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**REPORT ON**

**FOUNDATION INVESTIGATION AND DESIGN  
OVERHEAD SIGN STRUCTURES  
HIGHWAY 69 FROM 1.5 KM SOUTH OF HIGHWAY 559  
TO 3.5 KM NORTH OF HIGHWAY 559  
PARRY SOUND, ONTARIO  
G.W.P 335-00-00  
MINISTRY OF TRANSPORTATION, ONTARIO**

Submitted to:

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**FOUNDATION INVESTIGATION  
OVERHEAD SIGN STRUCTURES  
HIGHWAY 69 FROM 1.5 KM SOUTH OF HIGHWAY 559  
TO 3.5 KM NORTH OF HIGHWAY 559  
PARRY SOUND, ONTARIO  
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MINISTRY OF TRANSPORTATION, ONTARIO**

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## **1.0 INTRODUCTION**

Golder Associates Ltd. (Golder) has been retained by URS Canada Inc. (URS) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a foundation investigation as part of the detailed design for two overhead sign structures for the new Highway 69. The proposed work is part of the detailed design for the four-laning of Highway 69 and re-alignment of Highway 559 north of Nobel, Ontario including the construction of new bridges, associated highway on- and off-ramps, access roads and service roads.

The terms of reference for the work are outlined in Golder's proposal P31-1270 dated July 2003 that forms part of the Consultant's Agreement (Number P.O.5005-A-000320) for this project. The work was carried out in accordance with the Quality Control Plan for this project dated October 2003. The locations of the two proposed overhead sign structures, one on the southbound lanes (SBL) and one on the new northbound lanes (NBL) were provided to Golder by URS on February 16, 2005.

This report addresses the investigation for the two overhead sign structures only. Separate reports detail the foundation investigations for the bridge structures and swamp crossings / high fill areas.

The purpose of this investigation is to establish the subsurface conditions in the areas of the proposed signs by borehole drilling, rock coring, in situ testing and laboratory testing on selected samples. The boreholes for the overhead sign investigations were sited in the field by Golder personnel with reference to alignment stakes located by Callon Dietz Incorporated (Callon Dietz), a professional surveying company retained by URS.

## **2.0 SITE DESCRIPTION**

The proposed NBL overhead sign is to be located about 2.5 km north of the existing Highway 559 (north of Nobel, Ontario) and about 50 m east of the existing Highway 69 alignment. The proposed SBL overhead sign is to span over the existing Highway 69 alignment near the northern limit of the project site, about 3.9 km north of the existing Highway 559. The general location of the Highway 69 and Highway 559 project area is shown on the Site Location Map on Figure 1.

In general, the topography in the overall project area consists of rolling terrain including densely treed areas and numerous bedrock outcrops separated by low-lying swamp areas.

The NBL overhead sign is to be located at about Station 12+700 of the proposed new Highway 69 alignment. This sign location is situated on a fill area, likely waste material placed from the construction of a third lane (passing lane) for the existing Highway 69. The fill extends from about Station 12+690 to about Station 12+760 and is estimated to be about 30 m to 35 m wide and 1 m to 2 m thick (refer to Drawing 1A). It is understood that in order to construct the new Highway 69 alignment in this area, the NBL is to be located in a cut about 6 m below the existing ground surface. Therefore, it is anticipated that the majority of the fill material in this area will be removed as part of the highway construction. The top of the fill is at about Elevation 217 m at the sign location, referenced to Geodetic Datum.

The SBL overhead sign is to be located at about Station 14+100 of the proposed new Highway 69 alignment (which is coincident with the existing Highway 69 alignment at this location). The existing Highway 69 embankment in this area is estimated to be about 1 m to 3 m high with the natural ground surface sloping downward from east to west. Bedrock outcropping was observed to the east and north of the sign location, while a lower lying area exists to the west and southwest. The centreline of the existing highway is at about Elevation 222.7 m, referenced to Geodetic Datum.

### **3.0 INVESTIGATION PROCEDURES**

#### **3.1 Foundation Investigation**

The field work for the proposed SBL and NBL overhead signs was carried out on January 5 and January 11, 2006 respectively, during which time two sampled boreholes were put down for each sign structure (OHS-1 and OHS-2 for the SBL overhead sign and OHS-3 and OHS-4 for the NBL overhead sign).

The SBL boreholes were drilled with a track-mounted CME 55 drill rig using 108 mm inside diameter (I.D.) continuous flight hollow stem augers and an 'NQ' core barrel. The NBL boreholes were drilled using portable drilling equipment equipped with 'NQ' size casing and a 'BQ' size core barrel. All drilling equipment was supplied and operated by Marathon Drilling Co. Ltd. of Ottawa, Ontario. Where possible, soil samples were obtained at intervals of about 0.75 m depth, using a 50 mm outer diameter (O.D.) split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586-99). All boreholes were advanced to refusal on inferred bedrock. Bedrock coring was carried out to confirm bedrock at all borehole locations. However, in borehole OHS-2, only a limited depth of coring was possible due to problems with the equipment and water supply.

The inferred bedrock surface was encountered at depths ranging from 2.0 m to 4.6 m below the existing highway shoulder grade for the SBL overhead sign and from 0.7 m to 1.2 m below the existing ground surface for the NBL overhead sign. At investigated locations OHS-1, OHS-3 and OHS-4 the depth of investigation was further advanced into the bedrock by coring about 1.4 m to 2.2 m. At location OHS-2, the coring only advanced about 0.1 m into the bedrock. The groundwater level in the open boreholes / drillholes was observed following drilling operations. Water level readings are described on the Record of Borehole sheets that follow the text of this report. All boreholes were abandoned in accordance with O. Reg. 128 (amendment to O. Reg. 903).

The field work was supervised throughout by a member of our engineering staff, who confirmed the investigated locations, arranged for the clearance of underground service locations, supervised the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil and rock samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Mississauga geotechnical laboratory where the samples underwent further detailed visual examination and appropriate laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards as appropriate. Classification testing such as water content and grain size distribution were carried out on selected samples of the overburden soils.



All investigated locations were sited and ground surface geodetic elevations were established by Golder personnel with reference to alignment stakes provided by Callon Dietz. The investigated locations and ground surface elevations are shown on Drawings 1A and 1B.

## **4.0 GENERAL SITE GEOLOGY AND SUBSURFACE CONDITIONS**

### **4.1 Geology**

From published geologic information, the project site is located in the physiographic region known as the Georgian Bay Fringe. The Georgian Bay Fringe borders Georgian Bay as a broad belt characterized by shallow soil and bare bedrock knobs and ridges (The Physiography of Southern Ontario; Third Edition); however, Quaternary deposits of lacustrine and fluvial origin together with more recent swamp sediments have been accumulated between the bedrock ridges and, consequently, the overburden thickness and bedrock surface can be variable. The bedrock in the area are typically highly deformed gneisses and migmatites of the Britt Domain of the Central Gneiss Belt, a subdivision of the Grenville Structural Province (Geology of Ontario; OGS Special Volume 4). Deposition of Paleozoic strata and later erosion during glaciation left behind these Precambrian rocks covered only in a few places by the flat-lying Palaeozoic bedrock strata.

### **4.2 Subsurface Conditions and General Overview**

The detailed subsurface soil and groundwater conditions as encountered in the boreholes during the investigation, together with the results of the laboratory tests carried out on selected soil samples, are given on the attached Record of Borehole sheets following the text of this report. The results from the laboratory testing are provided in Appendix A. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests (SPTs). These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond the investigated locations.

The inferred soil stratigraphy as encountered at the investigated locations of the proposed NBL (Overhead Sign No.1) and SBL (Overhead Sign No. 2) locations is shown on Drawings 1A and 1B, respectively.

In general, the subsoils at the NBL overhead sign site consist of relatively thin deposits of fill material (to the west) or peat (to the east) underlain by bedrock. Both of the boreholes at this location were extended to the inferred bedrock surface and were cored about 1.4 m to 2.2 m into the bedrock.

In general, the subsoils at the SBL overhead sign site consist of sand and gravel embankment fill underlain by silty sand to sand and gravel deposits on the west side of the existing highway and underlain directly by bedrock on the east side of the existing highway. The total overburden thickness (not including embankment fill) ranges from about 0 m to about 3.1 m. Both of the boreholes at this location were extended to auger refusal (i.e. on the inferred bedrock surface);

one investigated location (on the east side) was cored about 1.8 m into the bedrock while the other investigated location (on the west side) was only cored to a limited depth.

A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

#### **4.2.1 Overhead Sign No. 1 (Highway NBL Sta. 12+700)**

##### **4.2.1.1 Peat**

About 0.1 m below the standing water surface at borehole OHS-4, a layer of peat containing some organics (wood fragments, rootlets) and trace to some sand was encountered. The surface of the peat was at Elevation 216.0 m and the thickness was about 0.7 m at the borehole location.

##### **4.2.1.2 Fill**

Fill material composed of sand with rock fill, some clay and trace to some organics was encountered below a thin layer of topsoil in borehole OHS-3. The top of the fill was at about Elevation 216.9 m and thickness was about 1.1 m at the borehole location. The fill area is estimated to be about 30 m to 35 m wide and extend from the driveway located to the north of the NBL overhead sign location (about Station 12+760) southerly to about Station 12+690.

##### **4.2.1.3 Bedrock**

Bedrock was cored at borehole locations OHS-3 and OHS-4. The surface of the bedrock is at about 1.2 m depth (Elevation 215.7 m) and 0.8 m depth (Elevation 215.3 m) at boreholes OHS-3 and OHS-4, respectively.

The bedrock samples are described as moderately weathered (near surface only) to fresh, grey to black to pink, fine to medium grained granitic gneiss containing near horizontal, distinct foliation. The Total Core Recovery measured on the core samples was 100 percent. The average Rock Quality Designation (RQD) measured on the core samples ranged from 38 percent in borehole OHS-4 to 42 percent in borehole OHS-3, indicating a rock mass of poor quality. It is anticipated that the quality of the rock mass will improve with depth. Based on the results of point load tests performed on the granitic gneiss from other sites within the project limits, the bedrock can be classified as a strong to very strong rock mass with medium strong zones.

##### **4.2.1.4 Groundwater Conditions**

The water levels in boreholes OHS-3 and OHS-4 on completion of drilling operations were measured at about 1.1 m depth (Elevation 215.8 m) and ground surface (Elevation 216.1 m),

respectively. Details of the groundwater conditions in the open boreholes are summarized on the Record of Borehole sheets following the text of this report. It should be noted that groundwater levels in the area are subject to seasonal fluctuations.

#### **4.2.2 Overhead Sign No. 2 (Highway 69 SBL Sta. 14+100)**

##### **4.2.2.1 Embankment Fill**

Both boreholes OHS-1 and OHS-2 were advanced through sand and gravel embankment fill comprising the shoulder of the existing highway embankment. The presence of rock fill and/or cobbles and boulders was inferred by grinding of the augers during borehole advancement. The ground surface elevation at the borehole locations was about Elevation 222.6 m and the inferred fill-native ground interface was found to range between about Elevation 221.0 m and 220.6 m, indicating an average embankment thickness of about 1.8 m at the embankment shoulders at about Station 14+100.

Standard Penetration Testing (SPT) carried out within the embankment fill measured 'N' values ranging from 13 blows to 46 blows per 0.3 m of penetration, indicating a compact to dense relative density.

##### **4.2.2.2 Silty Sand to Sand and Gravel to Sand**

Brown to grey silty sand to sand and gravel to sand deposits were encountered below the embankment fill in borehole OHS-2. The top of this series of native deposits is at about Elevation 221.0 m and the thickness of the native deposits is about 3.1 m at this borehole location. The bottom of this deposit was defined by refusal to further auger advancement.

Standard Penetration Testing (SPT) carried out within these strata measured 'N' values ranging from 3 blows to 39 blows per 0.3 m of penetration. The 'N' values indicate a very loose to dense relative density within the deposit.

The natural water content measured on samples of these sandy deposits ranged between about 5 percent and 21 percent, increasing with depth.

A grain size distribution for one sample from the sand portion of the deposit is shown on Figure A-1 of Appendix A.

##### **4.2.2.3 Bedrock**

Bedrock was cored to a depth of 1.8 m in borehole OHS-1. In borehole OHS-2, the bedrock surface was defined by refusal to further auger advance and checked by carrying out coring to a

limited depth (about 0.12 m). Additional coring at this location was not possible due to problems with the equipment and water supply. However, the small pieces of core that were recovered in OHS-2 showed the same distinct pattern of horizontal foliation oriented perpendicular to the axis of the core that was observed in the rock core obtained from borehole OHS-1.

The surface of the bedrock at this location varies from about the base of the embankment fill in OHS-1 (Elevation 220.6 m) to a depth of about 4.7 m below the shoulder of the existing highway embankment (Elevation 217.9 m).

The bedrock samples are described as fresh, light grey to pink, medium grained granitic gneiss containing near horizontal, distinct foliation. The Total Core Recovery measured on the core samples from OHS-1 was 100 percent. The Rock Quality Designation (RQD) measured on the core samples from OHS-1 ranged from 61 percent to 74 percent, indicating a rock mass of fair quality. Based on the results of point load tests performed on the granitic gneiss from other sites within the project limits, the bedrock can be classified as a strong to very strong rock mass.


#### **4.2.2.4 Groundwater Conditions**

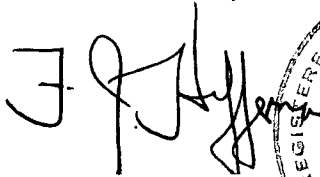
The water level in borehole OHS-2 on completion of drilling operations was measured at about 2.3 m depth (Elevation 220.3 m). Groundwater was not encountered in borehole OHS-1. Details of the groundwater conditions in the open boreholes are summarized on the Record of Borehole sheets following the text of this report. It should be noted that groundwater levels in the area are subject to seasonal fluctuations.

### 4.3 CLOSURE

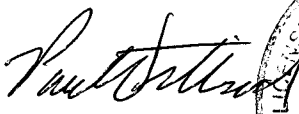
This Foundation Investigation Report was prepared by Mr. Chad Gilfillan and reviewed by Dr. J. Paul Dittrich, Ph.D., P.Eng., an Associate with Golder. Mr. Fintan Heffernan, P.Eng., Golder's Designated MTO Contact for this project, conducted an independent quality review of the report.

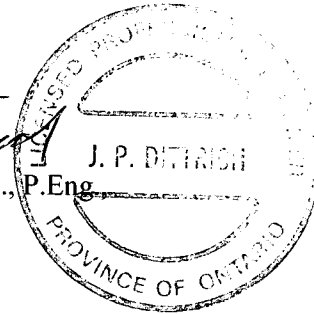
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**PART B**

**FOUNDATION DESIGN  
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HIGHWAY 69 FROM 1.5 KM SOUTH OF HIGHWAY 559  
TO 3.5 KM NORTH OF HIGHWAY 559  
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MINISTRY OF TRANSPORTATION, ONTARIO**

## **5.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS**

This section of the report provides recommendations on the foundation aspects of the proposed SBL and NBL overhead sign structures associated with the four-laning of Highway 69 north of Highway 559. The recommendations are based on interpretation of the factual geotechnical data obtained from the boreholes advanced during the subsurface investigation.

The interpretation and recommendations provided are intended only to provide the designers with sufficient information to assess the feasible foundation alternatives and to design the proposed structure foundations. As such, where comments are made on construction they are provided only in order to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods, scheduling and the like.

### **5.1 General**

It is understood that overhead signs are proposed for the new Highway 69 NBL at about Station 12+700 (Overhead Sign No.1) and for the existing Highway 69 – or new Highway 69 SBL – at about Station 14+100 (Overhead Sign No.2). The purpose of the signs will be to notify motorists of a change in speed limit and the change from four-lanes to two-lanes and vice-versa at the northern limit of the project. The overhead signs are to consist of standard Trichord overhead truss sign supports fabricated in galvanized structural steel and designed to the requirements of the *Ontario Highway Bridge Design Code*. Based on drawings provided by URS on February 16, 2005 and May 12, 2006 (see Appendix C), Overhead Sign No.1 and Overhead Sign No.2 are to span about 14.6 m and 20.0 m across the highway, respectively.

### **5.2 Overhead Sign Foundations**

Foundations for the overhead signs should be designed in accordance with the standard design methods for Tri-Chord Static Sign Supports that are contained in Section 4 and Standard Drawings SS118-3, SS118-26 and SS118-27 of MTO's *Sign Support Manual (MTO, 2004)*.

For standard design of sign foundations, caissons are to extend 5 m below the design frost depth (taken as 1.8 m for the Parry Sound area). Therefore, at this site, the standard caisson founding level would be 6.8 m below the ground surface, unless bedrock is encountered within this depth.

The following table summarizes the depth to bedrock and the bedrock surface elevation at each of the proposed sign support locations.



<i>Sign and Location</i>	<i>Borehole</i>	<i>G.S. Elev. at Borehole (m)</i>	<i>Depth to Bedrock<sup>(3)</sup> (m)</i>	<i>Bedrock Surface Elev. (m)</i>	<i>Proposed Grade<sup>(4)</sup> (m)</i>	<i>Estimated Depth to Bedrock<sup>(5)</sup> (m)</i>
Overhead Sign No. 1 Highway 69 NBL Station 12+700	OHS-3	216.9 <sup>(1)</sup>	1.2 m	215.7	211.9	0
	OHS-4	216.1	0.8 m	215.3	211.5	0
Overhead Sign No. 2 Highway 69 SBL Station 14+100	OHS-1	222.6 <sup>(2)</sup>	2.0 m	220.6	222.1	1.5
	OHS-2	222.6 <sup>(2)</sup>	4.7 m	217.9	221.8	3.9

**Notes:** 1. Borehole OHS-3 drilled through about 1.2 m of fill material. 2. Boreholes drilled through shoulder of existing Highway 69 embankment (about 1.6 m to 2.0 m of fill at the borehole locations). 3. Below existing ground surface at borehole locations. 4. Proposed finished ground surface at OHS footing locations (based on information provided by URS). 5. Below final finished ground surface at footing locations.

As can be seen in the table above, the bedrock surface relative to the finished ground surface at both overhead sign locations will be less than 6.8 m depth. Therefore, the standard design does not apply. Section 5.2.1 and Section 5.2.2 detail the foundation recommendations for Overhead Sign No.1 and Overhead Sign No.2, respectively.

### 5.2.1 Overhead Sign No.1 – Foundation Options

At the proposed location of Overhead Sign No.1 (Highway 69 NBL Sta. 12+700), bedrock was encountered between about Elevations 215.7 m and 215.3 m in boreholes OHS-3 and OHS-4, respectively. It is understood that the proposed finished ground surface at the footing locations for the overhead sign at Station 12+700 is to be at about Elevation 211.9 m (west side) and about Elevation 211.5 m (east side). Based on this, it is estimated that up to about 1 m of overburden and/or fill and about 4 m of bedrock will have to be removed in order to construct the footings (and adjacent highway alignment) at this location. Therefore, the overhead sign supports will have to be designed as caissons socketted into the rock or as spread footings anchored to the rock; recommendations for these two foundation options are provided in Sections 5.2.1.1 and 5.2.1.2, respectively.

Spread footings anchored to the bedrock is considered to be the more practical and cost-effective foundation option for Overhead Sign No.1. It would avoid the coring of large-diameter caissons into the strong to very strong granitic gneiss bedrock which is expected to be a difficult and costly process.

#### 5.2.1.1 Caisson Foundations Socketted into Rock

For Overhead Sign No.1, which is located within a rock cut area, bedrock will essentially be exposed at the ground surface following excavation in this area. As such, the depth to the surface of bedrock (below finished ground surface at the footings) will be negligible (and less than the frost depth of 1.8 m). In accordance with Standard Drawing SS118-3 of MTO's *Sign Support*

*Manual*, where bedrock is encountered at a depth,  $z$  (in metres), of less than 5 m below the bottom of the frost layer ( $z = 0$  m for this case), the required depth of the foundation below the frost layer may be taken as follows:

$$z + (5 \text{ m} - z) / 2$$

Based on the above equation, the caissons for support of the overhead sign would have to be socketted about 4.3 m into the granitic gneiss bedrock. However, as described in Section 4.2, the granitic gneiss bedrock at this site is characterized as strong to very strong, corresponding to typical uniaxial compressive strengths of greater than 50 MPa and potentially as high as 250 MPa. Forming a caisson socket by coring 4.3 m into the bedrock will be very difficult due to the strong to very strong nature of the bedrock and is not recommended.

#### **5.2.1.2 Spread Footings Anchored to Rock**

From a foundations perspective, spread footings anchored to the bedrock is the preferred option for support of Overhead Sign No.1 (Highway 69 NBL, Station 12+700). Spread footings for support of this sign may be placed at the base of the rock cut or may be placed with nominal embedment further into the rock, although such embedment would require the use of hoe ramming and/or line drilling with controlled blasting into the strong to very strong bedrock at this site. Subexcavation of any loose, fractured bedrock will be required prior to the construction of the footing. In this regard, MTO's Special Provision SP902S01 should be included in the Contract Documents, requiring inspection and approval of the foundation area by a Quality Verification Engineer prior to footing construction, to ensure that all loose and/or fractured rock has been removed from the foundation areas. As this location will be in a rock cut, variation in the rock surface (i.e. base of the cut) between the sign supports should be minimal; however, provision should be made in the Contract Documents for mass concrete placement to accommodate variations in the rock surface should they arise.

Resistance to lateral forces / sliding resistance between the concrete footings and the granitic gneiss bedrock should be calculated in accordance with Section 6.7.5 of the *Canadian Highway Bridge Design Code (CHBDC)*. The coefficient of friction,  $\tan \delta$ , may be taken as 0.70 for cast-in-place concrete footings constructed on the surface of the bedrock. This represents an unfactored value; in accordance with the *CHBDC*, a factor of 0.8 is to be applied in calculating the horizontal resistance. This sliding resistance can be supplemented as necessary by dowelling into the bedrock. The horizontal resistance of the dowels is dependent on the strength of the bedrock, grout and steel. Where the rock mass is as strong as or stronger than concrete, as is the case for this site, the design of the dowels in the rock may be handled in the same way as the dowel embedment into the concrete, assuming that the unconfined compressive strength of the grout is similar to that of the concrete. The rock dowels should have a minimum embedded

length within the bedrock of 1.5 m and the structural strength of the dowel and the compressive strength of the grout should not be exceeded.

Rock dowels/anchors can also be used to provide uplift resistance, to supplement the weight of the sign footing if necessary. For uplift of the dowels, a factored value of 600 kPa may be assumed for the grout-to-rock bond stress for ULS design (based on an ultimate bond stress of 1.5 MPa, from published values). The actual bond stress along the rock-grout interface may vary from the design value given and it should, therefore, be verified in the field by pull-out testing; in this case, a Non-Standard Special Provision (NSSP) will have to be included in the Contract Documents to cover this testing and a sample is included in Appendix B for reference.

The required anchor lengths for resistance of uplift loads should also be checked against a conical mode of failure through the rock mass. For this type of failure, taking into account the potential pressure of intersecting sets of discontinuities, it is common practice to consider the dead weight of the rock (based on a unit weight of bedrock of 23 kN/m<sup>3</sup>) within a cone extending from the centre of the bond zone to the rock surface with an apex angle of 90 degrees.

## **5.2.2 Overhead Sign No.2 – Foundation Options**

At the proposed location of Overhead Sign No.2 (Highway 69 SBL, Station 14+100), the bedrock surface dips from right to left (i.e. east to west) of the existing highway embankment, ranging from Elevation 220.6 m (east side) to Elevation 217.9 m (west side) at the borehole locations. Right of centerline (i.e. east side), given that bedrock is at or near the natural ground surface (i.e. below existing embankment fill) the foundation for the sign support can be designed as a caisson socketted into the bedrock or as a spread footing anchored to the bedrock. Left of centerline (i.e. west side), however, the existing highway embankment fill has been constructed on deposits of native silty sand to sand and gravel deposits overlying the sloping bedrock. Therefore, at this location consideration could be given to founding the left sign support on a caisson through the soil and socketted into the bedrock or, alternatively, the overburden soils could be subexcavated (including a portion of the existing highway embankment utilizing temporary shoring/roadway protection measures) to expose the bedrock and the sign supported on a spread footing anchored to the bedrock. Recommendations for these foundation options are provided in Sections 5.2.2.1 and 5.2.2.2.

For right of centreline, spread footings anchored to the bedrock is considered to be the more practical and cost-effective option. It should be noted that temporary shoring may be required given the close proximity of this footing to the existing roadway embankment. For left of centreline, a caisson through the soil and socketted into rock is considered to be the most practical option because it would have less of an impact on the existing embankment and traveled portion

of the roadway. However, given the potentially sloping nature of the bedrock, starting the socket may be difficult.

### 5.2.2.1 Caisson Foundation in Soil and Socketted into Rock

For the left support of Overhead Sign No.2, the depth to the surface of the bedrock will be about 2.1 m below the frost depth of 1.8 m relative to the proposed finished ground surface at the footing location (i.e. below the existing embankment fill). In accordance with Standard Drawing SS118-3 of MTO's *Sign Support Manual*, where bedrock is encountered at a depth,  $z$  (in metres), of less than 5 m below the bottom of the frost layer, the required depth of the foundation below the frost layer may be taken as follows:

$$z + (5 \text{ m} - z) / 2$$

Based on the above equation, the caissons for this support should be socketted about 1.5 m into the granitic gneiss bedrock, about 3.5 m below the frost depth.

Based on the results from borehole OHS-2, the fill and native soils have friction angles greater than 28 degrees as summarized in the following table.

### DESIGN PARAMETERS FOR OVERHEAD SIGN No. 2 – West Support

Reference Borehole	Stratum	Depth <sup>1</sup> (m)	Elevation (m)	Design Parameters <sup>2,3</sup>					Water Level (m)
				$\gamma$	$\gamma'$	$\phi'$	$c_u$	$K_p$	
OHS-2 (west support)	Sand and gravel fill	0.0 – 1.6	226.2 – 221.0	21	11	32	-	3.2	2.3 (Elev. 220.3)
	Silty Sand	1.6 – 2.2	221.0 – 219.2	19	9	28	-	2.8	
	Sand and gravel	2.2 – 2.9	219.2 – 218.6	20	10	33	-	3.4	
	Sand	2.9 – 4.7	218.6 – 216.7	20	10	32	-	3.2	

#### NOTES:

- Depths are given for the borehole location; the ground surface elevation at the borehole location should be compared to the finished ground surface elevation at the actual sign support location, and the depths of the soil strata and depth to bedrock adjusted accordingly.
- Design parameters:
  - $c_u$  = undrained shear strength (kPa);
  - $\phi'$  = effective friction angle (degrees);
  - $\gamma$  = bulk unit weight (kN/m<sup>3</sup>);
  - $\gamma'$  = effective unit weight below the groundwater level (kN/m<sup>3</sup>); and
  - $K_p$  = passive earth pressure coefficient.
- Although the passive resistance in the upper 1.8 m is neglected to account for frost action,  $c_u$ ,  $\phi'$  and  $K_p$  parameters are given in the event that the ground surface elevation varies significantly between the borehole and sign support locations.

As shown above, the friction angles within the upper 5 m of soil exceed the minimum criteria on which the standard overhead sign foundation is based, and so the standard caisson foundation

design (incorporating the required length of rock socket) may be applied for the west support of Overhead Sign No.2.

The passive resistance in front of the caisson within the upper 1.8 m below ground surface should be neglected in the design of the foundations to account for frost action

For the right support of Overhead Sign No.2, the surface of the bedrock is located within the frost depth of 1.8 m relative to the proposed finished ground surface at the footing location (i.e. below the existing embankment fill). Therefore, bedrock is encountered at a depth of less than 5 m below the bottom of the frost layer. Based on the above equation, the caisson for this support would have to be socketted about 2.5 m into the granitic gneiss bedrock.

It should be noted that the granitic gneiss bedrock at this site is characterized as strong to very strong, corresponding to typical uniaxial compressive strengths of greater than 50 MPa and potentially as high as 250 MPa. Because of this, and considering the potential sloping surface of the bedrock, coring 2.5 m into the bedrock will prove to be difficult.

#### **5.2.2.2 Spread Footings Anchored to Rock**

From a foundations perspective, anchored spread footings is the preferred option for the right support of Overhead Sign No.2 and could also be considered for the left support. In both cases, and especially at the left support, some temporary shoring/roadway protection measures are likely to be required give the close proximity of the existing roadway to the footing locations and considering the depth of excavation required to reach bedrock at the left support. Spread footings for the right (or left) support of this sign may be placed at the bedrock surface or with nominal embedment further into the bedrock. Refer to Section 5.2.1.2 for further design comments.

As noted above, spread footings anchored to bedrock can only be considered as a foundation option for support of Overhead Sign No. 2 (particularly at the left footing) if temporary shoring/roadway protection is provided as described in Section 5.4.

### **5.3 Construction Considerations**

It is recommended that an NSSP be included in the Contract Documents to warn the Contractor of the following items which are expected to affect the installation of the trichord overhead sign foundations:

- **Control of overburden soils and groundwater:** The overburden soils at the sign locations include water-bearing sand to sand and gravel and fills containing boulders (i.e. old rock fill embankment materials) as well as soft/loose peat deposits. These soils should be expected to be unstable below the groundwater level and could also contain voids within the fill matrix. It should be anticipated that the caisson holes

will have to be advanced using a temporary liner or casing, in order to minimize ground loss during drilling and concrete placement.

- If temporary shoring is employed to construct footings at Overhead Sign No. 2, groundwater inflow should be expected, especially at the left footing location where sand and gravel and sand deposits were encountered below the water table. Based on the grain size distribution for the sand deposit encountered in borehole OHS-2, and considering the limits of dewatering proposed by Powers (1992), it is considered that the volume of seepage through the sands (and the sand and gravels) could be significant. As such, a specialist dewatering firm/contractor should be retained to design the groundwater control measures at this location.

#### 5.4 Temporary Shoring


At the footing locations for Overhead Sign No.2, given the close proximity of the sign supports to the existing roadway embankment (and especially considering the depth of excavation required to reach bedrock at the left footing), the use of temporary shoring to maintain stability and protect the traveled portion of the existing roadway will be required.


All temporary excavation support systems should be in accordance with Special Provision 105S19 (dated June 2006) and designed to Performance Level 2. Roadway protection should also be in accordance with Special Provision 105S19.

#### 5.5 CLOSURE

This Foundation Design Report was prepared by Mr. Chad Gilfillan and reviewed by Dr. J. Paul Dittrich, Ph.D., P.Eng., an Associate with Golder. Mr. Fintan Heffernan, P.Eng., Golder's Designated MTO Contact for this project, conducted an independent quality review of the report.

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## References

Bowles, J.E. 1984. Physical and Geotechnical Properties of Soils, 2<sup>nd</sup> Edition. McGraw-Hill Book Company, New York.

Canadian Foundation Engineering Manual. 1992. Third Edition. Canadian Geotechnical Society, Technical Committee on Foundations.

Canadian Highway Bridge Design Code (CHBDC) and Commentary on CAN/CSA-S6-00. 2001. CSA Special Publication, S6.1-00. Canadian Standards Association.

Chapman, L.J. and Putnam, D.F. 1984. The Physiography of Southern Ontario, 3<sup>rd</sup> Edition (Ontario Geological Survey, Special Volume 2). Ontario Ministry of Natural Resources.

Kulhawy, F.H. and Mayne, P.W. 1990. Manual on Estimating Soil Properties for Foundation Design. EL-6800, Research Project 1493-6. Prepared for Electric Power Research Institute, Palo Alto, California.

Geology of Ontario. 1991. Ontario Geological Society, Special Volume 4, Part 1. Eds. P.C. Thurston, H.R. Williams, R.H. Sutcliffe and G.M. Stott. Ministry of Northern Development and Mines, Ontario.

Ministry of Transportation, Ontario. 2004. Sign Support Manual. Policy, Planning and Standards Division, Engineering Standards Branch, Bridge Office. August 2004.

Peck, R.B., Hanson, W.E., and Thornburn, T.H. 1974. Foundation Engineering, 2<sup>nd</sup> Edition, John Wiley and Sons, New York.

Sign Support Manual. 2004. Ministry of Transportation Ontario – Structural Office. The Queen's Printer for Ontario / Ronen Publishing House Inc., Toronto, Ontario.

U.S. Navy. 1971. Soil Mechanics, Foundations and Earth Structures. NAVFAC Design Manual DM-7, Washington, D.C.

## LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

### I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
SS	Split-spoon
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

### III. SOIL DESCRIPTION

#### (a) Cohesionless Soils

Density Index (Relative Density)	N Blows/300 mm or Blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

### II. PENETRATION RESISTANCE

#### Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

#### Consistency

	$c_u, s_u$	kPa	psf
Very soft		0 to 12	0 to 250
Soft		12 to 25	250 to 500
Firm		25 to 50	500 to 1,000
Stiff		50 to 100	1,000 to 2,000
Very stiff		100 to 200	2,000 to 4,000
Hard		over 200	over 4,000

#### Dynamic Cone Penetration Resistance; $N_d$ :

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

**PH:** Sampler advanced by hydraulic pressure

**PM:** Sampler advanced by manual pressure

**WH:** Sampler advanced by static weight of hammer

**WR:** Sampler advanced by weight of sampler and rod

#### Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm<sup>2</sup> pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance ( $Q_t$ ), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

### IV. SOIL TESTS

w	water content
$w_p$	plastic limit
$w_l$	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test <sup>1</sup>
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement <sup>1</sup>
$D_R$	relative density (specific gravity, $G_s$ )
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO <sub>4</sub>	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
$\gamma$	unit weight

**Note: 1** Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.



## LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

### I. General

$\pi$	3.1416
$\ln x$ ,	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
F	factor of safety
V	volume
W	weight

### II. STRESS AND STRAIN

$\gamma$	shear strain
$\Delta$	change in, e.g. in stress: $\Delta \sigma$
$\epsilon$	linear strain
$\epsilon_v$	volumetric strain
$\eta$	coefficient of viscosity
$\nu$	poisson's ratio
$\sigma$	total stress
$\sigma'$	effective stress ( $\sigma' = \sigma - u$ )
$\sigma'_{vo}$	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
$\sigma_{oct}$	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
$\tau$	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

### III. SOIL PROPERTIES

#### (a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight*)
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
$\gamma'$	unit weight of submerged soil ( $\gamma' = \gamma - \gamma_w$ )
$D_R$	relative density (specific gravity) of solid particles ( $D_R = \rho_s / \rho_w$ ) (formerly $G_s$ )
e	void ratio
n	porosity
S	degree of saturation

#### (a) Index Properties (continued)

w	water content
$w_l$	liquid limit
$w_p$	plastic limit
$I_p$	plasticity index $= (w_l - w_p)$
$w_s$	shrinkage limit
$I_L$	liquidity index $= (w - w_p) / I_p$
$I_C$	consistency index $= (w_l - w) / I_p$
$e_{max}$	void ratio in loosest state
$e_{min}$	void ratio in densest state
$I_D$	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

#### (b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

#### (c) Consolidation (one-dimensional)

$C_c$	compression index (normally consolidated range)
$C_r$	recompression index (over-consolidated range)
$C_s$	swelling index
$C_a$	coefficient of secondary consolidation
$m_v$	coefficient of volume change
$c_v$	coefficient of consolidation
$T_v$	time factor (vertical direction)
U	degree of consolidation
$\sigma'_p$	pre-consolidation pressure
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

#### (d) Shear Strength

$\tau_p, \tau_r$	peak and residual shear strength
$\phi'$	effective angle of internal friction
$\delta$	angle of interface friction
$\mu$	coefficient of friction $= \tan \delta$
$c'$	effective cohesion
$c_u, s_u$	undrained shear strength ( $\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
$p'$	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 + \sigma_3)/2$ or $(\sigma'_1 + \sigma'_3)/2$
$q_u$	compressive strength $(\sigma_1 + \sigma_3)$
$S_t$	sensitivity

- Notes:**
- 1  $\tau = c' + \sigma' \tan \phi'$
  - 2 shear strength  $= (\text{compressive strength})/2$
  - \* density symbol is  $\rho$ . Unit weight symbol is  $\gamma$  where  $\gamma = \rho g$  (i.e. mass density x acceleration due to gravity)

# LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

## WEATHERING STATE

**Fresh:** no visible sign of weathering.

**Faintly weathered:** weathering limited to the surface of major discontinuities.

**Slightly weathered:** penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

**Moderately weathered:** weathering extends throughout the rock mass but the rock material is not friable.

**Highly weathered:** weathering extends throughout rock mass and the rock material is partly friable.

**Completely weathered:** rock is wholly decomposed and in a friable condition but the rock texture and structure are preserved.

## BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	> 2 m
Thickly bedded	0.6 m to 2m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	< 6 mm

## JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	> 3 m
Wide	1 - 3 m
Moderately close	0.3 - 1 m
Close	50 - 300 mm
Very close	< 50 mm

## GRAIN SIZE

Term	Size*
Very Coarse Grained	> 60 mm
Coarse Grained	2 - 60 mm
Medium Grained	60 microns - 2 mm
Fine Grained	2 - 60 microns
Very Fine Grained	< 2 microns

Note: \* Grains >60 microns diameter are visible to the naked eye.

## CORE CONDITION

### Total Core Recovery

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

### Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

### Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid sticks.

## DISCONTINUITY DATA

### Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

### Dip with Respect to (W.R.T.) Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

### Description and Notes

An abbreviated description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

### Abbreviations

B - Bedding	P - Polished
FO - Foliation/Schistosity	S - Slickensided
CL - Cleavage	SM - Smooth
SH - Shear Plane/Zone	R - Ridged/Rough
VN - Vein	ST - Stepped
F - Fault	PL - Planar
CO - Contact	FL - Flexured
J - Joint	UE - Uneven
FR - Fracture	W - Wavy
MF - Mechanical Fracture	C - Curved
- Parallel To	
⊥ - Perpendicular To	

## **RECORD OF BOREHOLE SHEETS**

PROJECT 03-1111-028		RECORD OF BOREHOLE No OHS-1				1 OF 1 METRIC														
W.P. 335-00-00		LOCATION Hwy 69 Sta. 14+100 o/s 11.8 m Lt Centre-line median (OHS No.2)				ORIGINATED BY CMG														
DIST 52 HWY 69		BOREHOLE TYPE Power Auger 108 mm I.D. Hollow Stem Auger				COMPILED BY MM														
DATUM Geodetic		DATE January 5, 2006				CHECKED BY JPD														
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%) W <sub>p</sub> W      W <sub>L</sub>			γ	GR	SA	SI	CL
222.6	GROUND SURFACE							20	40	60	80	100	20	40	60	kN/m <sup>3</sup>				
0.0	Sand and gravel occ. cobbles and boulders (FILL) Compact to dense Brown to grey Dry		1	SS	13		222													
220.6			2	SS	46		221													
2.0	Bedrock  Refer to Record of Drillhole OHS-1 for details						220													
218.8							219													
3.8	End of Borehole  Notes: 1. Auger refusal at about 2.0 m depth. 2. Borehole dry upon completion of drilling.																			

PROJECT: 03-1111-028

**RECORD OF DRILLHOLE: OHS-1**

SHEET 1 OF 1

LOCATION: N 5035160.4 ;E 254059.9

DRILLING DATE: January 5, 2006

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: TRACK CME 55

DRILLING CONTRACTOR: MARATHON DRILLING LTD.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH	COLOUR % RETURN	JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate										BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage										PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular										PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break										BR - Broken Rock										NOTES WATER LEVELS INSTRUMENTATION										
									RECOVERY										FRACT. INDEX PER 0.3 m										DISCONTINUITY DATA										HYDRAULIC CONDUCTIVITY										Diametral Point Load Index (MPa)											RMC -Q AVG.									
									TOTAL CORE %					SOLID CORE %					R.Q.D. %										B Angle					DIP w.r.t. CORE AXIS					TYPE AND SURFACE DESCRIPTION					K, cm/sec																									
									888																																																												

DEPTH SCALE

1 : 50



LOGGED: CMG

CHECKED: JPD

MIS-RCK 002 031111028AARCK.GPJ GAL-MISS.GDT 5/10/06 JFC

PROJECT 03-1111-028		<b>RECORD OF BOREHOLE No OHS-2</b>				1 OF 1 <b>METRIC</b>										
W.P. 335-00-00		LOCATION Hwy 69 Sta. 14+100 o/s 26.4 m Lt Centre-line median (OHS No.2)				ORIGINATED BY CMG										
DIST 52 HWY 69		BOREHOLE TYPE Power Auger 108 mm I.D. Hollow Stem Auger				COMPILED BY MM										
DATUM Geodetic		DATE January 5, 2006				CHECKED BY JPD										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
222.6	GROUND SURFACE															
0.0	Sand and gravel (FILL) Compact Brown to grey Dry		1	SS	29											
221.0																
1.6	Silty fine Sand, trace gravel Very loose Brown Moist		2	SS	3											
220.4																
2.2	Sand and Gravel Dense Brown Wet		3	SS	39											
219.7																
2.9	Sand, trace to some silt and gravel, occasional thin silt layers Compact Brown to grey Wet		4	SS	20											
			5	SS	22											
217.9			6	SS	50/07											8 71 15 6
217.9	Inferred Bedrock (cored 0.1m) End of Borehole															
4.8	Notes:  1. Auger refusal at about 4.8 m depth.  2. Water level in borehole measured at 2.3 m depth upon completion of drilling.															

PROJECT		RECORD OF BOREHOLE No OHS-3				1 OF 1 METRIC											
W.P. 335-00-00		LOCATION Hwy 69 Sta. 12+700 o/s 12.3 m Rt Centre-line median (OHS No.1)				ORIGINATED BY CMG											
DIST 52 HWY 69		BOREHOLE TYPE Portable drilling equipment				COMPILED BY MM											
DATUM Geodetic		DATE January 11, 2006				CHECKED BY JPD											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL
							20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	20 40 60	kN/m <sup>3</sup>				
216.9	GROUND SURFACE																
0.0	Topsoil																
	Sand with rock fill, some clay, trace to some organics (FILL)																
215.7	Bedrock																
1.2	Refer to Record of Drillhole OHS-3 for details																
213.5	End of Borehole																
3.4	Note: Water level in open borehole at 1.1m depth upon completion of drilling.																





PROJECT <u>03-1111-028</u>		<b>RECORD OF BOREHOLE No OHS-4</b>				1 OF 1 <b>METRIC</b>										
W.P. <u>335-00-00</u>		LOCATION <u>Hwy 69 Sta. 12+700 o/s 26.8 m Rt Centre-line median (OHS No.1)</u>				ORIGINATED BY <u>CMG</u>										
DIST <u>52</u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable drilling equipment</u>				COMPILED BY <u>MM</u>										
DATUM <u>Geodetic</u>		DATE <u>January 11, 2006</u>				CHECKED BY <u>JPD</u>										
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED			W <sub>p</sub> W W <sub>L</sub> WATER CONTENT (%)			γ	GR SA SI CL	
216.1	GROUND SURFACE							20 40 60 80 100								
0.0	Water						216									
	Peat, some organics, trace to some sand															
215.3	Bedrock						215									
0.8	Refer to Record of Drillhole OHS-4 for details															
213.9	End of Borehole						214									
2.2	Note: Water level above ground surface prior to drilling.															

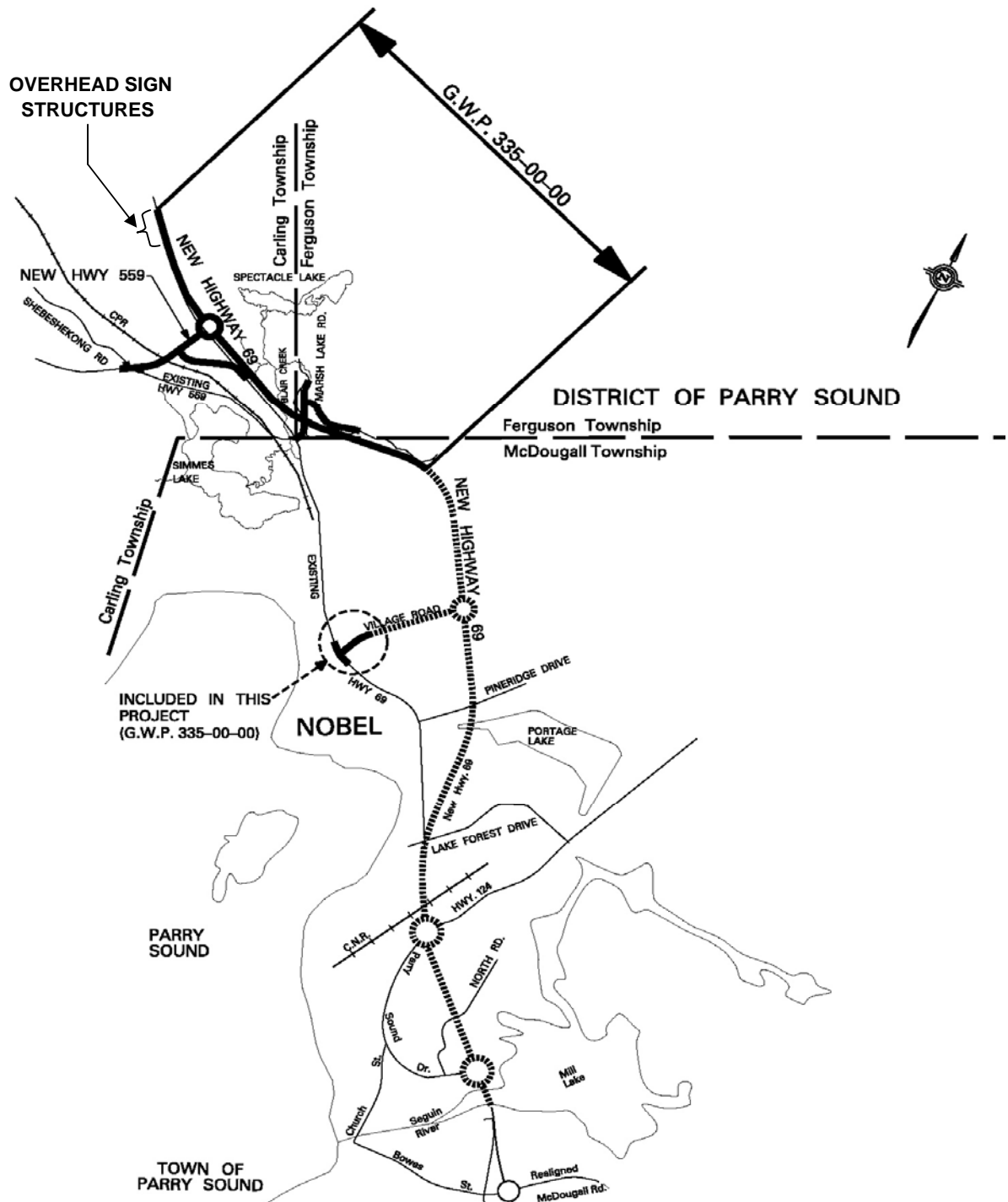


## **FIGURES**

# SITE LOCATION MAP

HIGHWAY 69 FROM 1.5 KM SOUTH OF HIGHWAY 559  
TO 3.5 KM NORTH OF HIGHWAY 559

FIGURE 1



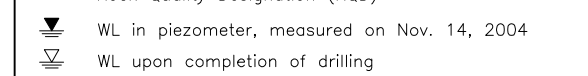
GWP No. 335-00-00  
Date: February 2006  
Project: 03-1111-028-8

Drawn by: CMG  
Checked by: JPD

Golder Associates

Provided in digital format by URS on January 7, 2005

## **DRAWINGS**



No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
BCB-1	199.4	5032671.2	256659.8
BCB-2	196.3	5032649.7	256645.6
BCB-3	199.6	5032679.6	256647.3
BCB-5	199.6	5032689.4	256607.2
BCB-6	199.5	5032697.7	256594.1

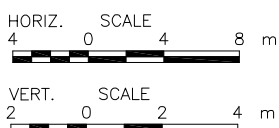
The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

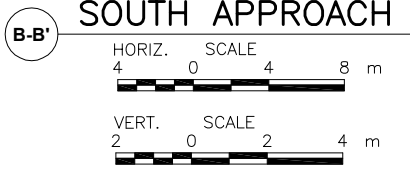
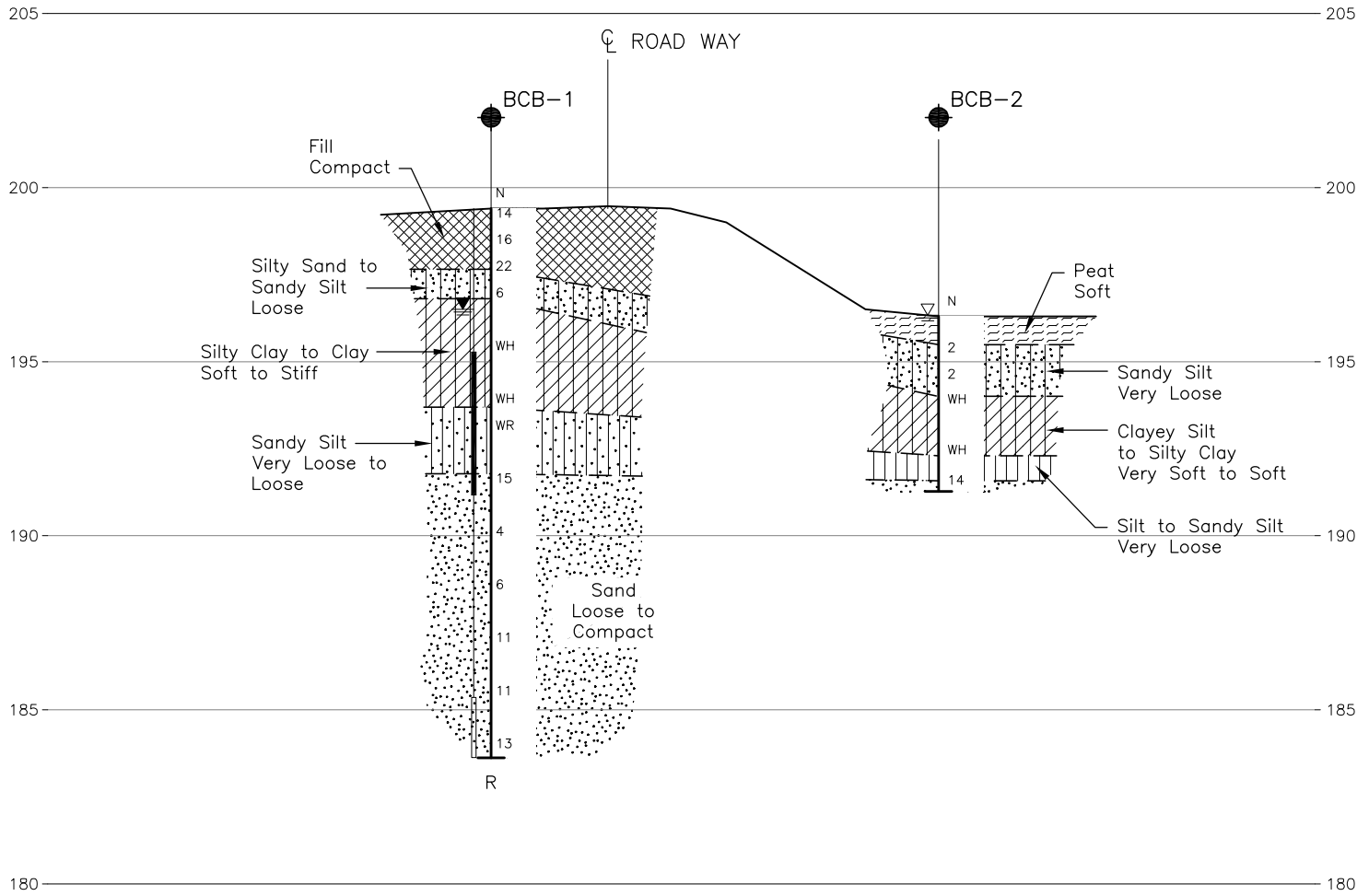
For subsurface information only.

Base plans provided in digital format by URS, drawing file no. BlairCreekReplaceGA.dwg, dated Nov. 2005 received Nov. 11, 2005.

\_\_\_\_\_

NO.	DATE	BY	REVISION
Geocres No. 41H-59			
HWY. 69		PROJECT NO. 03-1111-028	DIST. 52
SUBM'D. CMG	CHKD. CMG	DATE: SEPT. 2006	SITE:
DRAWN: JFC	CHKD. JPD	APPD:	DWG. 1A





**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

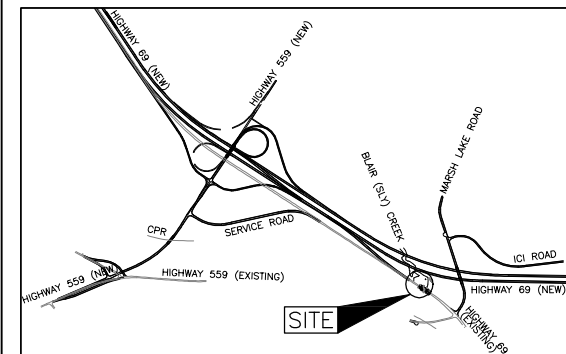
CONT No.  
GWP No. 335-00-00

EXIST. HIGHWAY 69 (SERVICE ROAD)  
PROPOSED REPLACEMENT BRIDGE OVER  
BLAIR (SLY) CREEK  
BOREHOLE SOIL STRATA

SHEET



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



### LEGEND

- Borehole - Current Investigation
- R Refusal
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated  
(Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- WL in piezometer, measured on Nov. 14, 2004
- WL upon completion of drilling

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
BCB-1	199.4	5032671.2	256659.6
BCB-2	196.3	5032649.7	256645.6

### NOTES

The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

For subsurface information only.

### REFERENCE

Base plans provided in digital format by URS, drawing file no. BlairCreekReplaceGA.dwg, dated Nov. 2005 received Nov. 11, 2005.



NO.	DATE	BY	REVISION
Geocres No. 41H-59			
HWY. 69	PROJECT NO. 03-1111-028		DIST. 52
SUBM'D. CMG	CHKD. CMG	DATE: SEPT. 2006	SITE:
DRAWN: MSM	CHKD. JPD	APPD.	DWG. 1B

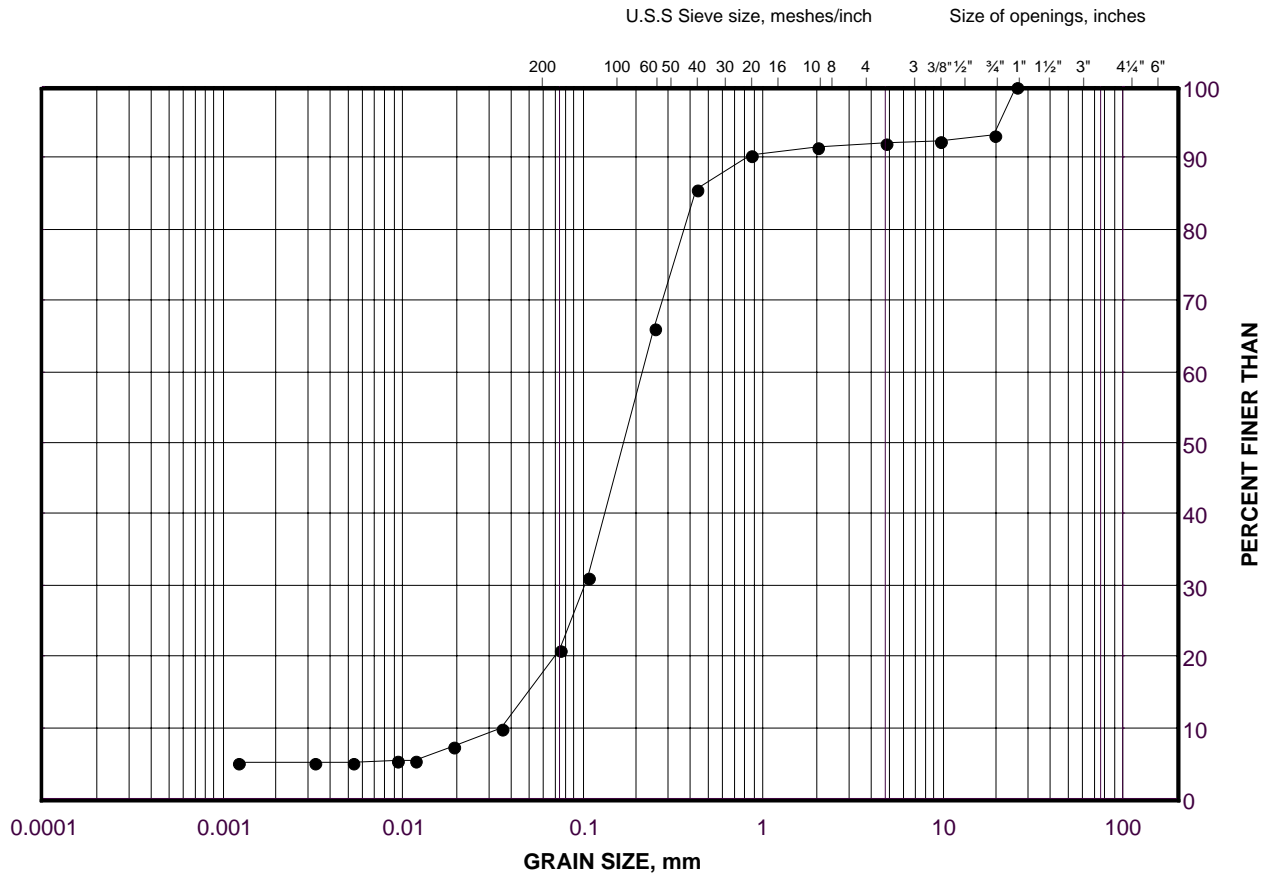
**APPENDIX A**  
**LABORATORY TEST DATA**



# GRAIN SIZE DISTRIBUTION

Sand, some silt, trace to some gravel and clay

FIGURE A-1



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	OHS-2	5	218.5

Project Number: 03-1111-028

Checked By: \_\_\_\_\_

**Golder Associates**

Date: 17-May-06

**APPENDIX B**

**SAMPLE NON-STANDARD SPECIAL PROVISIONS**

**DOWELS INTO ROCK – Item No.****CONCRETE SIGN SUPPORT STRUCTURE FOOTINGS – Item No.**

---

Non-Standard Special Provision

---

**Rock Dowel Testing**

All proposed testing procedures shall be in general conformance with ASTM D 3689-90 and ASTM D 114381 (Re-approved 1994). Field testing shall be carried out in the presence of, and the results reviewed and approved by, the Contract Administrator.

**Performance Tests**

The following table summarizes the number of rock dowels where performance testing shall be carried out to confirm that the design load of the rock dowels can be achieved. The Contract Administrator will select the rock dowels to be tested.

Bridge	Foundation	Number of Dowels for Performance Testing
Overhead Sign Station 12+700 NBL	West Footing	2
Overhead Sign Station 12+700 NBL	East Footing	2
Overhead Sign Station 14+100 SBL	West Footing	2
Overhead Sign Station 14+100 SBL	East Footing	2

Performance test shall be by axial tensioning using a hydraulic jack with a capacity of at least 1.5 times the ultimate strength of the dowels.

Rock dowels shall be loaded and unloaded in 3 cycles and measurements of the displacement of the dowel shall be carried out at each load increment (step) in accordance with the following schedule:

Cycle-Step	1-1	1-2	1-3	2-1	2-2	2-3	2-4
% Design Load	50	75	25	50	75	100	25
Cycle-Step	3-1	3-2	3-3	3-4	3-5		
% Design Load	50	75	100	110	25		

The design load shall be taken as 360 kN for 35M dowels, 252 kN for 30M dowels, 180 kN, for 25M dowels, and 108 kN for 20M dowels.

Displacement measurements shall be carried out at each load increment using calibrated displacement gauges capable of measuring movements of 0.0025 cm. Measurements shall be referenced to an independent fixed referenced point.

Rock dowels which fail to meet the acceptance criteria shall be replaced at the Contractor's expense and re-tested. If a rock dowel fails, 3 additional rock dowels shall be tested at the same abutment and pier footing as directed by the Contract Administrator.

Acceptance criteria for the rock dowels shall be in accordance with the Post-tensioning Institute (1985) as follows:

The dowels are acceptable if the total elastic movement is greater than 80% of the theoretical elastic elongation of the free stressing and is less than the theoretical elongation of the free stressing length plus 50% of the bond length.

**Basis of Payment**

Payment at the Contract Price for the above tender item shall include full compensation for all labour, equipment and material to do the work.

## **CONCRETE SIGN SUPPORT STRUCTURE FOOTINGS - Item No.**

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### **Non-Standard Special Provision**

---

This special provision is to highlight the construction concerns for the installation of the tri-chord overhead sign, Overhead Sign No. 2, at Highway 69 Station 14+100. The Contactor shall be alerted that the overburden soils at the sign location include water-bearing silty sands, sands and gravels and sand deposits which are water bearing and susceptible to soil cave-in, sloughing and potential boiling. In addition the sand and gravel fills (i.e. existing roadway embankment fills) may contain cobbles and boulders which could contain voids within the fill matrix.

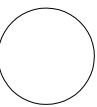
**APPENDIX C**

**SIGN SUPPORT DRAWINGS (URS) – STRUCTURE 1 AND 2**

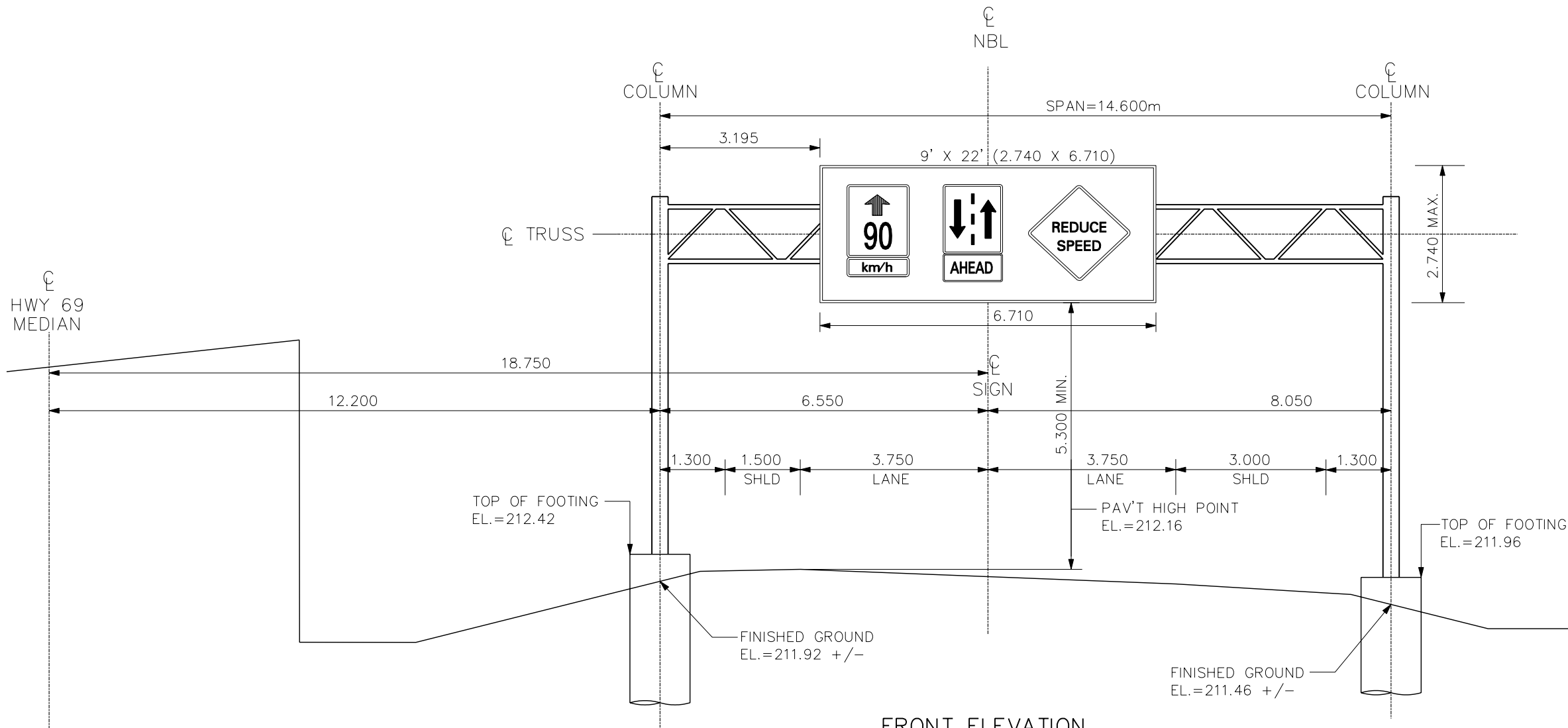
METRIC

PLATE No  
CONT No  
WP No 335-00-00

SIGN SUPPORT  
STRUCTURE 1



SHEET

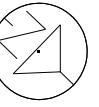



FRONT ELEVATION  
(IN DIRECTION OF NBL TRAFFIC)

STRUCTURE No. 1  
HIGHWAY 69 NBL  
STATION 12+700

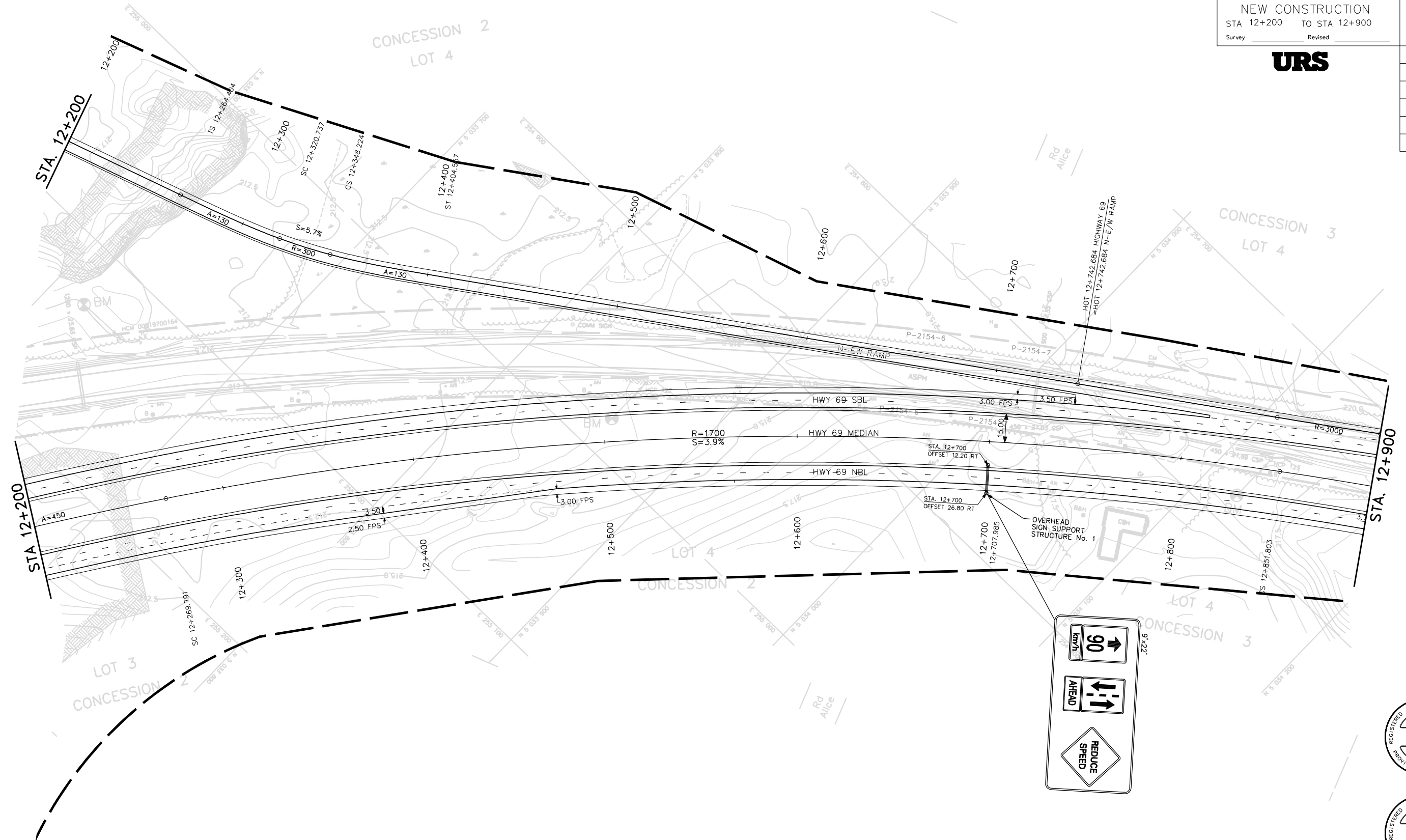


N.T.S.



SHEET  
6

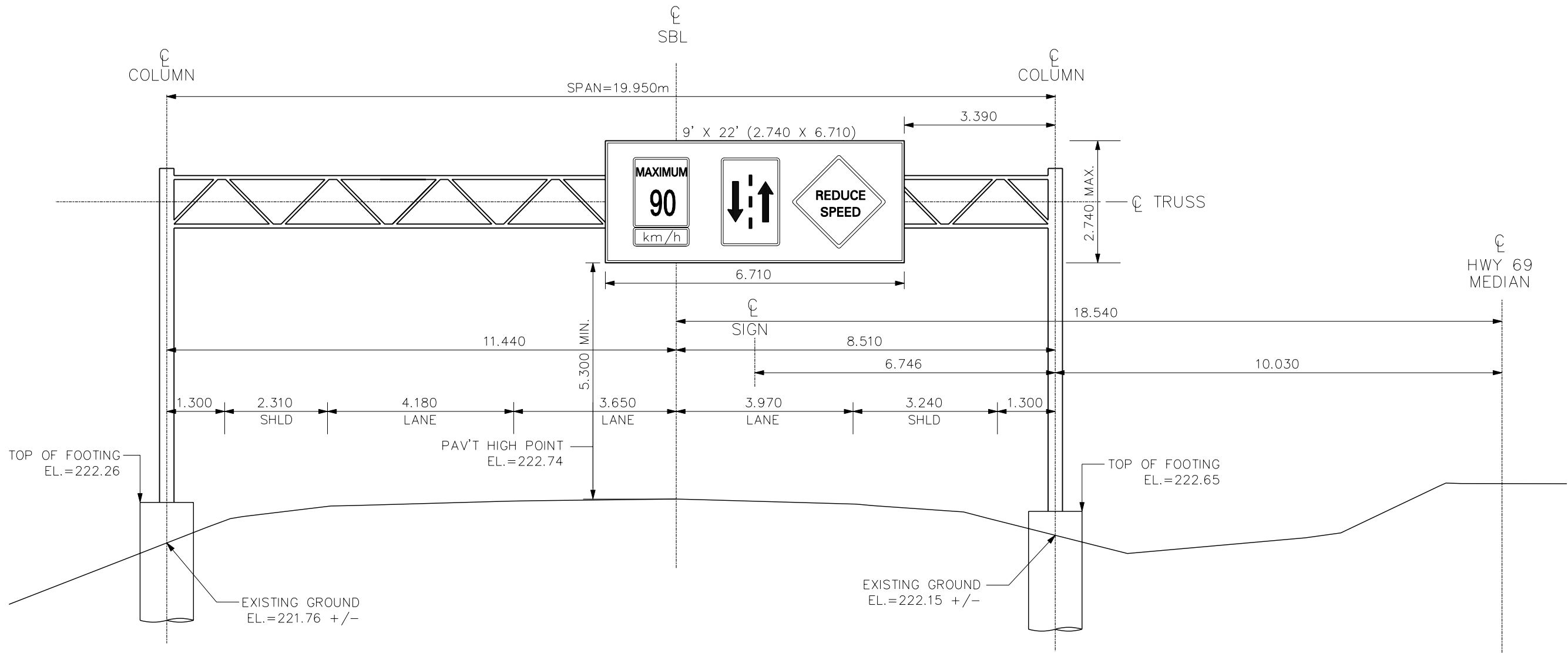
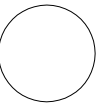
**URS**



SCALE





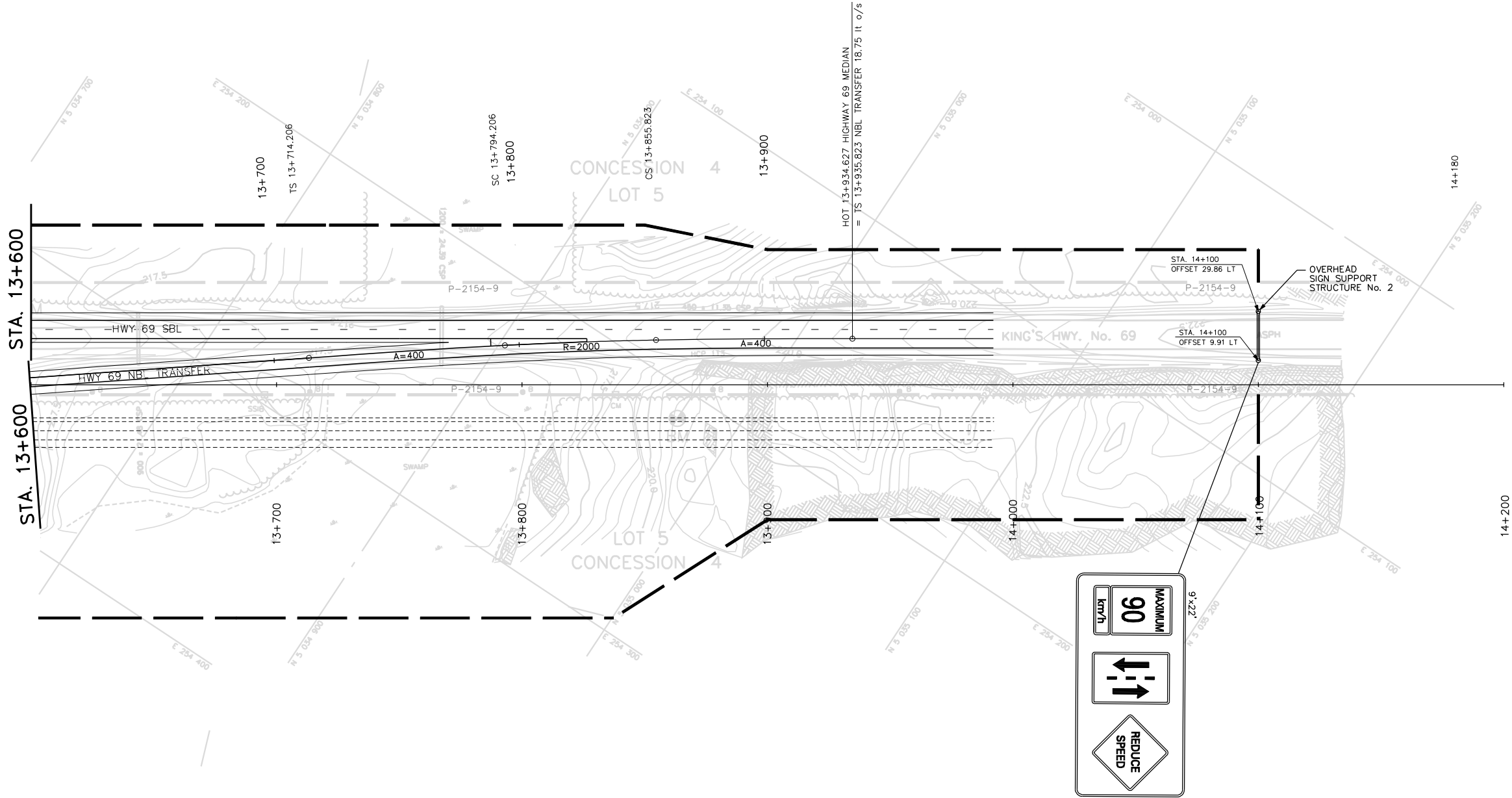


FRONT ELEVATION  
(DIRECTION OF NBL TRAFFIC)

STRUCTURE No. 2  
HIGHWAY 69 SBL  
STATION 14+100



N.T.S.



METRIC

PLATE No	PLATE
CONT No	
WP No	5538-04-01
NEW CONSTRUCTION	
STA 13+600	TO STA 13+993.113
Survey	Revised

URS



SHEET  
8

