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Structure Type Study

Ramp C over Norfolk Southern Railway

SCI-823-0.00
PID No. 19415

7306814

Prepared for
Ohio Department of Transportation

July 2005

CH2MHILL

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1. Introduction

Two (2) alternatives for construction of the proposed Ramp C 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 forward 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 most current version of the Ohio Department of Transportation Bridge Design Manual, the 2002 AASHTO Standard Specifications for Highway Bridges, 17th 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 C follows a 7°45'00" horizontal curve (739.30-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 C bridge will be superelevated at a constant 8.0 percent for the entire structure length.

The proposed Ramp C vertical alignment over NS Railway consists of a -1.70 percent slope at the rear approach, followed by a 250-foot crest vertical curve to a -5.20 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 C crosses the railway at a skew angle of approximately 60° (actual skew varies somewhat due to the curvature of Ramp C). No modifications to the existing railroad are anticipated as part of the project.

4. Proposed Maintenance of Traffic Solution

The proposed Ramp C alignment will carry traffic exiting westbound SR-823 onto northbound US-23. Because the Ramp C 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 9'-6". For alternatives where the superstructure depth is significantly less than 9'-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 hydraulic channel of the unnamed stream which flows parallel to the railroad and then turns into the existing railroad culvert south of the crossing. A formal hydraulic study has not been performed at this time; therefore, the limits of existing rip-rap are assumed to define the required channel in the vicinity of the crossing. Piers and abutment spill-through slopes have been placed clear of the existing rip-rap. 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 60° skew, 26'-6" track centers, adjacent stream channel, and railroad horizontal clearance considerations require a clear span (face-to-face of abutments) of over 200 feet. 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. However, there is adequate room for a pier between the existing stream channel and the eastern track.

The possible superstructure types are limited by the site characteristics. Given the minimum span length in excess of 200 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 C ahead 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 forward abutment. A retained-fill type and a spill-through type are both feasible options for the rear abutment. However, placement of the rear abutment must preserve the existing railroad culvert inlet, in order to prevent relocation or modifications to that drainage structure 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 forward abutment may require specialized fill material, rip-rap, or other means to protect against scour. The Department should consider performing both a Hydraulic Analysis and Scour Analysis to aid in selection of MSE wall details and abutment foundation details at the forward 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 162'-3" and 188'-9" center-to-center of bearings along the construction baseline. The seat-type rear abutment is on piles behind a spill-through 2:1 slope, with U-back wingwalls. The seat-type forward abutment is on piles behind a three-sided MSE wall. 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 72-inch webs spaced at 9'-0" on center.

The rear abutment is located such that the spill-through slope will not encroach upon the existing stream channel and railroad culvert entrance south of the bridge. Minor regrading of the channel will be required to eliminate the existing field drainage ditch east of the railroad culvert entrance. The pier is located to provide adequate horizontal railroad clearance to the footing on the south side and prevent interference with the stream channel on the north side. The forward abutment is located to provide 25'-0" clear between the MSE wall and nearest track centerline. All substructure units are set radial to the Ramp C 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 \$2,362,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be \$577,000, resulting in a total estimated ownership cost of \$2,939,000 in year 2008 dollars.

Alternative 2

Alternative 2 is a curved steel I-girder bridge with a single span of 217'-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 96-inch webs spaced at 9'-0" on center.

The rear abutment is located to prevent encroachment upon the existing stream channel. The MSE wingwalls on the north and south sides extend back to catch the same spill slope defined in Alternative 1, in order to prevent encroachment of fill upon the stream channel and railroad culvert entrance, respectively. Minor regrading of the channel will be required to eliminate the existing field drainage ditch east of the railroad culvert entrance. The skew at the rear abutment is approximately 50 degrees from the radial (right forward) at the centerline of bearing. The forward abutment is located to provide 25'-0" clear between the MSE wall and nearest track centerline. The skew at the forward abutment is approximately

67 degrees from the radial (right 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 \$3,124,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be \$405,000, resulting in a total estimated ownership cost of \$3,529,000 in year 2008 dollars.

6. Recommended Alternative

Two (2) structural solutions for the construction of the proposed Ramp C 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
- Shorter maximum span length
- 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 C 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 MSE retaining wall borings. If required, a third mobilization will target specific boring locations or in-situ testing recommended in the bridge and retaining wall Preliminary Design Report submissions.

Three borings at the Ramp C 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 C 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 spill-through 2:1 slope, and a seat-type forward abutment behind a three-sided MSE wall. Both abutments are assumed to be supported on HP14x73 piles driven to bedrock. The rear abutment will utilize battered piles in the front row to resist horizontal loads. The forward 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. The 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 C Over NS Railway
STRUCTURE TYPE STUDY

Filename: C:\Documents and Settings\NBROWN3\Local Settings\Temporary Internet Files\OLK3E\1603C Cost Comp.xls\Alternative Summary
 By: WRT Date: 6/23/2005
 Checked: SKT Date: 6/23/2005

COST COMPARISON SUMMARY

Alternative No.	Span Arrangement	Span 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	162.25 - 188.75	4 - Curved Steel Plate Girders	72" Web - Grade 50W	\$1,353,000	\$401,000	\$2,362,000	\$577,000	\$2,939,000
2	1	217.5	4 - Curved Steel Plate Girders	96" Web - Grade 50W	\$1,040,000	\$1,173,000	\$3,124,000	\$405,000	\$3,529,000

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	162.25 - 188.75	351.00	4 ~ Curved Steel Plate Girders	72" Web - Grade 50W	\$1,353,000	\$401,000	0.0	\$0	-\$80,000	\$281,000	\$407,000	\$0	\$2,362,000	\$577,000	\$2,939,000
2	1	217.50	217.50	4 ~ Curved Steel Plate Girders	96" Web - Grade 50W	\$1,040,000	\$1,173,000	133.5	\$34,000	\$0	\$354,000	\$513,400	\$10,000	\$3,124,000	\$405,000	\$3,529,000

NOTES:

- Approach roadway length equals the difference between the maximum bridge length and the bridge length for the alternative being considered.
 - 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. |
- 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.
 - 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.
 - Roadway incidental cost allowance includes provision for drainage, maintenance of traffic, and traffic control costs.
 - Estimated construction cost does not include existing structure removal, which should be quantified separately, if required.
 - The roadway profile has been set to provide adequate vertical clearance over the railroad for a superstructure depth of up to 9'-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	25.31	-2.00	-1302	\$62.00	-\$80,000
Alt. 2	23.25	0.00	0	\$62.00	\$0

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Filename: C:\Documents and Settings\NBROWN3\Local Settings\Temporary Internet Files\OLK3E\1603C Cost Comp.xls\Alternative Summary
 By: WRT Date: 6/23/2005
 Checked: SKT Date: 6/23/2005

SUPERSTRUCTURE

Alternative No.	Span Arrangement		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	Pressressed Girder Cost	Initial Superstructure Cost
	No. Spans	Lengths													
1	2	162.25 - 188.75	351.00	353.00	11,600	448	\$268,100	\$112,200	\$30,300	4 ~ Curved Steel Plate Girders	72" Web - Grade 50W	684400.0	\$942,400	\$0	\$1,353,000
2	1	217.5	217.50	219.50	7,200	278	\$166,700	\$69,800	\$30,300	4 ~ Curved Steel Plate Girders	96" Web - Grade 50W	561600.0	\$773,300	\$0	\$1,040,000

Deck Cross-Sectional Area:

Parapets:	No.	Individual Area (sq. ft.)	W (ft.)	Ave. W (ft.)	Slab Area	Parapet Area	Total Concrete Area (sq. ft.)
	2	4.26				8.52	
Alt. 1			0.71	33.00	23.4		34.2
Alt. 2			0.71	33.00	23.4		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):	Year 2004	Annual Escalation	Year 2008
Assume 285 lbs of reinforcing steel per cubic yard of deck concrete			
Deck Reinforcing	\$0.77	3.5%	\$0.88

Structural Steel Unit Costs (\$/lb.):

Material	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 59 pounds per each square foot of bridge deck area for Alt. 1. and 78 pounds per each square foot of bridge deck area for Alt. 2.

Reinforced Concrete Approach Slabs (T=15")

Unit Cost (\$/sq. yd.):	Year 2004	Annual Escalation	Year 2008
Length = 25 ft. Area = 92 sq. yd. Ave. Width = 33.00 ft.			
Approach Slabs	\$144.00	3.5%	\$165.00

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Filename: C:\Documents and Settings\NBROWN3\Local Settings\Temporary Internet Files\OLK3E\1603C Cost Comp.xls\Alternative Summary
 By: WRT
 Date: 6/23/2005
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SUBSTRUCTURE

Alternative No.	Span Arrangement	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	2 162.25 - 188.75	4 ~ Curved Steel Plate Girders	\$53,600	\$12,200	\$84,000	\$13,800	\$80,800	\$156,900	\$0	\$401,000
2	1 217.5	4 ~ Curved Steel Plate Girders	\$0	\$0	\$140,500	\$23,000	\$71,000	\$938,300	\$0	\$1,173,000

Pier QC/QA Concrete, Class QSC1 Cost:

Alt. 1	Volume (cu. yd.)	Year 2004	Year 2008	Total Cost
Component				
Cap	38.0	\$421.00	\$483.00	\$18,350
Columns	41.0	\$421.00	\$483.00	\$19,800
Footings	32.0	\$421.00	\$483.00	\$15,460
Total Pier Cost				\$53,600 Each Pier

Abutment QC/QA Concrete, Class QSC1 Cost:

Alt. 1	Volume (cu. yd.)	Year 2004	Year 2008	Total Cost
Component				
Rear	77.0	\$421.00	\$483.00	\$37,200
Forward	63.0	\$421.00	\$483.00	\$30,400
Wingwalls				
Rear	34.0	\$421.00	\$483.00	\$16,400
Forward	0.0	\$421.00	\$483.00	\$0
Alt. 2				
Component				
Rear	105.0	\$421.00	\$483.00	\$50,700
Forward	186.0	\$421.00	\$483.00	\$89,800
Wingwalls				
Rear	0.0	\$421.00	\$483.00	\$0
Forward	0.0	\$421.00	\$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.

Pier Abutment	Year 2004	Annual Escalation	Year 2008	Total Cost
Alt. 1	\$0.77	3.5%	\$0.88	\$156,900
Alt. 2	\$0.77	3.5%	\$0.88	\$938,300
MSE Wall	\$54.00	3.5%	\$62.00	

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

Year 2004	Annual Escalation	Year 2008	Total Cost
Alt. 1	0	0	\$0
Alt. 2	0	0	\$0
Temporary Shoring	\$23.50	3.5%	\$27.00
Temporary MSE Wall	\$27.50	3.5%	\$31.60

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
Alt. 2	0	\$0
Year 2004 Unit Cost	Annual Escalation	Year 2008
Year 2004	Escalation	Year 2008
\$23.50	3.5%	\$27.00
\$27.50	3.5%	\$31.60

Abutment Piles:

Alt. 1	Alt. 2	Number	Forward	Rear	Top Elevation	Bottom Elevation	Length per Pile	Total Pile Length	Total Cost
Alt. 1	Alt. 2	24	541.0	0.0	520.0	520.0	25	600	\$24,800
Alt. 2	Alt. 1	0	0.0	0.0	0.0	0.0	0	0	\$0
Alt. 1	Alt. 2	15	11	19	573.5	527.0	566.0	527.0	\$56,000
Alt. 2	Alt. 1	14	19	11	571.5	520.0	563.5	520.0	\$71,000
Year 2004 Unit Cost	Annual Escalation	Year 2008	Year 2008	Year 2008	Year 2008	Year 2008	Year 2008	Year 2008	Year 2008
\$24.41	3.5%	\$28.00	\$28.00	\$28.00	\$28.00	\$28.00	\$28.00	\$28.00	\$28.00
\$11.57	3.5%	\$13.30	\$13.30	\$13.30	\$13.30	\$13.30	\$13.30	\$13.30	\$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
Alt. 2	0	\$0
Year 2004 Unit Cost	Annual Escalation	Year 2008
Year 2004	Escalation	Year 2008
\$23.50	3.5%	\$27.00
\$27.50	3.5%	\$31.60

Substructure

SCI-823-0.00
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Filename: C:\Documents and Settings\NBROWN\Local Settings\Temporary Internet Files\OLK3E1\1603C Cost Comp.xls\Alternative Summary
Date: 6/23/2005
By: WRT
Date: 6/23/2005
Checked: SKT

LIFE CYCLE MAINTENANCE COST

Alt. No.	Span Arrangement	Span Arrangement Lengths	Structural Steel Painting			Superstructure Sealing			Approach Pavement Resurfacing				
			Cost Per Cycle	Number of Maintenance Cycles	Total Life Cycle Cost	Cost Per Cycle	Number of Maintenance Cycles	Total Life Cycle Cost	Cost Per Cycle	Number of Maintenance Cycles	Total Life Cycle Cost		
1	2	162.25 - 188.75	\$0	0	\$0	\$0	0	\$0	0	\$0	\$0	0	\$0
2	1	217.5	\$0	0	\$0	\$2,200	7	\$15,400					

Alt. No.	Span Arrangement	Span Arrangement Lengths	Bridge Deck Overlay (5)			Bridge Redecking (5)			Superstructure Life Cycle Maintenance Cost (1)	Total Alternative Construction Cost	Total Relative Ownership Cost
			Deck Demo & Chipping	Deck Overlay	Deck Concrete	Deck Reinforcing	Deck Joint	Deck Removal			
1	2	162.25 - 188.75	\$35,200	\$42,600	\$4,500	\$268,100	\$18,000	\$96,000	\$577,000	\$2,362,000	\$2,939,000
2	1	217.5	\$21,800	\$26,500	\$9,000	\$166,700	\$36,100	\$59,600	\$405,000	\$3,124,000	\$3,529,000

Structural Steel Painting:

Structural Steel Area:

Alt. No.	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.)	Painting Cost per sq. ft.:	Year	
									2004	2008
Alt. 1	351.00	0	217.50	20%	0	0	0	\$5.00	\$5.74	
Alt. 2	217.50	0	217.50	20%	0	0	\$1.25	\$1.43	\$1.43	
								\$1.25	\$1.43	
								Annual Escalation	3.5%	
								Total	\$10.03	

Superstructure Sealing:

PS Concrete Area:

Alt. No.	No. Stringers	Total Span Length (ft.)	Nominal Exposed Beam Area (sq. ft.)	Secondary Member Allowance	Total Exposed Concrete Area (sq. ft.)	Sealing Cost per sq. yd.:	Year	
							2004	2008
Alt. 1	0	0	0	10%	0	\$9.66	\$9.66	
Alt. 2	0	0	0	10%	0			
							Annual Escalation	3.5%
							Total	\$11.11

Bridge Redecking:

Bridge Deck Joint Cost per foot:

Structural Expansion Joint Including Elastomeric Strip Seal	Year 2008	Annual Escalation	Year 2008

Ave. Joint Length

Alt. No.	Ave. Joint Length	No. Joints
Alt. 1	33.00	2
Alt. 2	66.00	2

Bridge Deck Removal Cost:

Alt. No.	Deck Area (3) (sq. ft.)	Year 2008	Deck Removal Cost
Alt. 2	7,200	2008	\$8,280

Bridge Deck Overlay (Item 848):

Bridge Deck MSC Overlay Cost per sq. yd.:

Micro Silica Modified Concrete Overlay Using Hydrodemolition (1.25" thick) Surface Preparation Using Hydrodemolition	Year 2004	Annual Escalation	Year 2008

Hand Chipping (10% of deck area)

Year 2004	Annual Escalation	Year 2008
\$37.07	3.5%	\$42.54

Bridge Deck MSC Overlay Cost per cu. yd.:

Micro Silica Modified Concrete Overlay (Variable Thickness), Material Only	Year 2004	Annual Escalation	Year 2008

Deck Area (3) (sq. ft.)

Alt. No.	Deck Area (sq. ft.)	Hand Chipping (sq. yd.)	Deck Area (sq. yd.)
Alt. 1	11,600	32	1,289
Alt. 2	7,200	20	800

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

Bridge Deck Joint Gland Replacement Cost per foot:

Elastomeric Strip Seal Gland	Year 2004	Annual Escalation	Year 2008

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 Planning, Asphalt Concrete, per sq. yd. (Item 254)

Year 2004	Annual Escalation	Year 2008
\$72.00	3.5%	\$82.62

Asphalt Concrete Surface Course, per cu. yd.

Year 2004	Annual Escalation	Year 2008
\$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. 2	133.5	490	1.50	20.4

APPENDIX B

Preferred Alternative Site Plan and Details



1/3

SCI-823-0.00

SITE PLAN

SCIO COUNTY
BRIDGE NO. SCI-823-1603
RAMP C OVER NORFOLK SOUTHERN - ALT. 1

DESIGNED BY: WRT
CHECKED BY: DGS
DATE: 07/05
REVIEWED BY: SMN
STRUCTURE FILE NUMBER: 5775

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

BENCHMARKS

CURVE C-2
P.I. STA. = 3898+09.03
 $\Delta = 57^{\circ}43'34''$ (RT.)
 $D_c = 07^{\circ}45'00''$
 $R = 739.30'$
 $T = 407.49'$
 $L = 744.85'$
 $E = 104.87'$
 $e_{max} = 0.073$

TRAFFIC DATA

CURRENT ADT (2010) = 6200
DESIGN ADT (2030) = 9400
DESIGN ADTT = 1320

LEGEND

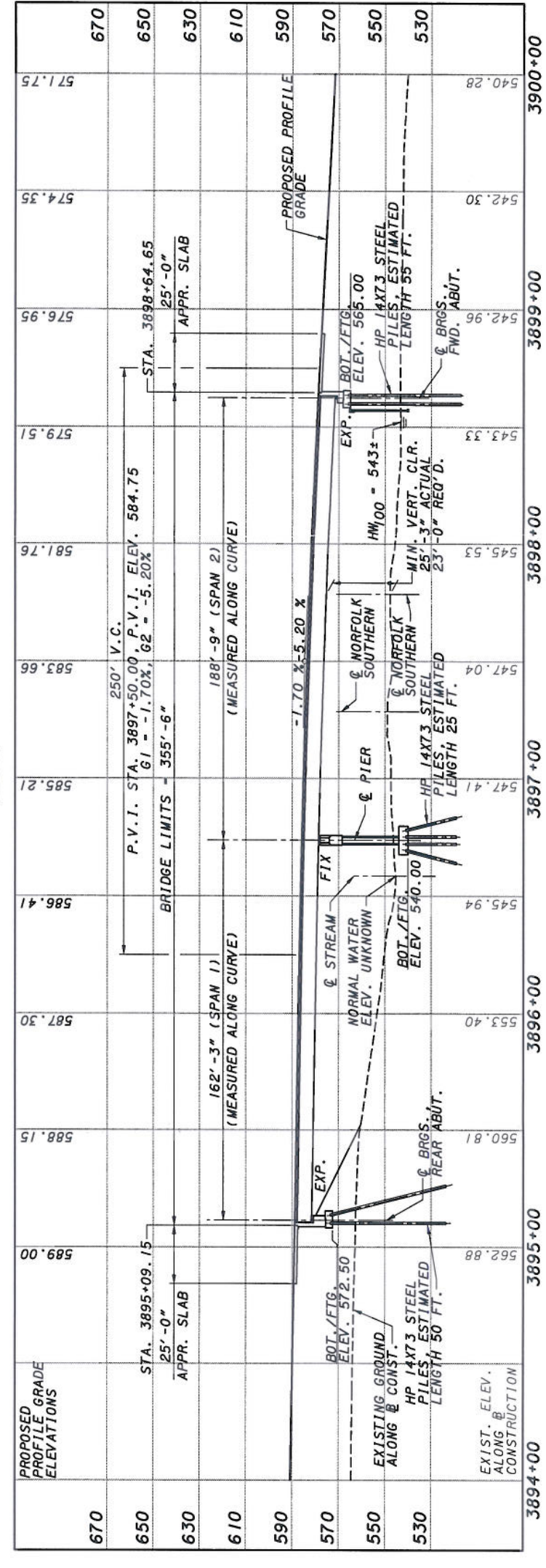
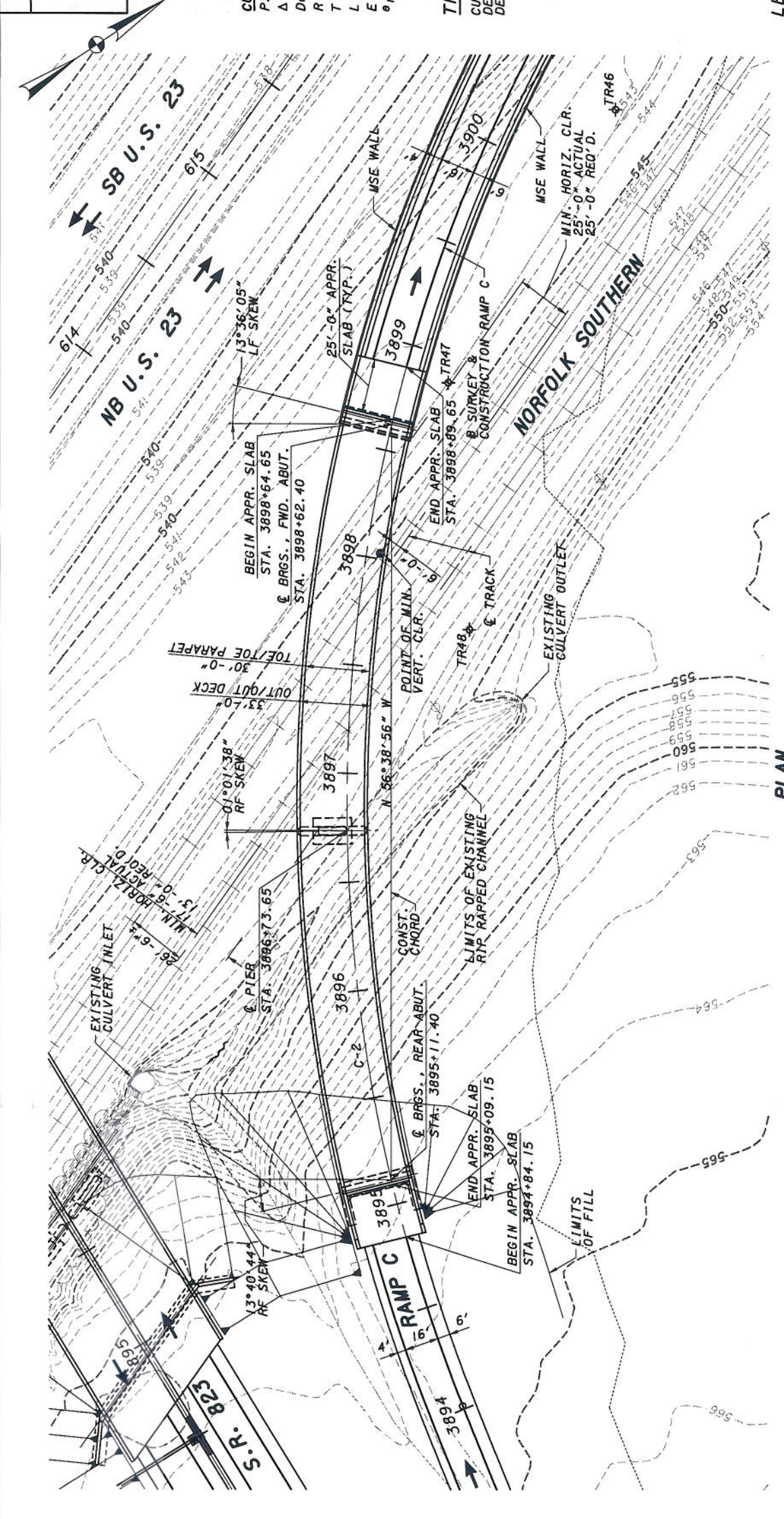
⚡ DENOTES SOIL BORING LOCATION

NOTE

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

PROPOSED STRUCTURE

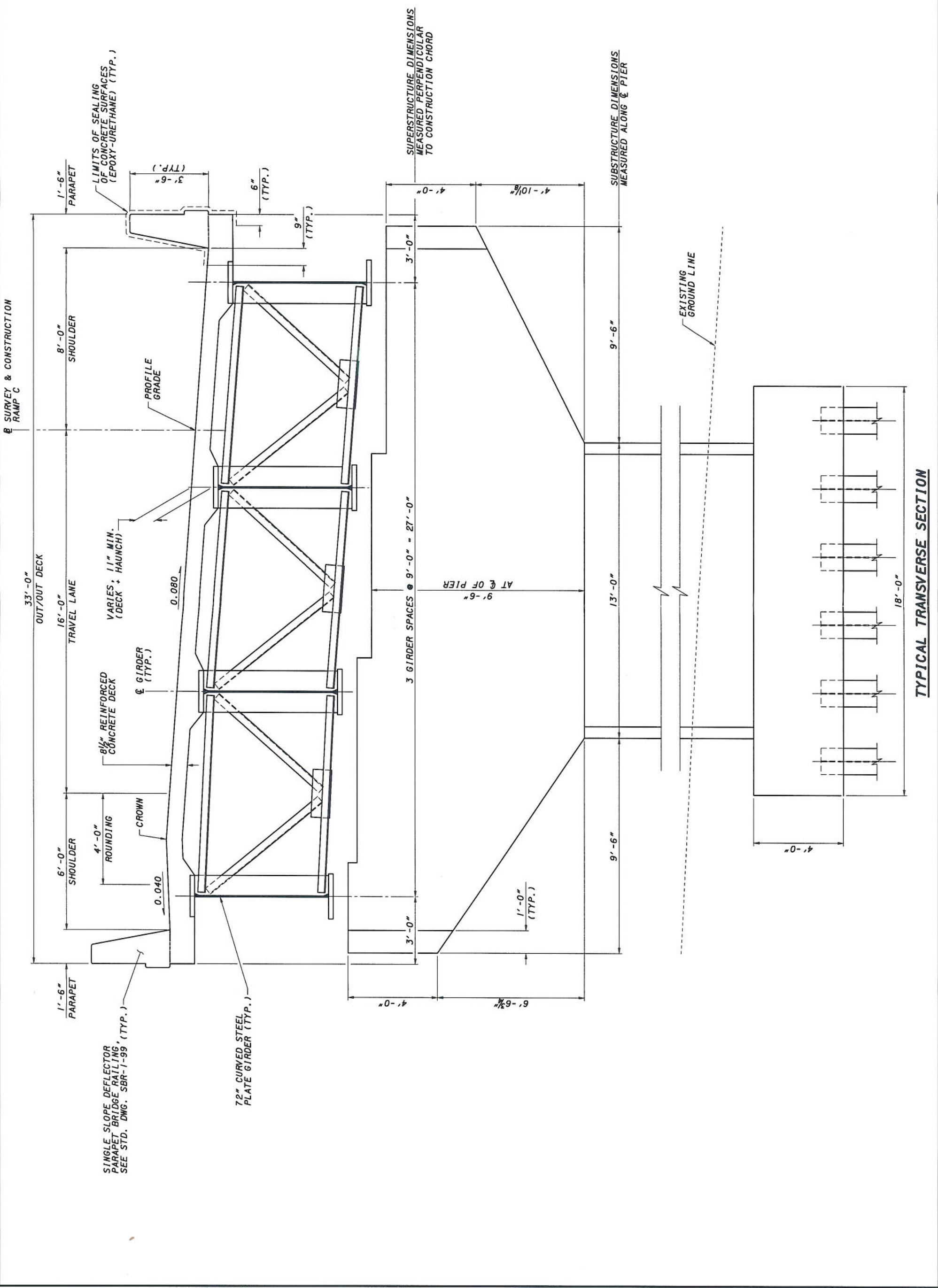
TYPE: TWO-SPAN COMPOSITE CURVED STEEL PLATE GIRDERS (NON-PAINTED ASTM A709, GR 50W) WITH REINFORCED CONCRETE DECK ON JOINTED STUB ABUTMENT (REAR) AND JOINTED STUB ABUTMENT ON MSE WALL (FWD.) WITH T-TYPE PIER
LENGTH OF SPAN: 162'-3", 188'-9", MEASURED @ ABUTMENT BRGS. - @ PIER BRGS. - @ ABUTMENT BRGS.
ROADWAY: 30'-0" TOE/TOE PARAPETS
SIDEWALK: NONE
DESIGN LOADING: HS25 (CASE 11) AND THE ALTERNATE MILITARY LOADING, FWS = 60 LB/FT²
SKEW: 13°40'44" RF (REAR ABUTMENT), 01°01'38" RF (PIER), 13°36'05" 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 = 739.30 FT.)
CROWN: 0.080 FT/FT
LATITUDE: N 38°53'34"
LONGITUDE: W 82°59'57"



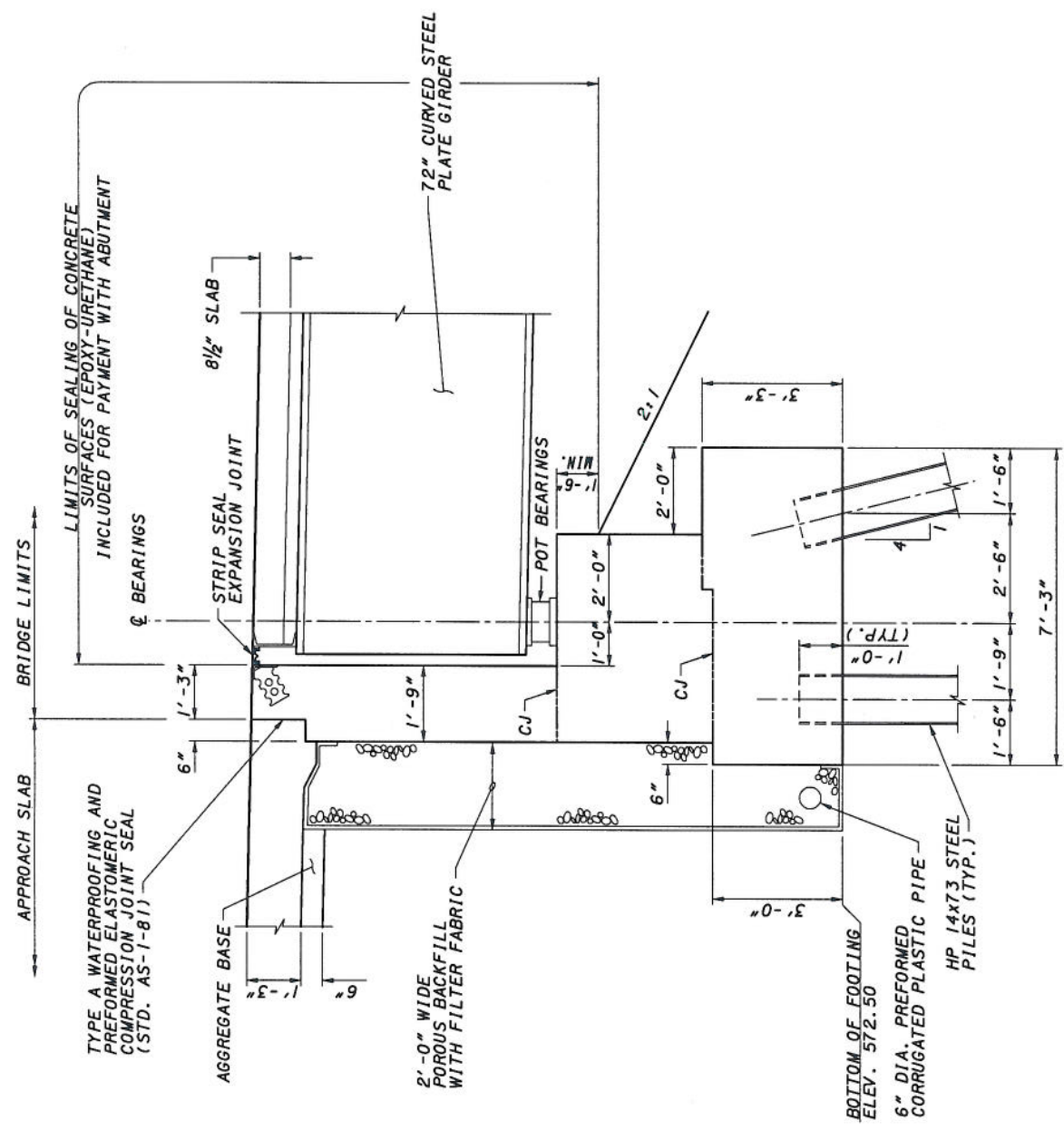
PROFILE ALONG B SURVEY AND CONSTRUCTION, RAMP C



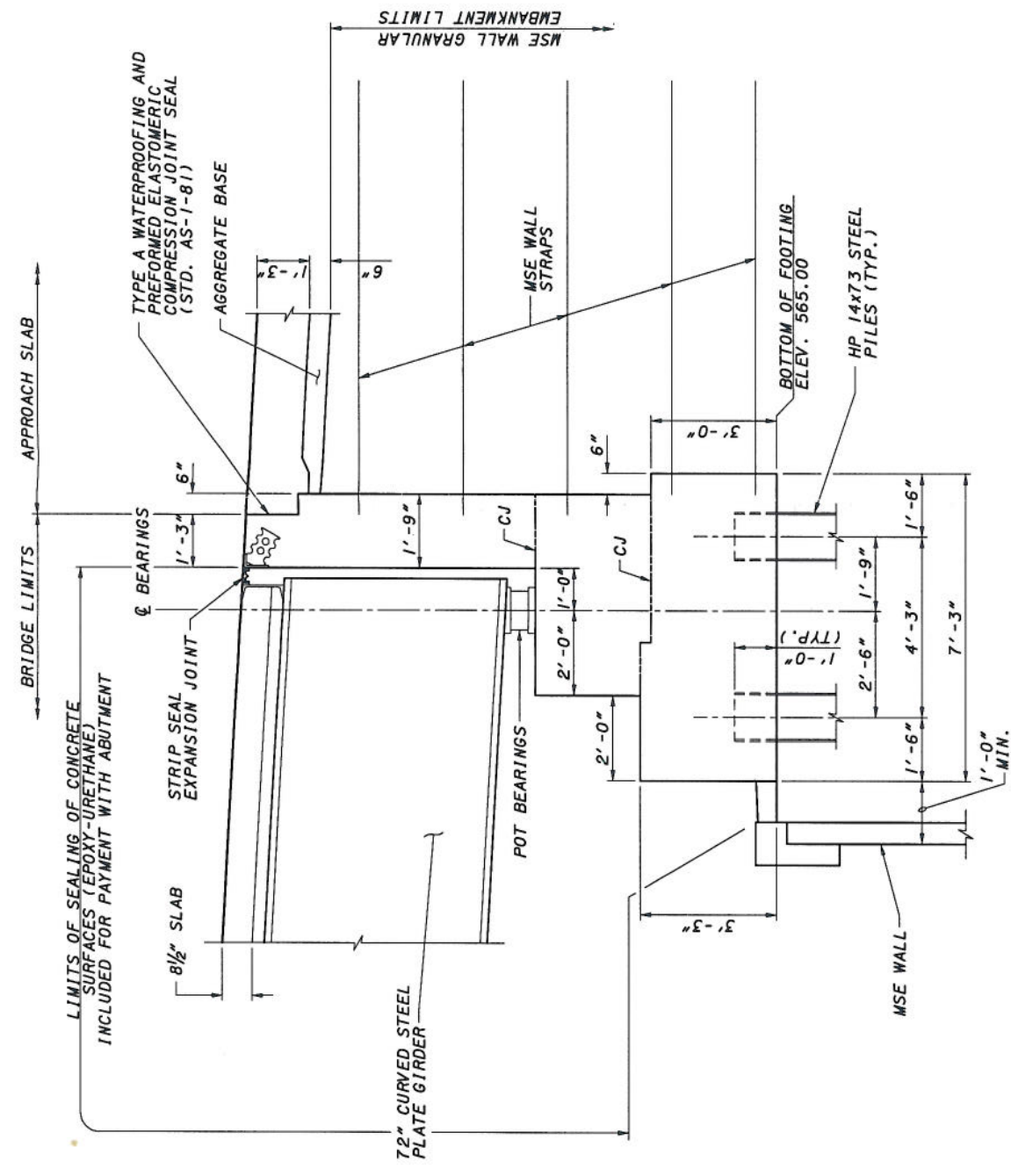
DESIGNED	WRT	SKT
REVIEWED	DGS	REVISIO
DATE	07/05	STRUCTURE FILE NUMBER



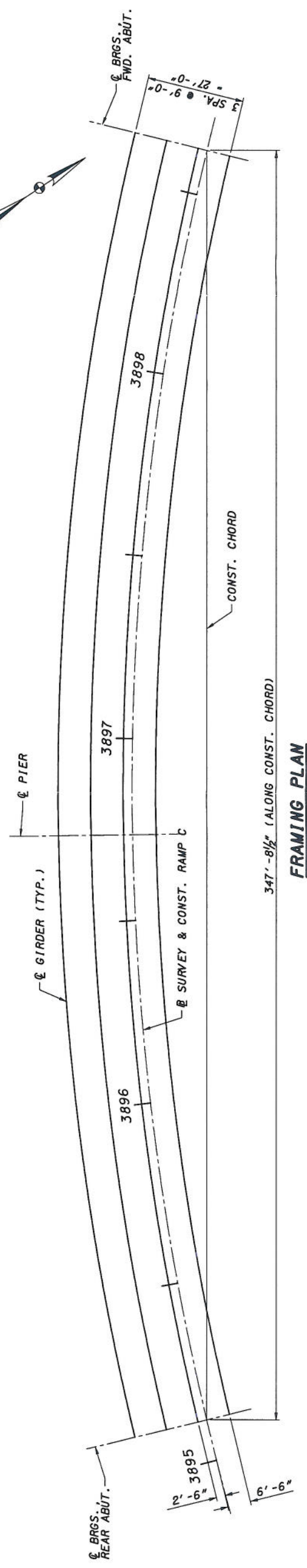
DESIGNED	DGS	DATE	07/05
DRAWN	MME	REVIEWED	GAS
CHECKED	REVISED	STRUCTURE FILE NUMBER	
SKT			



REAR ABUTMENT SECTION



FORWARD ABUTMENT SECTION



FRAMING PLAN

APPENDIX C

Vertical Clearance Calculations

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

Filename: \\aries\proj\TranSystems\31986119415\structures documents\Step 7 - Type Study\Bridge SCI823-1603C Ramp C over Railroad\{RampC_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 - 72" 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	549.76
2	Top/Rail West NB	n/a	549.76
3	Top/Rail East SB	n/a	548.74
4	Top/Rail West SB	n/a	548.48

PROFILE DATA - RAMP C

Linear: PVT Sta. 3893+25.00 PVC Sta. 3896+25.00
 PVT Elev. 591.98 PVC Elev. 586.88
 g -1.70%

Vertical Curve: PVC Sta. 3896+25.00 PVI Sta. 3897+50.00 PVT Sta. 3898+75.00
 PVT Elev. 586.88 PVI Elev. 584.75 PVT Elev. 578.25
 g1 -1.70%
 g2 -5.20%
 LVC 250

Superelevation Data:

Station	Left Shoulder	Pavement	Right Shoulder
3894+00.00	-4.0%	8.0%	-8.0%
3900+00.00	-4.0%	8.0%	-8.0%

POINT	RAMP C LOCATION			RAMP C PG ELEV.	LT. SHOULDER X-SLOPE	PVMT X-SLOPE	RT. SHOULDER X-SLOPE	RAMP C - FINISHED GRADE @ POINT
	DESCRIPTION	STA.	OFF.*					
1	RT. FASCIA GIRDER	3897+24.07	6.50	584.51	-4.0%	8.0%	-8.0%	583.99
2	RT. FASCIA GIRDER	3897+47.03	6.50	583.76	-4.0%	8.0%	-8.0%	583.24
3	RT. FASCIA GIRDER	3897+76.60	6.50	582.69	-4.0%	8.0%	-8.0%	582.17
4	RT. FASCIA GIRDER	3898+02.64	6.50	581.65	-4.0%	8.0%	-8.0%	581.13

* 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 = 5 in

POINT	GIRDER DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	72" PLATE GIRDER	8.50	2.50	2.5	72	2.5	2.5	90.50 in
2	72" PLATE GIRDER	8.50	2.50	2.5	72	2.5	2.5	90.50 in
3	72" PLATE GIRDER	8.50	2.50	2.5	72	2.5	-	88.00 in
4	72" PLATE GIRDER	8.50	2.50	2.5	72	2.5	-	88.00 in

VERTICAL CLEARANCE - RAMP C OVER NORFOLK SOUTHERN

POINT	LOCATION	RAMP C - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. GIRDER ELEVATION	NORFOLK SOUTHERN - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)
1	RT. FASCIA GIRDER	583.99	90.50	576.44	549.76	26.68
2	RT. FASCIA GIRDER	583.24	90.50	575.70	549.76	25.94
3	RT. FASCIA GIRDER	582.17	88.00	574.84	548.74	26.10
4	RT. FASCIA GIRDER	581.13	88.00	573.79	548.48	25.31

OK
 OK
 OK
 OK

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

Filename: \\aries\proj\TranSystems\31986119415\structures documents\Step 7 - Type Study\Bridge SCI823-1603C Ramp C over Railroad\{RampC_Vert_Clr.xls\Alternative 2

By: WRT
 Checked: SKT

Date: 06/19/2005
 Date:

LEGEND:

User Input - Not Critical
 User Input - Critical to Output

Alternative 2 - 96" 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	549.76
2	Top/Rail West NB	n/a	549.76
3	Top/Rail East SB	n/a	548.74
4	Top/Rail West SB	n/a	548.48

PROFILE DATA - RAMP C

Linear:	PVT Sta. 3893+25.00	PVC Sta. 3896+25.00		
	PVT Elev. 591.98	PVC Elev. 586.88		
	g -1.70%			
Vertical Curve:	PVC Sta. 3896+25.00	PVI Sta. 3897+50.00	PVT Sta. 3898+75.00	
	PVC Elev. 586.88	PVI Elev. 584.75	PVT Elev. 578.25	
	g1 -1.70%			
	g2 -5.20%			
	LVC 250			
Superelevation Data:	Station	Left Shoulder	Pavement	Right Shoulder
	3894+00.00	-4.0%	8.0%	-8.0%
	3900+00.00	-4.0%	8.0%	-8.0%

POINT	RAMP C LOCATION				RAMP C PG ELEV.	LT. SHOULDER X-SLOPE	PVMT X-SLOPE	RT. SHOULDER X-SLOPE	RAMP C - FINISHED GRADE @ POINT
	DESCRIPTION	STA.	OFF.*						
1	RT. FASCIA GIRDER	3897+24.07	6.50		584.51	-4.0%	8.0%	-8.0%	583.99
2	RT. FASCIA GIRDER	3897+47.03	6.50		583.76	-4.0%	8.0%	-8.0%	583.24
3	RT. FASCIA GIRDER	3897+76.60	6.50		582.69	-4.0%	8.0%	-8.0%	582.17
4	RT. FASCIA GIRDER	3898+02.64	6.50		581.65	-4.0%	8.0%	-8.0%	581.13

* 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 = 5.5 in

POINT	GIRDER DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	96" PLATE GIRDER	8.50	2.75	2.75	96	2.75	2.5	115.25 in
2	96" PLATE GIRDER	8.50	2.75	2.75	96	2.75	2.5	115.25 in
3	96" PLATE GIRDER	8.50	2.75	2.75	96	2.75	-	112.75 in
4	96" PLATE GIRDER	8.50	2.75	2.75	96	2.75	-	112.75 in

VERTICAL CLEARANCE - RAMP C OVER NORFOLK SOUTHERN

POINT	LOCATION	RAMP C - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. GIRDER ELEVATION	NORFOLK SOUTHERN - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)
1	RT. FASCIA GIRDER	583.99	115.250	574.38	549.76	24.62
2	RT. FASCIA GIRDER	583.24	115.250	573.64	549.76	23.88
3	RT. FASCIA GIRDER	582.17	112.750	572.77	548.74	24.03
4	RT. FASCIA GIRDER	581.13	112.750	571.73	548.48	23.25

OK
 OK
 OK
 OK

APPENDIX D

Preliminary Structure Site Plans



SCI-823-0.00

SITE PLAN

SCIO TO COUNTY
BRIDGE NO. SCI-823-1603
RAMP C OVER NORFOLK SOUTHERN - ALT. 2

DESIGNED BY: MME
CHECKED BY: DGS
DATE: 07/05
REVIEWED BY: GAS

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

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: 22'-0"

ROADWAY: 3'-0" (each side)

SIDEWALK: 3'-0" (each side)

DESIGN LOADING: 8 1/2"

SKEW: 2 1/2"

WEARING SURFACE: 10 1/2"

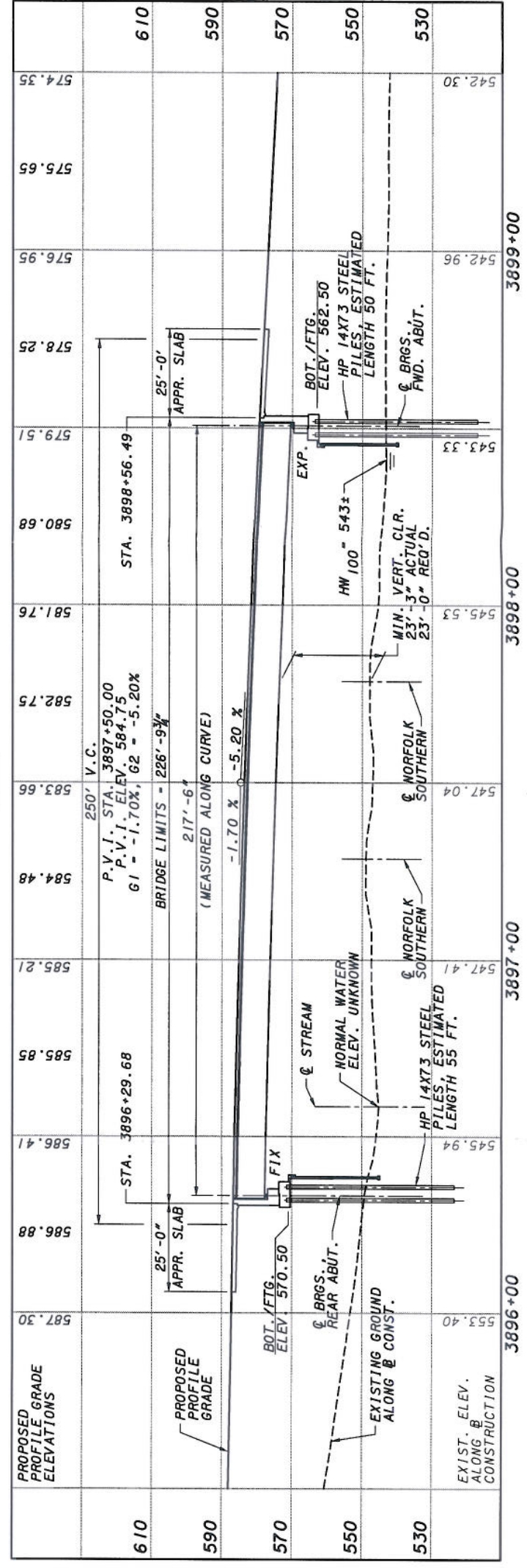
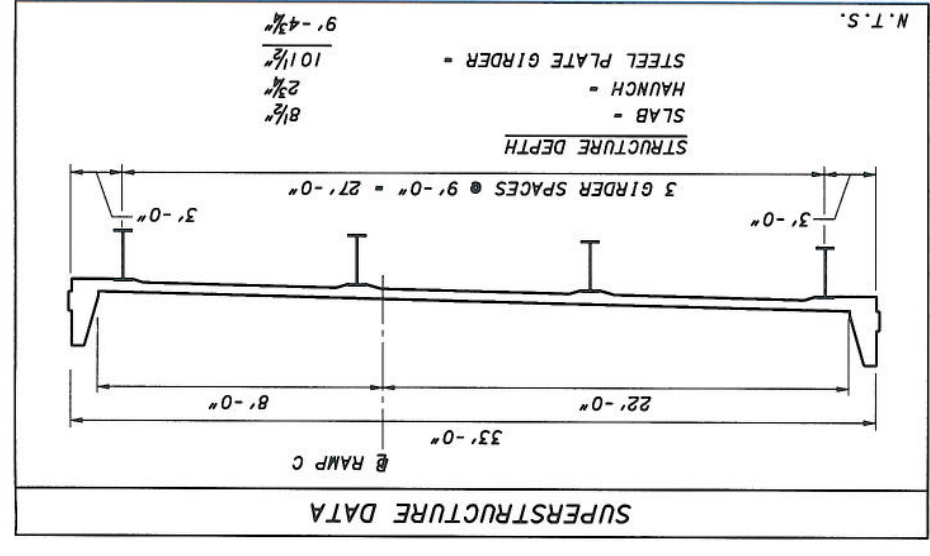
APPROACH SLABS: 9'-4 3/4"

ALIGNMENT: 33'-0"

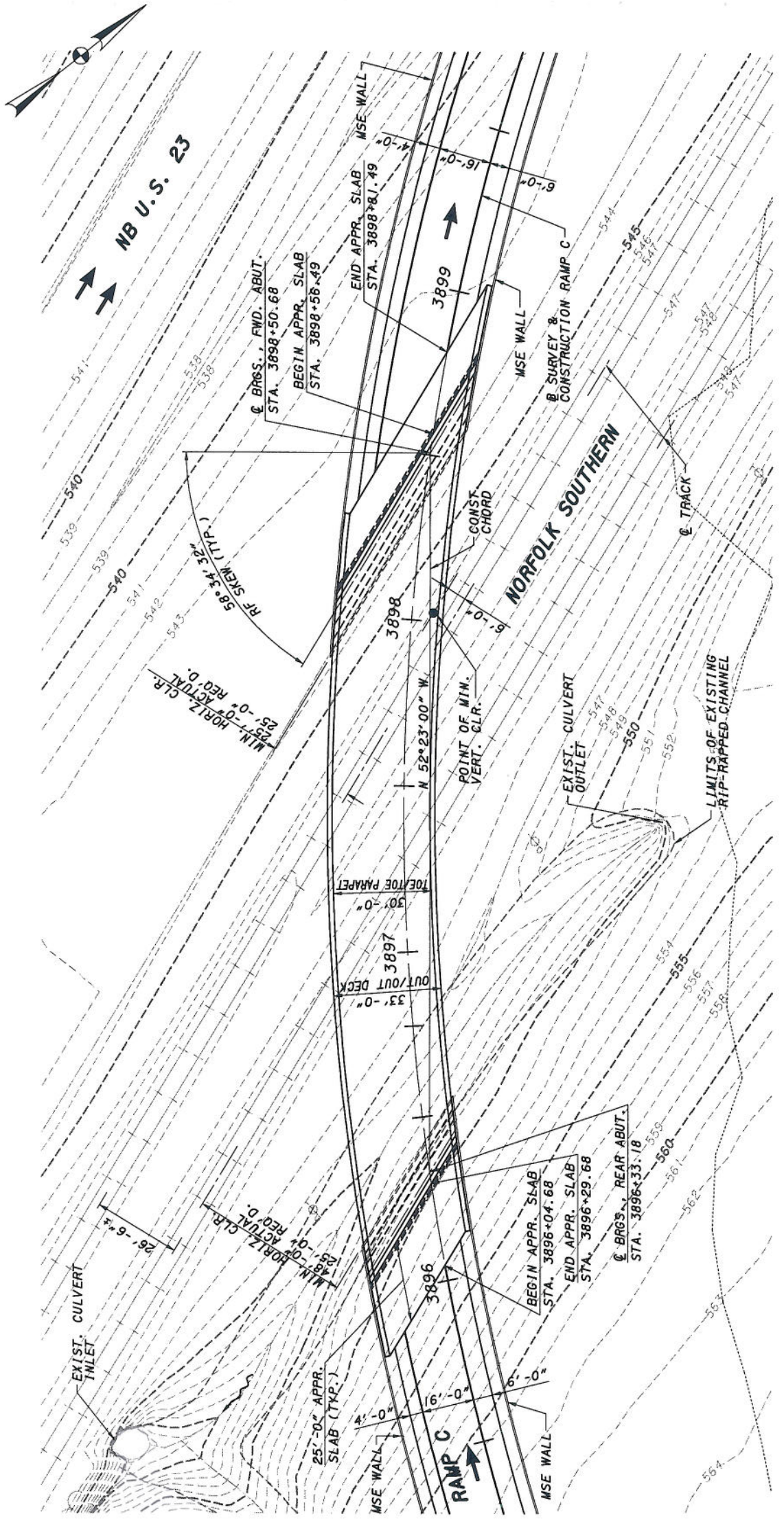
CROWN: 8'-0"

LATITUDE: 3899+00

LONGITUDE: 3899+00



PROFILE ALONG B SURVEY AND CONSTRUCTION, RAMP C



PLAN

APPENDIX E

Preliminary Foundation Recommendations



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.

Mr. Greg Parsons, P.E.
May 2, 2005
Page 2

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

Mr. Greg Parsons, P.E.

May 2, 2005

Page 3

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 from 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.

Mr. Greg Parsons, P.E.
May 2, 2005
Page 4

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.

Mr. Greg Parsons, P.E.
May 2, 2005
Page 5

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.

Mr. Greg Parsons, P.E.

May 2, 2005

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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.

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Foundation Recommendations – Ramp B - #1

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

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

**Assuming spread footings founded on embankment fill.

Ramp B - #2

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

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

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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.

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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.

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Foundation Recommendations – Ramp C - #2

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

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

**Assuming spread footings founded on embankment fill.

MSE Wall Stability

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

General Information

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

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



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Closing

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

Sincerely,

DLZ OHIO, INC.

P. Paul Painter

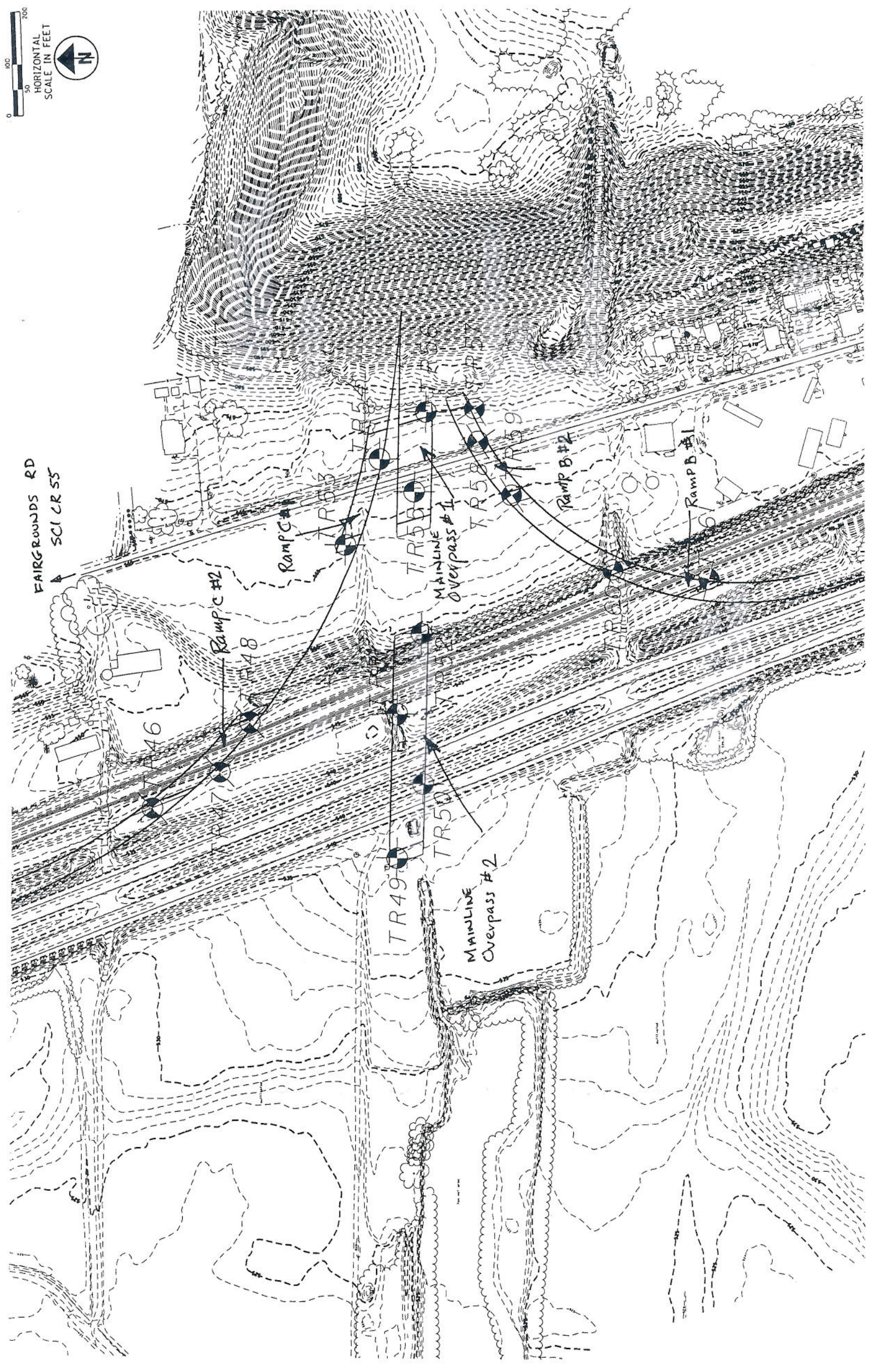
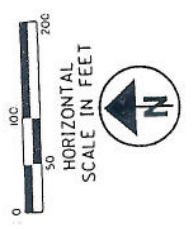
P. Paul Painter
Engineering Geologist

*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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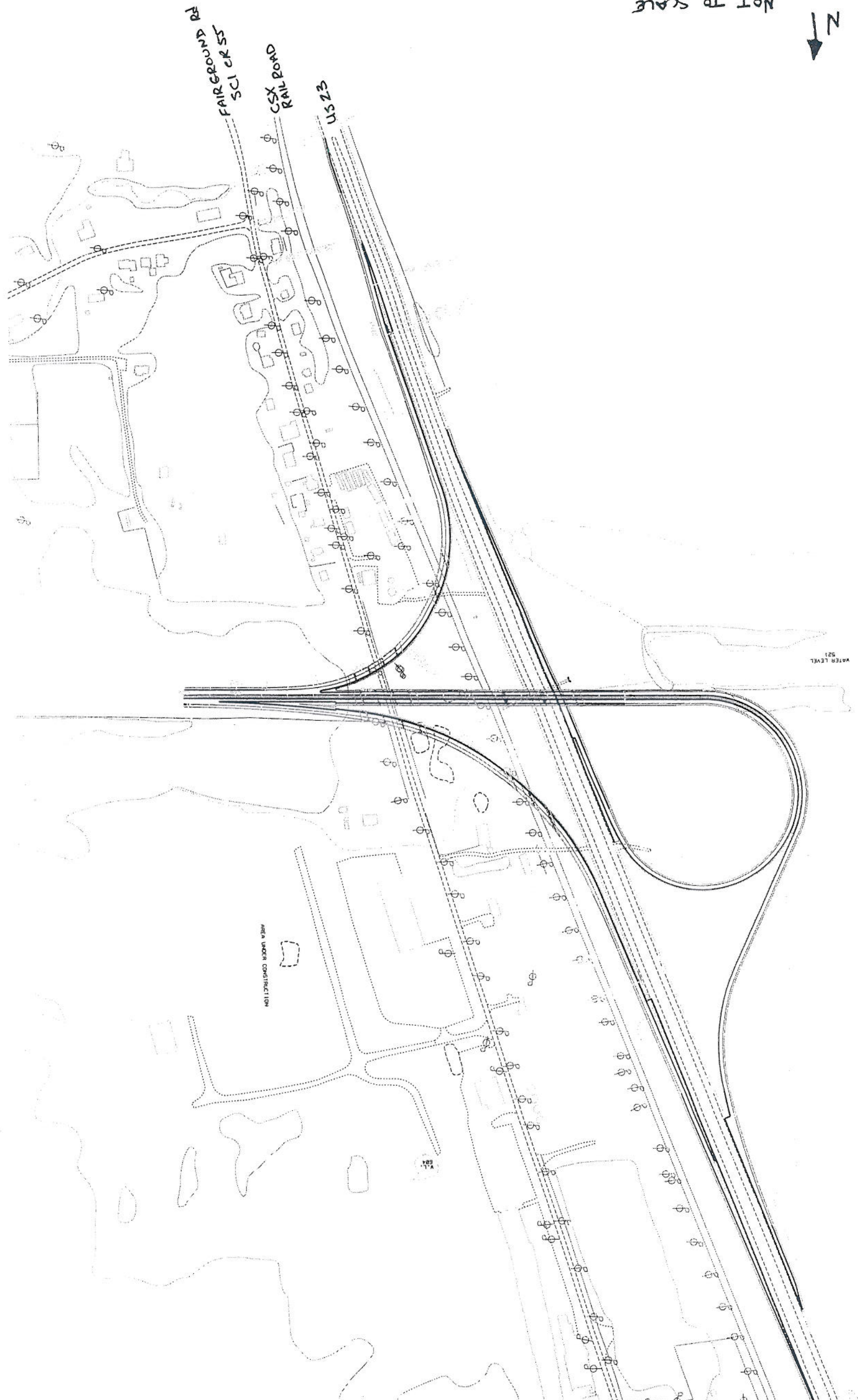
DLZ Ohio, Inc.
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SCI-823-0.00

US 23 / SCI-823-0.00 Interchange

Ramp Layout

NOT TO SCALE



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

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

Cohesive Soils – Consistency

<u>Term</u>	<u>Unconfined Compression tons/sq.ft.</u>	<u>Blows/Foot Standard Penetration</u>	<u>Hand Manipulation</u>
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:

<u>Description</u>	<u>Size</u>	<u>Description</u>	<u>Size</u>
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:

<u>Term</u>	<u>Relative Moisture or Appearance</u>
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.

<u>Term</u>	<u>Relative Moisture or Appearance</u>
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**.

<u>Term</u>	<u>Description</u>
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.

Client: TranSystems, Inc. **LOG OF: Boring TR-46** Location: Forward Abutment - Ramp C - #2 Date Drilled: 03/17/05 Job No. 0121-3070.03

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Drive	Press / Core	Hand Penetrometer (tsf)	WATER OBSERVATIONS:	DESCRIPTION	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL ○ Blows per foot - ———	
										% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay		
0.1	543.0	2	1	1				Water seepage at: 13.5'-19.0'	Topsoil - 1" FILL: Very loose brown and black GRAVEL WITH SAND (A-1-b), some silty clay; contains roots; damp. Stiff brown SILT AND CLAY (A-6a), little fine to coarse gravel, trace fine to coarse sand; damp to moist. Medium dense brown and gray GRAVEL WITH SAND (A-1-b), little silty clay; moist. Loose brown GRAVEL WITH SAND (A-1-b), trace silt, trace clay; wet. @ 18.0', heaving sand. Dense light brown GRAVEL WITH SAND AND SILT (A-2-4), trace clay, trace fine to coarse gravel; moist to wet. @ 23.0', gray. 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.								
5.5	542.9	1	2	2				Water level at completion: 6.0' (Prior to coring) 5.0' (Including drill water)			44	19	--	13	16	8	
8.5	537.5	2	4	3			2.0				56	15	--	9	16	4	Non-Plastic
13.5	534.5	3	18	4							33	31	--	13	20	3	Non-Plastic
15	529.5	6	12	5							30	11	--	24	25	9	
19.0	524.0	4	8	6													
20		3		7													
25		4	12	8													
26.0	517.0	5	14	9													
		12	14	10													
		5	3	11													
		15															
		20															
		16															
		15															
		20															
		14															
		19															
		20															
		5															
		12															
		50/3															

LOG OF: Boring TR-46

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.		Hand Penetrometer (tsf)	WATER OBSERVATIONS:	GRADATION	STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL Blows per foot - ○
				Drive	Press / Core				
30	513.0						Water seepage at: 13.5'-19.0' Water level at completion: 6.0' (Prior to coring) 5.0' (Including drill water)		
		Core 120"	Rec 118"	RQD 83%	R1		DESCRIPTION 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. Bottom of Boring - 37.0'		
35									
37.0	506.0								
40									
45									
50									
55									
60									

LOG OF: Boring TR-47

Location: Pier location - Ramp C - #2

Date Drilled: 03/17/05

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Hand Penetro-meter (tsf)	WATER OBSERVATIONS:	GRADATION					STANDARD PENETRATION (N) Natural Moisture Content, % - PL ——— LL Blows per foot - ○ ———	
							% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt		% Clay
0.1	542.0	1		1	1.5	Water seepage at: 13.0'-18.0'							
	541.9	2	10			Water level at completion: 18.0' (Prior to coring)							
		4				9.0' (including drill water)							
5		2	13	2	2.5								
		4											
		6	10										
7.0	535.0	4	15	3	4.5	Topsoil - 1"							
		10				Stiff brown and gray CLAY (A-7-6), trace fine sand; slightly organic; moist.							
		2	7			@ 3.0', very stiff.							
		2				@ 6.0', hard.							
10		1	10	4	0.5	Medium stiff brown SANDY SILT (A-4a), trace gravel, trace clay; moist to wet.	0	0	--	2	48	50	
		2											
		2	7										
13.0	529.0			6	--	Very loose brown COARSE AND FINE SAND (A-3a), trace clay; wet.	1	2	--	83	15		Non-Plastic
		WOH	18										
		WOH											
		WOH											
15				7									
		WOH	18										
		WOH											
		WOH											
18.0	524.0			8	1.5	Stiff brown SANDY SILT (A-4a), some gravel; moist.	30	11	--	24	22	14	
		11											
		14	10										
		12											
20				9	--	Very stiff to hard dark gray SANDY SILT (A-4a), little clay; moist.	15	9	--	35	26	15	
		42											
		34	12										
		17											
21.0	521.0			10	--	Very soft black SHALE; highly weathered, carbonaceous, laminated, broken, contains silt filled high angle fracture.	29	23	--	31	12	5	Non-Plastic
		4											
		10	11										
		21											
23.0	519.0			11	--	Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, laminated to medium bedded, slightly fractured.							
		50/4	4			@ 26.7'-28.4', 30.0'-30.2', vertical healed fracture.							
25													
		50/4											
26.5	515.5												
30													

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

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Hand Penetro-meter (tsf)	WATER OBSERVATIONS:	GRADATION					STANDARD PENETRATION (N) Natural Moisture Content, % - PL ——— LL Blows per foot - 10 20 30 40								
							% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt		% Clay							
0	547.0																			
3.0	544.0	2 2 3 14		1		FILL: Loose brown GRAVEL WITH SAND (A-1-b); contains mostly coal fragments and cinders; dry to damp.														
5		WOH WOH WOH	1	2		FILL: Very loose brown SILT AND CLAY (A-6a), little fine to coarse sand; contains roots, coal and cinder fragments; damp.														
6.5	540.5	WOH 2 3 16		3	2.5	Very stiff brown and gray SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; damp to moist.														
10		2 5 7 17		4	3.5															
13.0	534.0	2 5 6 15		5	3.5															
15		1 2 2 5		6		Very loose brown COARSE AND FINE SAND (A-3a), little to some gravel, trace clay; wet.														
18.0	529.0	1 1 1 8		7																
20		6 6 7 10		8		Medium dense brown SANDY SILT (A-4a), some gravel, little clay; moist.														
23.5	523.5	2 7 30 15		9		@ 21.0'; trace gravel and trace clay.														
25		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																				

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

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Drive	Hand Penetrometer (tsf)	WATER OBSERVATIONS: Water seepage at: 18.0'-28.0' Water level at completion: 14.0' measured inside of augers	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL Blows per foot - ○					
								% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay						
0	537.5																		
4		4		1		4.5+	Hard brown SILT AND CLAY (A-6a), little fine to coarse sand, trace gravel; damp. @ 6.0', stiff; moist. @ 11.0', little gravel. Loose brown SANDY SILT (A-4a), trace to little gravel, trace clay; moist. Loose brown SILT (A-4b); moist. Very loose brown GRAVEL WITH SAND (A-1-b), trace to little clay; moist to wet. @ 21.0', medium dense. @ 29.0', possible broken sandstone.												
5		3	4	2		4.0													
		4	4	3		1.5													
		5	5	4		1.0													
		2	2	5		1.5													
10		3	3	6															
		2	2	7															
		3	4	8															
		4	5	9															
13.0	524.5	WOH	2	10															
		2	2	11															
15		WOH	2	12															
15.5	522.0	2	18																
		1	2	13															
		2	3	14															
		3	18																
18.0	519.5	WOH	3	15															
		WOH	3	16															
		WOH	3	17															
		5	9	18															
		18	12																
		2	2	19															
		6	6	20															
		2	2	21															
		6	5	22															
		8	8	23															
		5	8	24															
		10	43	25															
		50/4	18	26															
30				27															

LOG OF: Boring TR-50A

Location: Pier # 2 - Mainline Overpass # 2

Date Drilled: 3/22/05

Depth (ft)	Elev. (ft)	Blows per ft	Recovery (in)	Sample No.		Hand Penetro-meter (tsf)	WATER OBSERVATIONS:	GRADATION					STANDARD PENETRATION (N) Natural Moisture Content, % - PL ——— Natural Moisture Content, % - Blows per foot - LL ———		
				Drive	Press / Core			% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt		% Clay	
0.1	540.0														
	539.9						Water seepage at: 18.0'-25.0' Water level at completion: 18.0' measured inside of augers								
3.0	537.0	3 2 3	10	1			Topsoil -1" FILL: Loose dark brown SANDY SILT (A-4a), trace gravel; contains roots; damp.								
5		2 1 2	8	2		1.0	Stiff brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; moist.								
		2 3 3	13	3		2.0	@ 6.0'-7.5', little to some gravel.								
10		1 2 3	16	4		1.5									
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.	1	4	--	7	57	33		
15		WOH 2 3	18	6		1.5		32	20	--	12	18	18		
		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	21		
20		2 5 11	16	9			Medium dense brown GRAVEL WITH SAND (A-1-b), trace clay; wet.								
21.0	519.0	2 7 50	18	10			Medium hard brownish gray SANDSTONE; highly weathered.	42	24	--	20	14	14		
24.5	515.5	25 37 50/4	10	11			Hard gray SANDSTONE; fine grained, slightly weathered, argillaceous, medium bedded.								
27.5	512.5						@ 28.1'-28.7', 29.0'-29.1' clay seams								
30															

Client: TranSystems, Inc. Project: SCI-823-0.00

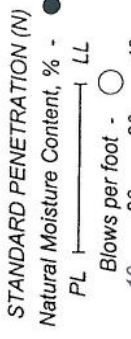
Job No. 0121-3070.03

Date Drilled: 3/22/05

Location: Pier # 2 - Mainline Overpass # 2

LOG OF: Boring TR-50A

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Drive	Press / Core	Hand Penetro-meter (tsf)	WATER OBSERVATIONS:					
							Water seepage at: 18.0'-25.0' Water level at completion: 18.0' measured inside of augers					
DESCRIPTION							GRADATION					
							% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
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.					
37.5	502.5	Bottom of Boring - 37.5'										
35												
40												
45												
50												
55												
60												



LOG OF: Boring TR-51

Location: Pier # 1 - Mainline Overpass # 2

Date Drilled: 03/17/05

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.		Hand Penetrometer (tsf)	DESCRIPTION	GRADATION					STANDARD PENETRATION (N) Natural Moisture Content, % - PL ——— LL Blows per foot - ○ ——— 40			
				Drive	Press / Core			% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt		% Clay		
0.1	545.0						Topsoil - 2"									
5	544.9	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.									
5.5	539.5	1 2 3	13	2		1.0	Very stiff brown SILTY CLAY (A-6b), trace fine to coarse sand, trace fine to coarse gravel; damp.									
8.0	537.0	2 3 6	8	3		3.5	Very loose to loose brown GRAVEL WITH SAND (A-1-b); damp.									
10		3 3 4	10	4		2.0	@ 11.0', moist.									
13.0	532.0	1 1 1	7	5		1.5	Very loose brown COARSE AND FINE SAND (A-3a), trace fine to coarse gravel, trace clay; wet.	43	28	--	11	7	11			Non-Plastic
15		WOH WOH WOH	18	6			Medium dense reddish brown SANDY SILT (A-4a), little gravel; damp to moist.	12	28	--	45	15	15			Non-Plastic
18.0	527.0	WOH WOH WOH	18	7			Stiff gray CLAY (A-7-6); moist.	19	19	--	30	24	8			Non-Plastic
20		16 7 8	18	8			Medium hard black SHALE; moderately weathered, pyritic, laminated, broken.	0	0	--	1	43	55			
23.0	522.0	7 14 11	14	9			@ 28.1'-28.2', gray. Hard gray SANDSTONE									
25	519.5	1 3 5	11	10		1.5										
25.5		20 50/3	8	11												
28.6	516.4															
30																

LOG OF: Boring TR-51

Location: Pier # 1 - Mainline Overpass # 2

Date Drilled: 03/17/05

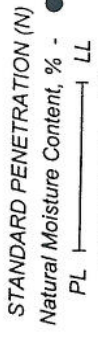
Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Drive	Press / Core	Hand Penetrometer (tsf)	WATER OBSERVATIONS:	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL Blows per foot - ○ ——— 40									
									% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay										
30	515.0							Water seepage at: 13.0'-18.0' Water level at completion: 21.0' (Prior to coring) 13.0' (Including drill water)																
		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.																
37.5	507.5																							
40																								
45																								
50																								
55																								
60								Bottom of Boring - 37.5'																

LOG OF: Boring TR-52

Location: Rear Abutment - Mainline Overpass # 2

Date Drilled: 03/15/05

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.		Hand Penetro-meter (tsf)	WATER OBSERVATIONS:	DESCRIPTION	GRADATION							
				Drive	Press / Core				% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay		
30	528.0						Water seepage at: 23.0'-30.0' Water level at completion: 27.0' (Prior to coring) 6.0' (Including drill water)									
33.5	524.5	22 50/5	10	13				Medium dense brown SANDY SILT (A-4a), trace clay; wet.								
35								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'								



LOG OF: Boring TR-55A Location: Forward Abutment - Mainline Overpass #1 Date Drilled: 3-15-05

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Hand Penetro-meter (tsf)	WATER OBSERVATIONS:	GRADATION	STANDARD PENETRATION (N)	
									Drive
0	565.5					Water seepage at: 13.0'-18.0' Water level at completion: 18.0' (Prior to coring) 18.0' (Including drill water)			
3.0	562.5	3 5 5 10		1	4.5+	Hard gray SILTY CLAY (A-6b); damp.	22 15 -	10 20 30 40	
5		6 7 7 9		2	4.5+		23 21 19		
8.0	557.5	11 11 9 12		3	4.5+		5 25 -		
10		4 5 4 14		4	3.5	Very stiff to hard brown SANDY SILT (A-4a), trace gravel; damp. @ 11.0', hard.	39 16 16	Non-Plastic	
13.0	552.5	5 4 3 12		5	4.5+		9 38 --		
15		2 2 2 15		6		Loose brown COARSE AND FINE SAND (A-3a), trace gravel; wet. 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.	41 13	Non-Plastic	
18.0	547.5	1 2 2 7		7					
20		35 50/5 12		8					
25		Core 120"		RQD R-1 64%					
30.0	535.5								

Bottom of Boring - 30.0'

Client: TranSystems, Inc.

Project: SCI-823-0.00

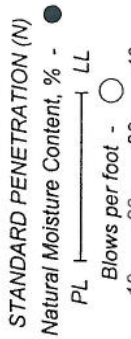
Job No. 0121-3070.03

Location: Forward Abutment - Mainline Overpass #1

Date Drilled: 3-15-05

LOG OF: Boring TR-55A

Depth (ft)	Elev. (ft)	Blows per foot	Recovery (in)	Sample No.	Drive	Press / Core	Hand Penetro-meter (tsf)	WATER OBSERVATIONS:	GRADATION						
									% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	
30	535.5							Water seepage at: 13.0'-18.0' Water level at completion: 18.0' (Prior to coring) 18.0' (including drill water)							
35															
40															
45															
50															
55															
60															



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

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Hand Penetrometer (tsf)	WATER OBSERVATIONS:	GRADATION	STANDARD PENETRATION (N)
0.2	569.5					Water seepage at: None		
	569.3					Water level at completion: Dry (Prior to coring) 7.5' (including drill water)		
3.0	566.5	2 2 3 15		1	2.5	Topsoil -3" Very stiff brown SANDY SILT (A-4a), trace clay, trace gravel; damp to moist.		
5.0		4 6 9 17		2	4.5+	Hard brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; damp.		
8.0	561.5	4 6 9 16		3	4.25	Loose brown and gray SANDY SILT (A-4a), trace clay; damp to moist.	0 0	2 58 41
10.0		2 2 3 18		4			0 1	19 55 25
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.		
20.0		Core Rec 120"	120"	RQD R-1 68%				
25.0	544.5					Bottom of Boring - 25.0'		

LOG OF: Boring TR-57

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Drive	Press / Core	Hand Penetro-meter (tsf)	WATER OBSERVATIONS:	DESCRIPTION	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL Blows per foot - ○		
										% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay			
0.3	569.5							Water seepage at: None	Topsoil -4"									
5	569.2	2 3 4	14	1			4.0	Water level at completion: Dry (Prior to coring) 3.5' (including drill water)	Very stiff to hard brown SILT AND CLAY (A-6a), trace fine to coarse sand; damp.	0	0	1	64	35				
		3 5 7	12	2			4.5			0	0	10	67	23				
		4 5 6	17	3			3.5		Stiff brown SILT AND CLAY (A-6a), little fine to coarse sand; damp to moist.	0	0	19	26	17				
8.0	561.5	1 2 2	18	4			1.0		Medium dense brown SANDY SILT (A-4a), little gravel, trace clay; damp.	23	15	4	64	31				
10	559.0									0	2							
10.5		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	0							
14.0	555.5																	
15																		
20		Core 120"	Rec 120"			RQD 90%			Hard gray SILTSTONE interbedded with SHALE; slightly weathered, laminated. @ 22.7'-22.9' high angle fracture									
20.9	548.6																	
22.9	546.6								Hard gray SHALE; slightly weathered, laminated, slightly fractured.									
25.0	544.5								Bottom of Boring - 25.0'									
30																		

Project: SCI-823-0.00

Date Drilled: 3-16-05

LOG OF: Boring TR-58

Location: Pier # 1 - Ramp B - #2

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Drive	Press / Core	Hand Penetrometer (tsf)	WATER OBSERVATIONS:	DESCRIPTION	GRADATION					STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL ——— Blows per foot - ○		
										% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt		% Clay	
0.3	567.0							Water seepage at: None									
0.3	566.7							Water level at completion: Dry (Prior to coring) 4.0' (including drill water)	Topsoil -4"								
1		2	16	1			--		Soft brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; damp to moist.								
2		2	16						@ 0.0'-2.5', contains roots.								
3		6	15	2			4.25		@ 3.5', very stiff to hard, damp.								
4		8	15														
5		3	18	3			3.5										
6		6	18														
7		7	18														
8.0	559.0								Loose dark brown COARSE AND FINE SAND (A-3a), trace to little clay, trace gravel; damp.								
9		2	16	4													
10		4	16														
11		3	16														
12		4	15	5													
13		4	15														
14		4	15														
15		3	15														
16		4	15														
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99		4	15														
100		4	15														

Depth (ft)	Elev. (ft)	Blows per ft	Recovery (in)	Sample No.	Drive	Press / Core	Hand Penetrometer (tsf)	WATER OBSERVATIONS: Water seepage at: 19'-21.5' Water level at completion: Dry (Prior to coring) 17.0' (including drill water)	GRADATION					STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL Blows per foot - ○							
									% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt		% Clay						
0	564.5																				
3		3	3	14	1																
5		2	2	12	2																
5.5	559.0																				
2		2	2	3	3																
2		2	2	15	3																
2		2	2	1	4																
2		2	2	13	4																
10		2	2	2	5																
10.5	554.0																				
2		2	2	2	6																
1		1	2	3	7																
2		2	3	12	7																
0		0	1	14	8																
1		1	1	1	9																
1		1	36	50	9																
21.5	543.0																				
32		32	50/3	9	10																
50/3																					
25.0	539.5																				
30																					

DESCRIPTION

Loose dark gray SANDY SILT (A-4a), trace clay, trace gravel; damp.

@ 3.5', brown; Moist.

Very loose to loose brown COARSE AND FINE SAND (A-3a), trace clay, trace silt; moist.

Loose brown SANDY SILT (A-4a), little gravel, trace clay; damp to moist.

@ 16.0', little to some clay.

@ 19.0'-21.5', wet.

Medium hard gray SHALE; slightly weathered.

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.

LOG OF: Boring TR-60 Location: Rear Abutment - Ramp B - #1 Date Drilled: 3-14-05

Depth (ft)	Elev. (ft)	Blows per ft	Recovery (in)	Sample No.	Hand Penetrometer (tsf)	WATER OBSERVATIONS	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL ○		
							% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay			
0.1	554.0					Topsoil -1"									
3.0	553.9	4 8 7	12	1		FILL: Medium dense brown SANDY SILT (A-4a), little gravel, trace clay; damp.									
5	551.0	4 4 4	12	2		Loose brown COARSE AND FINE SAND (A-3a), little gravel, trace clay; damp.	33	43	--	11	13				
10		3 2 2	9	3											
10.5	543.5	3 2 3	13	4		Loose brown SANDY SILT (A-4a), little gravel, trace clay; damp.	50	20	--	9	17				
15		3 3 4	1	6		@ 13.5', moist.									
18.0	536.0	2 3 3	14	7		Very loose to loose brown COARSE AND FINE SAND (A-3a), trace clay, trace gravel; wet.	10	53	--	20	17				
20		1 1 2	17	8											
23.0	531.0	4 3 3	16	9		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	7 4 4	18	10		Loose reddish brown FINE SAND (A-3), trace clay; wet.	7	14	--	59	21				
28.0	526.0	3 6 4	18	11		Soft black SHALE; highly weathered.									
30		50/4	4	12											

Client: TranSystems, Inc.		Location: Rear Abutment - Ramp B - #1		Date Drilled: 3-14-05		Job No. 0121-3070.03									
LOG OF: Boring TR-60		Project: SCI-823-0.00		GRADATION		STANDARD PENETRATION (N)									
Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Hand Penetrator (tsf)	WATER OBSERVATIONS:	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	Natural Moisture Content, % - PL	LL
								Drive	Press / Core	Core	Rec	Blows per foot -			
30	524.0					Water seepage at: 18'-28' Water level at completion: 26.0' (Prior to coring) 19.0' (Including drill water)									
35		Core 120"	119"	RQD R-1 79%		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.									
40.0	514.0					@ 39.9', Hard gray SANDSTONE.									
45															
50															
55															
60							Bottom of Boring - 40.0'								

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Drive	Press / Core	Hand Penetro-meter (tsf)	WATER OBSERVATIONS:	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL Blows per foot - ○			
									% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay				
0	547.0																	
5.5	541.5	2 2 2	2 2	1														
		3 4 3	3 1	2														
		2 3 3	3 16	3			2.5											
10.5	536.5	1 3 5	5 12	4			2.25											
		1 2 2	2 13	5														
		0 0 0	0 16	6														
		0 0 1	1 18	7														
		1 3 2	2 18	8														
		1 1 3	3 18	9														
23.0	524.0	50/3	3	10														
25.0	522.0																	
30																		

DESCRIPTION

FILL: Loose black SANDY SILT (A-4a), little gravel; organic; dry to damp.

Very stiff light brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; damp.

@ 8.5'; brown.

Very loose brown COARSE AND FINE SAND (A-3a); moist.

@ 10.5'-12.5'; little clay

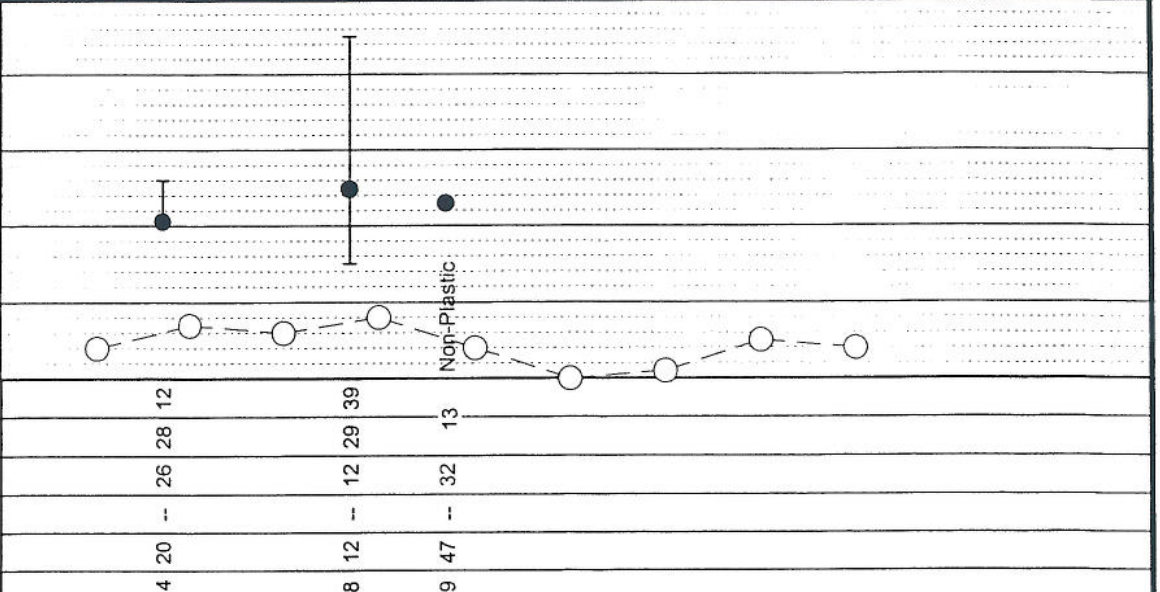
@ 13.5'; wet.

@ 18.0'; very loose to loose.

Medium hard black SHALE; moderately weathered.

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



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

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Dive	Press / Core	Hand Penetro-meter (tsf)	WATER OBSERVATIONS:	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL Blows per foot - ○ 10 20 30 40					
									% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay						
30	517.0							Water seepage at: 13.5'-23.0'												
30.5	516.5							Water level at completion: 14.0' Prior to coring 9.0' Measured from inside the augers after coring												
								DESCRIPTION												
								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.												
								Bottom of Boring - 35.0'												
35.0	512.0																			
40																				
45																				
50																				
55																				
60																				

