		WOH WOH WOH	18	7									
18.0	527.0	16 7 8	18	8			Medium dense reddish brown SANDY SILT (A-4a), little gravel; damp to moist.						
20		7 14 11	14	9				19	19	--	30	24	8
23.0	522.0	1 3 5	11	10		1.5	Stiff gray CLAY (A-7-6); moist.	0	0	--	1	43	55
25 / 25.5	519.5	20 50/3	8	11			Medium hard black SHALE; moderately weathered, pyritic, laminated, broken. @ 28.1'-28.2', gray.						
28.6	516.4						Hard gray SANDSTONE						
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-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	% 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	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.							
35														
37.5	507.5						Bottom of Boring - 37.5'							
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-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	% 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.						
40.4	517.6	Core 120"	Rec 120"	RQD 35%	R1		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'						

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○
10 20 30 40

Depth scale: 30, 35, 40, 45, 50, 55, 60

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

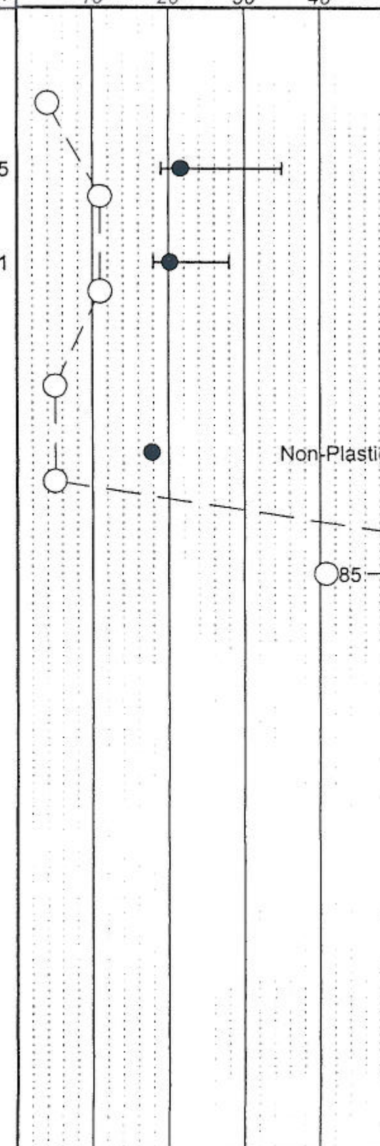
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-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 Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.2	567.5 / 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.						
		2 5 6	17	2		3.5		0	0	--	4	61	35
5.5	562.0	3 5 6	18	3		2.25	Very stiff brown SANDY SILT (A-4a), trace clay; damp.	0	0	--	12	67	21
		1 3 2	11	4		2.0							
10.5	557.0	1 2 3	13	5			Loose dark brown COARSE AND FINE SAND (A-3a), trace to little clay, trace gravel; damp.	8	38	--	37	18	
13.6	553.9	7 35 50/4	14	6			Soft gray SHALE; moderately weathered.						
15.0	552.5	Core 120"	Rec 120"	RQD 83%	R-1		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.						
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'						

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



Depth scale: 5, 10, 20, 30

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

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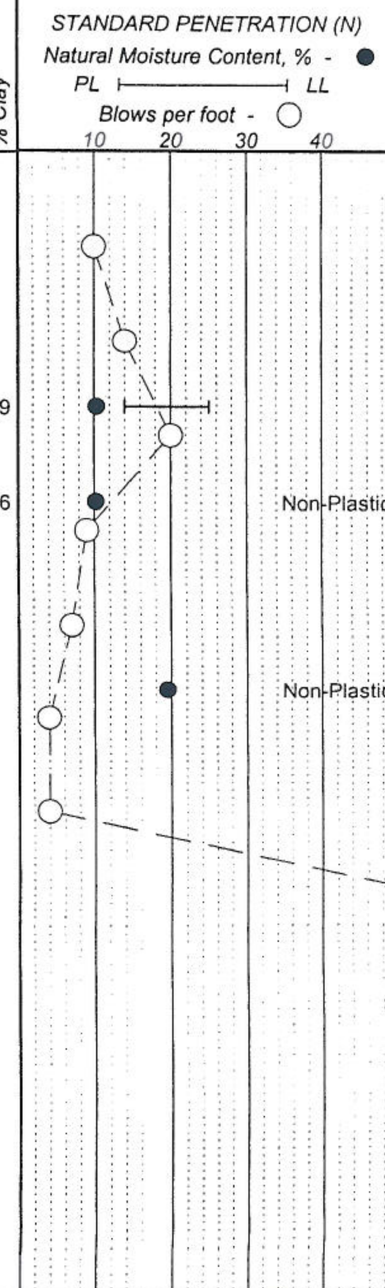
Client: TranSystems, Inc. | *Project:* SCI-823-0.00 | *Job No.* 0121-3070.03

LOG OF: Boring TR-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	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	565.5						Hard gray SILTY CLAY (A-6b); damp.						
		3 5 5	10	1		4.5+							
3.0	562.5						Hard brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; damp.						
		6 7 7	9	2		4.5+							
		11 11 9	12	3		4.5+		22	15	--	23	21	19
8.0	557.5						Very stiff to hard brown SANDY SILT (A-4a), trace gravel; damp.						
		4 5 4	14	4		3.5		5	25	--	39	16	16
		5 4 3	12	5		4.5+	@ 11.0', hard.						
13.0	552.5						Loose brown COARSE AND FINE SAND (A-3a), trace gravel; wet.						
		2 2 2	15	6				9	38	--	41	13	
		1 2 2	7	7									
18.0	547.5						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.						
		35 50/5	12	8									
		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]

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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	% 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														

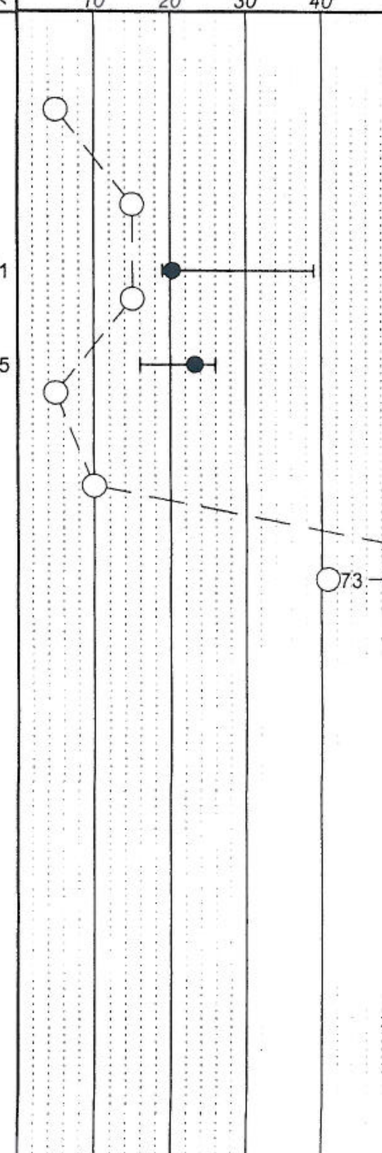
DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

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

LOG OF: Boring TR-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 Penetro-meter (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.2	569.5 / 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.						
		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
		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.						
		Core 120"	Rec 120"	RQD 68%	R-1								
25.0	544.5						Bottom of Boring - 25.0'						



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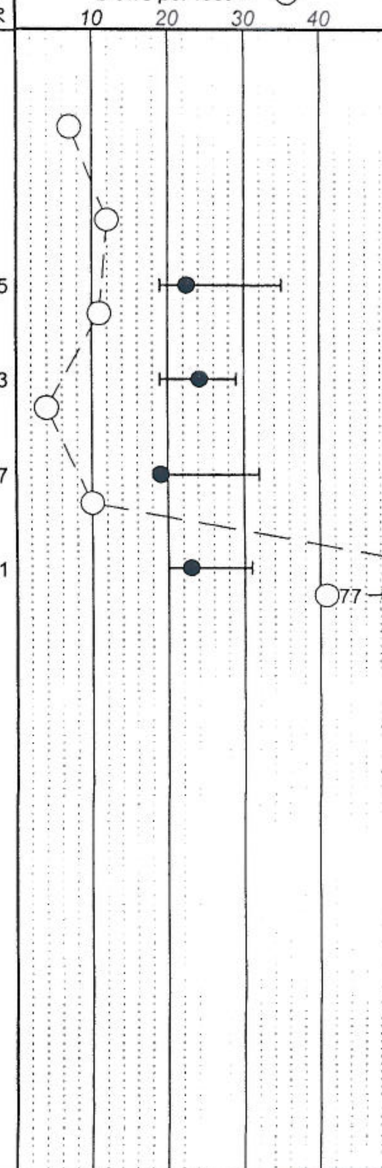
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

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	% 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.						
5		3 5 7	12	2		4.5							
		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
10.5	559.0	2 5 5	14	5			Medium dense brown SANDY SILT (A-4a), little gravel, trace clay; damp.	23	15	--	19	26	17
14.0	555.5	12 27 50/3	13	6			Soft to medium hard gray SHALE; moderately weathered, laminated. @ 15.8'-16.3', 19.1'-19.5', clay seams	0	2	--	4	64	31
		Core 120"	Rec 120"	RQD 90%	R-1								
20.9	548.6						Hard gray SILTSTONE interbedded with SHALE; slightly weathered, laminated. @ 22.7'-22.9' high angle fracture						
22.9	546.6						Hard gray SHALE; slightly weathered, laminated, slightly fractured.						
25.0	544.5						Bottom of Boring - 25.0'						

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



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

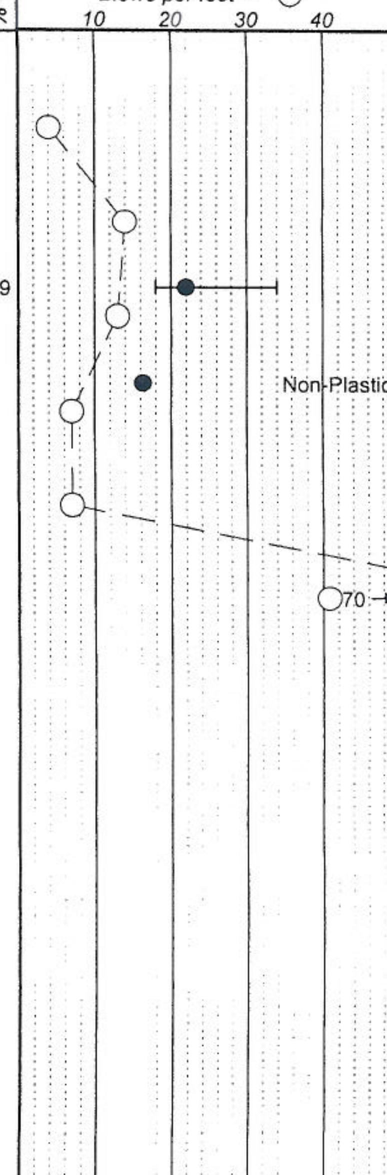
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

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 Penetro-meter (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.						
5		3 6 8	15	2		4.25							
		5 6 7	18	3		3.5		0	0	--	6	65	29
8.0	559.0						Loose dark brown COARSE AND FINE SAND (A-3a), trace to little clay, trace gravel; damp.						
10		2 4 3	16	4				7	34	--	40	19	
		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													

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



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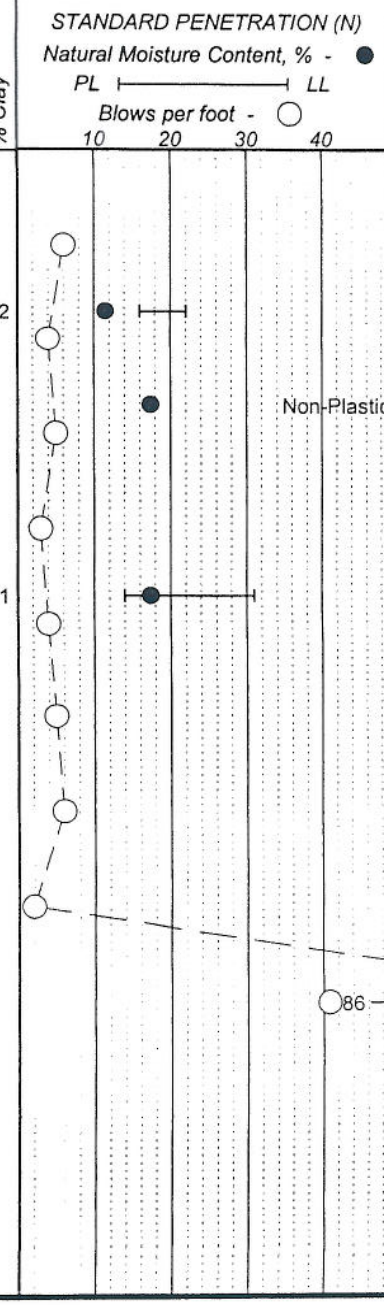
Client: TranSystems, Inc. | *Project:* SCI-823-0.00 | *Job No.* 0121-3070.03

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	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	564.5						Loose dark gray SANDY SILT (A-4a), trace clay, trace gravel; damp.						
		3 3 3	14	1									
5		2 2 2	12	2			@ 3.5', brown; Moist.	7	13	--	26	32	22
5.5	559.0						Very loose to loose brown COARSE AND FINE SAND (A-3a), trace clay, trace silt; moist.						
		2 2 3	15	3				15	36	--	37	12	
10		2 2 1	13	4									
10.5	554.0						Loose brown SANDY SILT (A-4a), little gravel, trace clay; damp to moist.						
		2 2 2	16	5				14	25	--	31	9	21
15		1 2 3	15	6									
		2 3 3	12	7			@ 16.0', little to some clay.						
20		0 1 1	14	8			@ 19.0'-21.5', wet.						
21.5	543.0	1 36 50	12	9			Medium hard gray SHALE; slightly weathered.						
		32 50/3	9	10									
25.0	539.5	Core 120"	Rec 119"	RQD 65%	R-1		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													



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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	% 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	534.5						Medium hard to hard gray SILTSTONE interbedded with SHALE; very fine to fine grained, slightly weathered, argillaceous, thinly bedded, slightly fractured. @ 31.4'-31.7', clay seams with high angle fractures							
33.0	531.5						Hard black SHALE; fine grained, slightly weathered, carbonaceous, thinly bedded. @ 33.8'-34.0', high angle fractures and broken.							
35.0	529.5						Bottom of Boring - 35.0'							
40														
45														
50														
55														
60														

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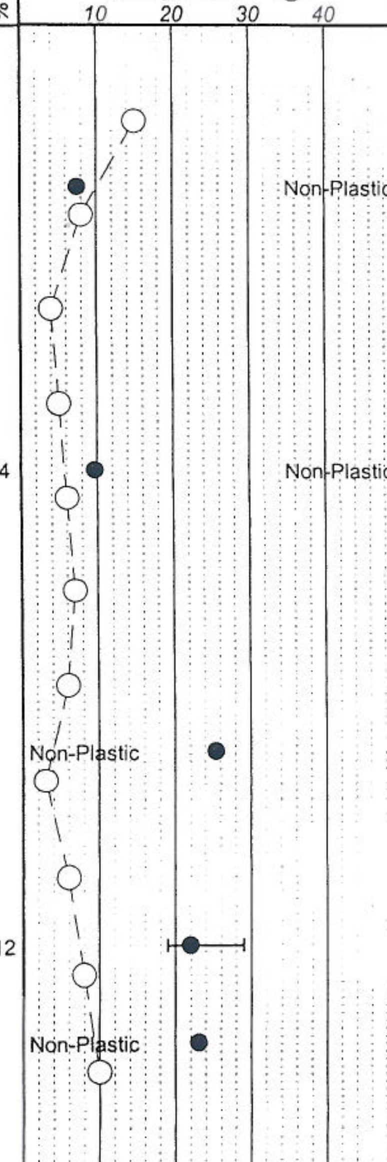
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-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	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.0	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	
		3 2 2	9	3									
		3 2 3	13	4									
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
		3 3 4	1	6			@ 13.5', moist.						
		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	
		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
25.5	528.5	3 6 4	18	11			Loose reddish brown FINE SAND (A-3), trace clay; wet.	7	14	--	59	21	
28.0	526.0	50/4	4	12			Soft black SHALE; highly weathered.						

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



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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 Penetrometer (tsf)	DESCRIPTION	% 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	Core 120"	Rec 119"	RQD 79%	R-1		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. @ 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														

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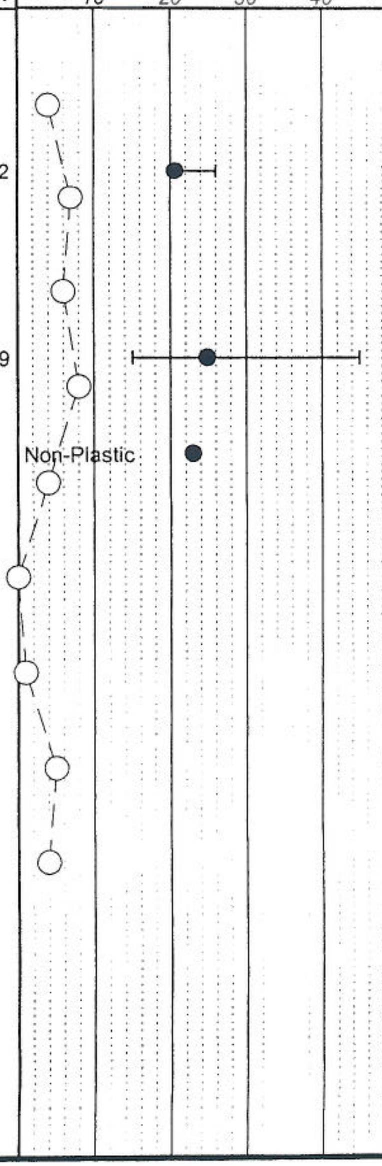
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

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	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	547.0						FILL: Loose black SANDY SILT (A-4a), little gravel; organic; dry to damp.						
		2 2 2	2	1									
5		3 4 3	1	2				14	20	--	26	28	12
5.5	541.5						Very stiff light brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; damp.						
		2 3 3	16	3		2.5							
		1 3 5	12	4		2.25	@ 8.5', brown.	8	12	--	12	29	39
10.5	536.5						Very loose brown COARSE AND FINE SAND (A-3a); moist.						
		1 2 2	13	5			@ 10.5'-12.5', little clay	9	47	--	32	13	
		0 0 0	16	6			@ 13.5', wet.						
15													
		0 0 1	18	7			@ 18.0', very loose to loose.						
20		1 3 2	18	8									
		1 1 3	18	9									
23.0	524.0	50/3	3	10			Medium hard black SHALE; moderately weathered.						
25.0	522.0	Core 120"	Rec 114"	RQD 92%	R-1		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													



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

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	% 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														