



**FEASIBILITY FOUNDATION INVESTIGATION AND DESIGN
REPORT 5 – GEOGRAPHICAL TOWNSHIP OF ORFORD
for
HIGHWAY 401 – CHATHAM-KENT
FROM 0.9 KM EAST OF ESSEX COUNTY ROAD 42
EASTERLY 66.1 KM TO THE ELGIN COUNTY BOUNDARY
AGREEMENT NUMBER 3004-E-0001
GWP NO. 80-00-00**

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PML Ref.: 05TF060-5
Index No.: 116FIDR
GEOCRES No.: 40I12-27
January 29, 2010



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**Feasibility Foundation Investigation and Design
Report 5 – Geographical Township of Orford**
for
Highway 401 – Chatham-Kent
From 0.9 Km East of Essex County Road 42
Easterly 66.1 Km to the Elgin County Boundary
Agreement Number 3004-E-0001
GWP No. 80-00-00

1. INTRODUCTION

This report presents the results of the foundation feasibility study carried out for the proposed widening of the Highway 401 section through the Geographical Township of Orford, County of Kent. The study is being carried out for McCormick Rankin Corporation (MRC) on behalf of the Ministry of Transportation of Ontario (MTO).

MTO plans to widen the Highway 401 section extending from 0.9 km east of Essex County Road 42 easterly 66.1 km to the Elgin County Boundary from four to six lanes. Feasibility studies are required for the foundations of the existing bridge structures and structural culverts (span larger than 3.0 m) between the study limits. The freeway section traverses five geographical townships and the reporting was separated into five reports designated as follows:

- Report 1 – Geographical Township of Tilbury East/North
- Report 2 – Geographical Township of Raleigh
- Report 3 – Geographical Township of Harwich
- Report 4 – Geographical Township of Howard
- Report 5 – Geographical Township of Orford

This report concerns the Highway 401 section through the Geographical Township of Orford. This highway section extends from the boundary between the Howard and Orford Townships to the east limit of the study at the Elgin County limits for approximately 10.7 km. A key map for this section of Highway 401 is highlighted in Figure 5-1.



Within the limits of Orford Township there are three underpass structures, including the underpass for one interchange and five structural culverts that are described in the following section.

All dimensions in this report are provided in metres except where indicated.

2. SITE DESCRIPTION

The Highway 401 through the Geographical Township of Orford is currently a four-lane freeway. There is a Chainage equation change about 237 m east of the Howard/Orford Township line:

$$\text{Station } 21+376.96 \text{ Howard} = \text{Station } 10+000.0 \text{ Orford}$$

The following table lists the MTO site numbers, locations and types of the three bridge structures and five structural culverts along this section of Highway 401.

LIST OF STRUCTURES

Structure Name	Site No.	Station	Type
Kenesserie Road Underpass	13-267	21+140(*)	4-span steel girder structure
Culvert Site 13-418	13-418-C	21+359.7(*)	Conc. Open Footing (4.27 by 2.44 by 59.1)
Culvert Site 13-419	13-419-C	10+816	Conc. Open Footing (3.70 by 2.40 by 77.4)
Culvert Site 13-420	13-420-C	12+180.75	Conc. Open Footing (3.10 by 1.80 by 54.4)
Culvert Site 13-421	13-421-C	12+819.25	Conc. Open Footing (3.70 by 2.40 by 60.0)
Orford Road Underpass	13-263	13+824.5	4-span steel girder interchange structure
Duart Road Underpass	13-264	17+888.6	4-span steel girder structure
Culvert Site 13-422	13-422-C	19+080.25	Conc. Open Footing (3.00 by 2.40 by 59.2)

Notes: Culvert sizes taken from RFP documents as Span by Width by Length in metres.

(*) – Howard Township Chainage. All chainages should be considered approximate.



The typical topography near the highway corridor within the Geographical Township of Orford is typically flat or shows a gentle undulation. The highway grades rise gradually to the east with an approximate relief of 16 m, based on inferred pavement surface elevations at the underpass locations.

The land use is agricultural and the typical vegetation beyond the highway corridor comprises mostly of farming crops. Isolated stands of trees are also present along highway corridor and some of the drainage ditches. The roadside ditches are typically covered with grasses. Scattered farm residences and facilities are located near Highway 401. Steel towers from a section of a Hydro corridor are present north of the highway in the vicinity of the Duart Road underpass structure.

Natural drainage of the lands located along the highway is generally poor. The highway crosses several creeks and drains that were constructed to enhance the natural drainage of the farmland and lower the perched groundwater that is typically encountered at depths close the ground surface along the highway corridor.

The MTO design frost depth for the Geographical Township of Orford is 1.2 m.

3. INVESTIGATION PROCEDURES

The foundation feasibility analyses for this report were based primarily on a review of existing data and literature. The data comprised five geological maps and literature, three physiographic maps, nine previous MTO construction contract documents and foundation investigation reports, three groundwater data documents, including 11 water well records and other sources of documents such as mosaics of aerial photographs and base maps and topographic maps. Table 5-1 provides a list of the reference documents reviewed for this study. A large number of these documents were in poor condition prior to scanning by MTO. The inferred data referred in this report was double-checked where possible. Chainages are approximate unless clearly provided on the reference documents. The majority of elevations and dimensions were converted to the metric system from imperial units. All dimensions and elevations provided in this report should be verified during detail design.



A summary of the stratigraphy encountered in the water wells is provided on the attached Table 5-2 and details of the measured groundwater levels and encountered bedrock levels in the wells were included on the attached Site Plans, Drawings 5-1, 5-2 and 5-3. These water levels were in general agreement with those levels inferred from the published MOE website.

A site reconnaissance visit was also carried out at each of the bridge structure and culverts. Representative photographs showing relevant natural features and geomorphology are included in Appendix A.

Subsurface field explorations were not carried out for this report. Copies of the previous records of boreholes and associated location plans relevant to the existing structures were included in Appendix B.

4. LITERATURE REVIEW

4.1 Inferred Subsurface Conditions

The reviewed geological and physiographic maps and literature indicated that Highway 401 through the Geographical Township of Orford straddles the northern and eastern slopes of the Blenheim moraine and the sandy delta deposits (Bothwell Sand Plain) laid within the glacial Lake Warren by the precursor of the Thames River.

The following tables provide a summary of the site conditions that were previously encountered or inferred at the location of three bridge structures and five culverts within the Geographical Township of Orford.



For the structures where previous reports were not prepared or were not available, the subsurface conditions were assumed to be similar to those encountered or inferred for the adjacent structures.

SUMMARIZED SUBSURFACE CONDITIONS

Structure Name	Soil Cover Levels (*)		Bedrock (**)		Groundwater (**)	
	Sand	Silty Clay Till	Depth (m)	Elev.	Depth (m)	Elev.
Kenesserie Road Underpass	Compact. 1.5 to 2.7 m (elev. 198.8 to 200.0)	Very stiff to hard. Termination depths 19.8 and 29.6 m	>40.5	<163.7	Perched: 0.6 Regional: 12.5 to 14.3	Perched: 200.7 Regional: 191.4 to 192.0
Culvert Site 13-418						
Culvert Site 13-419			43.0	162.7		
Culvert Site 13-420	Compact. 4.3 to 4.4 m (elev. 205.1 to 205.7)	Very stiff to hard. Termination depths: 10.7 to 20.4 m	43.0	162.7	Perched: 1.7 Regional: 16.5 to 21.3	Perched: 208.3 Regional: 188.0 to 192.3
Culvert Site 13-421			51.2	162.2		
Orford Road Underpass						
Duart Road Underpass	Loose to compact. 3.0 to 3.5 m (elev. 214.1 to 214.6)	Stiff to hard. Termination depths 9.4 to 13.1 m	60.0 to <64.0	149.4 to 153.4	Perched: 1.4 Regional: 29.0 to 32.0.	Perched: 216.0 Regional: 183.5 to 184.4
Culvert Site 13-422			>58.2	<157.3		

Notes: (*) From borehole data. Levels indicated are inferred depths and elevations of the bottom of the soil units. Topsoil and fill units were disregarded.

(**) Bedrock and groundwater levels based on water well and borehole data (circa 1950 to 1970).

The relatively shallow deposits of compact sand from the Bothwell Sand Plain overlie deep typically very stiff clay and silty clay till deposits. Topsoil and fill encountered during previous investigations and water well drilling were disregarded because present conditions will likely differ from those recorded. The typical soil stratigraphy encountered in the previous investigations indicate that the sand deposits extend to depths ranging from 1.5 to 4.4 m, elevations 198.8 to 214.6.



The underlying cohesive deposit of clay/silty clay till extends deeper than the 9.4 to 29.6 m termination depth of the boreholes. Scattered thin clay layers (about 150 mm thick in the available boreholes) containing organic matter occur between the sand and the clay are inferred to originate from shallow lacustrine deposits within old surface depressions. A few hundred meters to the east of Duart Road, the highway traverses lacustrine deposits from an embayment of the Lake Warren between two diverging strands of the Blenheim moraine.

The bedrock underlying the Highway 401 alignment through the Geographical Township of Orford varies from black bituminous shale with shale interbeds of the Kettle Point Formation on the west to grey shale and limestone of the Hamilton Group on the east. The bedrock was encountered in the water wells at depths ranging from 43.0 to 60.0 m (deeper than 64.0 m near Duart Road). The bedrock surface was relatively level at about elevation 162.2 to 162.7 between Kenesserie Road and Orford Road, dipping below elevation 157.3 to 149.4 at and to the east of Duart Road.

A perched groundwater table was encountered within the sand deposit at 0.6 to 1.7 m depths, elevation 200.7 to 216.0. The regional groundwater level is located at depths ranging from 12.5 to 32.0 m, elevations 183.5 to 192.3.



4.2 Inferred Structure Foundations

Based on the construction drawing reviewed, the abutments and piers of the underpass structures were founded on spread footing and/or concrete filled 323 mm O.D. steel tube (pipe) piles driven to relatively low capacities of 267 and 356 kN. The following table summarizes the foundation type and founding levels that were indicated for the spread footings and driven steel tube piles.

BRIDGE STRUCTURE - EXISTING FOUNDATIONS

Structure	Abutments			Piers		
	Type	Elevation		Type	Elevation	
		Top Footing / Pile Cap	Bottom Footing / Pile Tip		Top Footing / Pile Cap	Bottom Footing / Pile Tip
Kenesserie Road Underpass	Spread Footing	200.2	199.0	Spread Footing	200.2	199.0
Orford Road Underpass	Piles (356 kN)	213.7	201.2	Spread Footing	209.6	208.4
Duart Road Underpass	Piles (267 kN)	222.2	211.8	Piles (267 kN)	219.3	211.8

Note: Elevations were taken from reference drawings for top of spread footings, top of piles and pile tips. Pile capacities indicated in brackets were also taken from the reference drawings.

The culverts over 3 m span being assessed are of the concrete frame open footing type. It is inferred that the culvert footings were founded on the native sandy deposits about 1.2 m below grade for frost protection.



5. SITE RECONNAISSANCE

The site reconnaissance of the structures within this geographic township was carried out on January 26 and 27, and June 29, 2006. Twenty-eight relevant photographs of the structure and culvert sites are presented in Appendix B for reference. The following notes were compiled.

- In general, the site visits confirmed that the three bridge structures and five culverts are located on generally flat to gently undulating terrain (photographs 5-1, 5-3, 5-4, 5-7, 5-15, 5-18, 5-20, 5-21, 5-24 and 5-26). There are no major stream crossings within the alignment.
- The visual inspection of the underpass structure foundations did not reveal signs of distress such as settlements or other distortion (photographs 5-2, 5-16 and 5-22).
- Displacement and rotation of original concrete wing walls of some of the culverts was noted (photographs 5-7 and 5-25).
- Surface water was noted locally along the roadside ditches at the underpass structure and culvert locations (photographs 5-12, 5-17, 5-20 and 5-21). The roadside ditches were locally grass covered and wet.
- Approach embankment settlements were not noticed during the site visits. The assessment indicated that the bridge approach embankments were typically stable. No signs of distress such as erosion, sloughing or sliding were noted on the bridge approach embankments (photographs 5-4, 5-19, 5-23 and 5-24).
- The channels at the inlet/outlet of the culverts were locally narrowed by sandy soils sloughing off the earth bank (photographs 5-12, 5-13, 5-14, 5-25 and 5-27).
- Erosion control of the highway embankment near the ends of culverts where the wing walls were removed is being accomplished with rock cover (photographs 5-9 and 5-10).
- Swampy ground was not noted within or near the structures or culverts within the alignment. However, some areas were wet possibly due to poor drainage on the relatively flat terrain (photographs 5-12, 5-17, 5-20 and 5-21).



- The exit and on-ramps of the Orford Road interchange were constructed over terrain that is typically flat and free of swampy soils (photographs 5-17 and 5-19).
- The north approach embankment of Kenesserie Road crosses over an existing concrete culvert that conveys the drainage water downstream of the culvert site 13-418 (photograph 5-5 and 5-6).

6. DISCUSSION AND RECOMMENDATIONS

6.1 General

The MTO is currently planning to widen Highway 401 through the County of Kent from four to six lanes of traffic. This report pertains to the section through the Geographical Township of Orford. It is understood that the two widening alternatives being currently considered essentially comprise the following:

Alternative 1 – Adding one lane to the inside of the westbound and eastbound lanes

Alternative 2 – Adding one lane to the outside of the westbound and eastbound lanes

It is envisaged that Alternative 1 will require filling of the median ditch and construction of a barrier along the centreline of the median. Existing culvert and bridge structures would not require foundation modifications.

At the Orford Road interchange, approximate Sta. 13+825, two new ramps, S-E and N-W are planned in addition to realigning the existing W-N/S, E-N/S, N/S-E and N/S-W entrance/exit terminals to improve the interchange for future traffic operations and maintain a Parclo A interchange configuration.

Construction of Alternative 2 will likely require the modification of the existing bridge structures or alternatively the construction of new structures. One option for modification of the underpass structures is to cut into the existing approach embankment foreslopes (in front of the abutments) and construct permanent vertical retaining wall for abutment support. Widening to the outside will also require alterations to the interchange ramps and the extension of culverts. It is considered



further that the alternatives for the construction of new underpass structures comprise constructing on the same alignment or on new alignment to the west or east of the existing alignment.

The following sections of this report provide comments for planning purposes and an overview of the advantages and disadvantages, costs and risks/consequences of each alternate configuration from a foundation perspective.

6.1.1 Structure Foundations

As indicated previously, it is envisaged that the widening alternative comprising the addition of traffic lanes to the inside will not require new foundations or modifications to existing foundations. The alternative of widening to the outside of the existing lanes will likely require new construction or alteration of the existing structures in view of their currently narrow four-span configuration. It is noted that the structures may also require replacement or widening due to a requirement to increase their current number of traffic lanes over Highway 401.



Based on the available data, the following foundation levels for shallow and deep foundations are anticipated.

PRELIMINARY REFERENCE FOUNDING LEVELS AND GEOTECHNICAL RESISTANCES ⁽¹⁾

Structure site	Shallow Foundations ⁽²⁾				Deep Foundations ⁽³⁾			
	Founding Levels ⁽⁴⁾		Geotechnical Resistance		Founding Levels		Geotechnical Resistance ⁽⁵⁾	
	Depth (m)	Elev.	ULS (kPa)	SLS (kPa)	Depth (m)	Elev.	ULS (kN)	SLS (kN)
Kenesserie Road Underpass	3.7	199.0	500	300	41	162	2,000	N/A
Orford Road Underpass	2.0	208.4	350	200	49	162	2,000	N/A
Duart Road Underpass	N/A	N/A	N/A	N/A	66	153	2,000	N/A

Notes: ⁽¹⁾ Geotechnical resistances are to be confirmed during detailed design.

⁽²⁾ Abutments founded below the 1.2 m foundation frost depth on engineered fill may be designed for 900 kPa ULS and 350 kPa SLS for a granular pad thickness ≥ 2.0 m.

⁽³⁾ Driven pile tips assumed to be established on the bedrock underlying the sites.

⁽⁴⁾ Footing founding levels provided to match those of existing footings and assumed min. 1.5 m wide. Spread footings not used on Duart Road Underpass structure.

⁽⁵⁾ Resistance for HP 310x110 piles. SLS resistance is not applicable to piles driven to refusal on unyielding bedrock. Drag down forces not considered.

Subject to structural analyses, existing structure foundations may be reused for new structures constructed on the same alignment (such as, the centre pier foundations). The installation of new steel H-piles will be required for construction of new integral or semi-integral bridge abutments in addition to the other design items specific to these abutment types. Where new embankments on embankment widenings are designed, the detail design should allow for potential drag down forces due to settlement of the native soil.

Where culvert extensions are required, it is envisaged that the extensions may be founded on the native typically compact sandy soils that are inferred to exist at the founding subgrade level of the existing culverts. The extensions may be founded on the native soils and designed for preliminary geotechnical resistances of 300 kPa at ULS and 150 kPa at SLS.



6.1.2 Embankment Stability

For the widening alternative comprising the addition of traffic lanes on the inside of the highway, the placement of fill on the existing median is not envisaged to cause slope instability problems.

The alternative of widening the highway to the outside the existing bridge structures will likely require replacement of the existing structures. Any new bridges built to the west or east of the existing alignments will require the construction of new approach embankments comprising about 6 to 7 m high fills at the abutments or widening of the existing embankments. It is envisaged that these embankments, if required, would comprise of earth fill. The embankment subgrade typically comprises of a layer of compact sand overlying very stiff to hard silty clay till. The soils are typically wet containing a relatively high perched groundwater condition.

No signs of distress such as erosion, sloughing or sliding were noted on the existing bridge approach embankments. Based on the condition of the existing earth embankments, it is considered that the earth slopes will be stable at the standard earth slope configurations of 2H:1V. If rockfill is used, the stable slope configuration would be 1.25H:1V.

It is considered that the existing native soils are capable of withstanding the additional loading of the new earth embankments or embankment widening, if required. Furthermore, the sandy soil units are considered to have relatively high permeability characteristics and are typically not considered susceptible to short term stability problems due to potential high pore water pressures induced by loading from the new fill. This facet of the construction should, however be checked further during detail design.

The widening of the embankments is not expected to cause stability problems at the location of the culvert extensions in view of the relatively low additional fills (estimated 2 to 3 m high) that would be required. The faces of the inlet and outlet channels should be cut at 3H:1V slopes to minimize erosion or sloughing of the existing sandy subgrade at the ditch line.



6.1.3 Embankment Settlement

The estimated settlements of new embankments constructed separately from the existing fills are expected to be significant, in the order of 50 mm at the location of the highest fill (behind the abutments). Most of the settlements will be contributed by the compact sand units since the underlying very stiff to hard clay/silty clay till is heavily preconsolidated. The settlements are expected to occur during construction.

Where the embankments are widened the estimated magnitude of settlements is about half those indicated for separate embankments.

The requirement for management control of the settlements should be considered during detail design. Construction of new embankments in advance of installation of new piles would minimize post-construction effects such as potential drag down forces on piles for new or widened foundations.

Settlements of the compact sand and very stiff to hard subgrade soils at the culvert extension sites under the anticipated 2 to 3 m high new embankment platform widenings are considered to be negligible and be completed during construction. Cambers are not considered a requirement to be incorporated during construction of these culverts.

6.1.4 Construction Considerations

The construction of the alternative to widen to the inside is considered to be straightforward from a foundation point of view since new bridges would not be required.

It is envisaged that the new structures that would be required for the alternative comprising of the widening to the outside would be three-span structures. Where the access to the existing structures is temporarily closed during construction of the new structures, the installation of the new pier and abutment foundations is expected to be straightforward at all three bridge structures. The construction of new structures on the same alignment while maintaining through traffic on the



existing structures will require shoring of the approach embankment fills (on longitudinal directions). This may be required for interchanges such as Orford Road.

Excavations for the installation of new centre pier foundations or footing foundations for abutments on native soils will require control of the perched groundwater within the sandy soils encountered near the ground surface. Road protection as outlined in the SP 105S19 will likely be needed for the excavations required for new centre pier and abutment foundations located within the wet sand deposit. The performance level of the protection systems should be determined during detail design.

In addition, the widening or realignment of the north approach embankment at the Kenesserie Road bridge structure will likely require the extension of the existing concrete culvert that crosses Kenesserie Road north of the underpass.

The existing foundations maybe widened to accommodate new or wider structures (if structurally feasible). Where these existing foundations bear on driven pipe piles, new piles should be installed to the bedrock surface to prevent differential settlements. It is recommended that the need for pre-augering of the soil cover prior to the installation of new driven pipe piles be assessed at the detail design stage on a site specific basis. The depth of the pre-augering should be determined during detail design and consider that the existing low capacity pipe piles are installed at about 8 to 10 m depths (elevations 201 to 212) and the underlying bedrock surface is at 41 to 66 m depths (elevations 153 to 162), that is about 45 to 50 m deeper than the existing pile tips. Pre-augering will avoid/minimize lateral forces and drag-down loads on the existing piles due to displacement of soil surrounding the existing piles. These effects maybe mitigated by using steel H-piles instead of pipe piles for the foundation widening. For widening of the existing foundations with deep foundations, the existing structure should be monitored during pile driving to bedrock.



6.1.5 Advantages and Disadvantages of Alternate Configurations

In view of the foregoing considerations the following table summarizes the advantages and disadvantages and inferred risks/consequences of each of the alternate configurations from a foundation perspective. This preliminary analysis is based on the currently planned widening of Highway 401 from four to six lanes. Other facets of the project that may need to be considered, such as future widening to eight lanes and the condition of existing underpass structures are to be addressed by others.

ADVANTAGES AND DISADVANTAGES – BRIDGE STRUCTURES

Structure Name	Widening to Inside		Widening to Outside (*)			
	Advantages	Disadvantages	New Structure on Existing Alignment		New Structure on New Alignment	
			Advantages	Disadvantages	Advantages	Disadvantages
Kenesserie Road Underpass	Use of existing structure and approach embankment. Least costly and little disruption to traffic.	None	Use of existing embankment. Reuse of existing foundations	New structure required. Shoring existing embankment or closing traffic on bridge	None	New structure and approach embankments required. Culvert north of structure needs extensions.
Orford Road Underpass	Use of existing structure and approach embankment. Least costly and little disruption to traffic.	None	Use of existing embankment. Reuse of existing foundations	New structure required. Shoring existing embankment or closing traffic on bridge	None	New structure and approach embankments required.
Duart Road Underpass	Use of existing structure and approach embankment. Least costly and little disruption to traffic.	None	Use of existing embankment. Reuse of existing foundations	New structure required. Shoring existing embankment or closing traffic on bridge	None	New structure and approach embankments required.

Notes: (*) Assumes widening to the outside will require a new bridge structure or modifications to the existing structure, including removal of the approach embankment foreslope and construction of permanent vertical retaining walls.



ADVANTAGES AND DISADVANTAGES –CULVERTS

Structure Name	Widening to Inside		Widening to Outside	
	Advantages	Disadvantages	Advantages	Disadvantages
Culvert Site 13-418	Culvert extensions not required	None	None	Culvert extensions required
Culvert Site 13-419	Culvert extensions not required	None	None	Culvert extensions required
Culvert Site 13-420	Culvert extensions not required	None	None	Culvert extensions required
Culvert Site 13-421	Culvert extensions not required	None	None	Culvert extensions required
Culvert Site 13-422	Culvert extensions not required	None	None	Culvert extensions required

Note: Use of centre section of culvert is subject to structural verification.

Since widening to the inside will not require extensions of the culverts this option will be considered less costly than the widening to outside alternative. Roadway protection maybe required for either alternative.

Since the Orford section of the Highway 401 does not contain EB/WB overpasses or Drain Bridges, widening to the inside for this section of the Highway 401 will involve the least risk since shoring of the approach embankments, construction of new embankments and bridges or widening of existing embankment will not be required or will be minimized when compared with the widening to the outside option.

6.2 Preferred Alternative Considerations

From the foundation point of view the Preferred Alternative to widen Highway 401 from four to six lanes of traffic is to widen to the inside (previously designated Alternative 1: adding traffic on the inside of the existing lanes). The selected alternative depended on additional considerations such as the future addition of traffic lanes that were addressed by others.

The preferred option plans provided by MRC are appended to this report as Drawings P5-1 to P5-3.



The preferred option to widen the highway to the inside would not require changes to the existing underpasses.

For the Preferred Alternative, two new ramps, S-E and N-W, are to be introduced to the Orford Road interchange in addition to realigning the existing entrance/exit ramps to improve the interchange ramps.

It is considered that the design and construction of the proposed preferred alternative for the widening of the Highway 401 to the inside is feasible.

6.3 Foundation Investigation Areas For Detail Design

The Preferred Alternative of widening Highway 401 from four to six lanes by adding traffic lanes to the inside would not require foundation investigations at the bridge and culvert structures through the Geographical Township of Orford, unless the bridge structures require widening or replacement due to other considerations.

The foundation investigations for new bridges and culvert structures that would be required for detailed design of the Highway 401 widening preferred option are listed on the following tables.

FOUNDATION INVESTIGATION AREAS – BRIDGE STRUCTURES

Stations (*)	Proposed Works	Existing Data (**)
21+140 (Howard Township)	Kenesserie Road Underpass, widening or replacement	4 boreholes to depths of 7.4 to 29.7 m
13+824.5	Orford Road Underpass, widening or replacement	3 boreholes to depths of 10.7 to 20.4 m
17+888.6	Duart Road Underpass, widening or replacement	5 boreholes to depths of 9.4 to 13.1 m

Notes: (*) Stations are approximate.

(**) Relevant data from previous foundation investigation reports. Refer to Table 5-1 for list of reference documents.



FOUNDATION INVESTIGATION AREAS –CULVERTS

Stations (*)	Proposed Works	Existing Data
21+359.7 (Howard Township)	Culvert Site 13-418 extensions	Data not available
10+816	Culvert Site 13-419 extensions	Data not available
12+180.75	Culvert Site 13-420 extensions	Data not available
12+819.25	Culvert Site 13-421 extensions	Data not available
19+080.25	Culvert Site 13-422 extensions	Data not available

Notes: (*) Stations refer to Orford Township unless otherwise noted. Stations are approximate.



7. CLOSURE

This report was prepared by Mr. C. M. P. Nascimento, P. Eng. Senior Project Engineer and reviewed by Mr. B. R. Gray, M. Eng., P. Eng., MTO Designated Contact.

Yours very truly

Peto MacCallum Ltd.



Carlos M.P. Nascimento, P.Eng.
Senior Project Engineer



Brian R. Gray, MEng, P.Eng.
MTO Designated Contact

CN-cn:mi/lmr



TABLE 5-1
LIST OF REFERENCE DOCUMENTS
(TOWNSHIP OF ORFORD)

A. Geological Maps

- Geological Map of the Province of Ontario, Map No. 1958B Ontario, Department of Mines, Compiled 1958. Scale 1:1,267,200.
- Quaternary Geology of Ontario, Southern Sheet, Map 2556 from Ontario Ministry of Northern Development and Mines, Compiled 1991. Scale 1:1,000,000.
- Drift - Thickness Contours, Kent County, Preliminary Map 52-4A, Prepared by J.F. Caley and B.V. Sanford, 1951, Published 1952 by Department of Mines and Technical Surveys of the Geological Survey of Canada.
- Bedrock Contours, Kent County, Preliminary Map 52-4B, Prepared by J.F. Caley and B.V. Sanford, 1951, Published 1952 by Department of Mines and Technical Surveys of the Geological Survey of Canada.
- Ontario Geological Map, Map No. 2196 from Ontario Department of Mines and Northern Affairs, Compiled 1970. Scale 1:1,013,760 (1 inch = 16 miles).

B. Physiographic Maps

- Soil Map of the County of Kent, Soil Survey Report No. 3, Published by the Experimental Farms Branch, Ottawa, 1936, Scale 1/2 inch = 1 mile.
- Physiography of Southern Ontario Map P.2715 Ontario Geological Survey, 1984. Scale 1:600,000.
- Physiography of the Southwestern Portion of Southern Ontario, Map 2225 Ontario Department of Mines and Northern Affairs, Ontario Research Foundation, Published 1972, Scale 1:253,440 (1 inch = 4 miles).

C. MTO Reports and Drawings

- (1) Contract Drawings for Contract No. 80-03 for Highway 401, from 0.6 km west of interchange No. 12 (Kent Bridge Road) easterly to 1.1 km west of interchange No. 14 (Kenesserie Road), August 1979.
- (2) Construction Drawings for Highway 401 Underpass at Co. Road 16 (Kenesserie Road) site 13-267, File No. 60 F 289, WP 89-59 (TWP No. 111-267) dated December 1960



- (3) Foundation Investigation Report for Highway 401 Underpass at Co. Road 16 (Kenesserie Road) Site 13-267, File No. 60 F 289, WP 89-59, Geocres 40I5-5 prepared by William A. Trow and Associates Ltd., dated March 25, 1960.
- (4) Construction Drawing for Highgate Sideroad (Orford Road) Interchange Structure, Site 13-263, File No. 60 F 250C, WP 91-59.
- (5) Foundation Investigation Report for Highgate Sideroad Interchange (Orford Road) Structure, Site 13-263, File No. 60 F 250C, WP 91-59. Geocres 40I12-012 prepared by Universal Geotechnique Limited Report No. 428/60, undated.
- (6) Hot mix paving of Highway 401 from 1.8 km West of County Road 20 (Orford Road) easterly to 2.5 km east of County Road 3 (Furnival Road). WP No. 601-93-00 and 601-93-01, Contract No. 97-44, dated April 18, 1997 prepared by Dillon Consulting.
- (7) Soil data from resurfacing of Highway 401 from 1.0 km west of interchange #14 (Orford Road) easterly to 2.5 km east of intersection #15 (Furnival Road), WP No. 54-77-01, Contract No. 80-53, dated July 18, 1979.
- (8) Construction Drawings for Muirk Underpass Structure (Duart Road), Site No. 13-264, File No. 60 F 249C, WP 92-59.
- (9) Foundation Investigation Report for Muirk Underpass Structure (Duart Road), Site No. 13-264, File No. 60 F 249C, WP 92-59. Geocres 40I12-011 prepared by Universal Geotechnique Limited, Report No. T 429/60, undated.

D. Ground Water Data

- Water Well Records for Ontario (Kent-Lambton) 1946-1974, Ministry of the Environment, Water Resources Bulletin 2-20 Ground Water Series Published 1977.
- Ground Water Probability, County of Kent, Water Resources Map 3117-1, Ontario Resources Commission 1970. Scale 1:100,000.
- Southern Ontario Drainage Basins, Map 3002-2, Ministry of the Environment, Water Quantity Management Branch, 1973, Scale 1:500,000.
- Essex-Chatham-Kent Groundwater Management Study, Ministry of Environment, http://www.ene.gov.on.ca/envision/water/groundwater/essex_chatham_kent/index.htm. Last modified on October 21, 2008.

E. Other Sources

- Air Photo Mapping of existing conditions provided by MTO – digital files.
- Chatham – Kent Base Mapping and Mosaic provided by MTO and MRC – digital files.
- Topographic Map of Ontario, Chatham Sheet, Geographic Section of Department of National Defense 1913, Reprinted 1940. Scale: 1 inch = 1 mile.

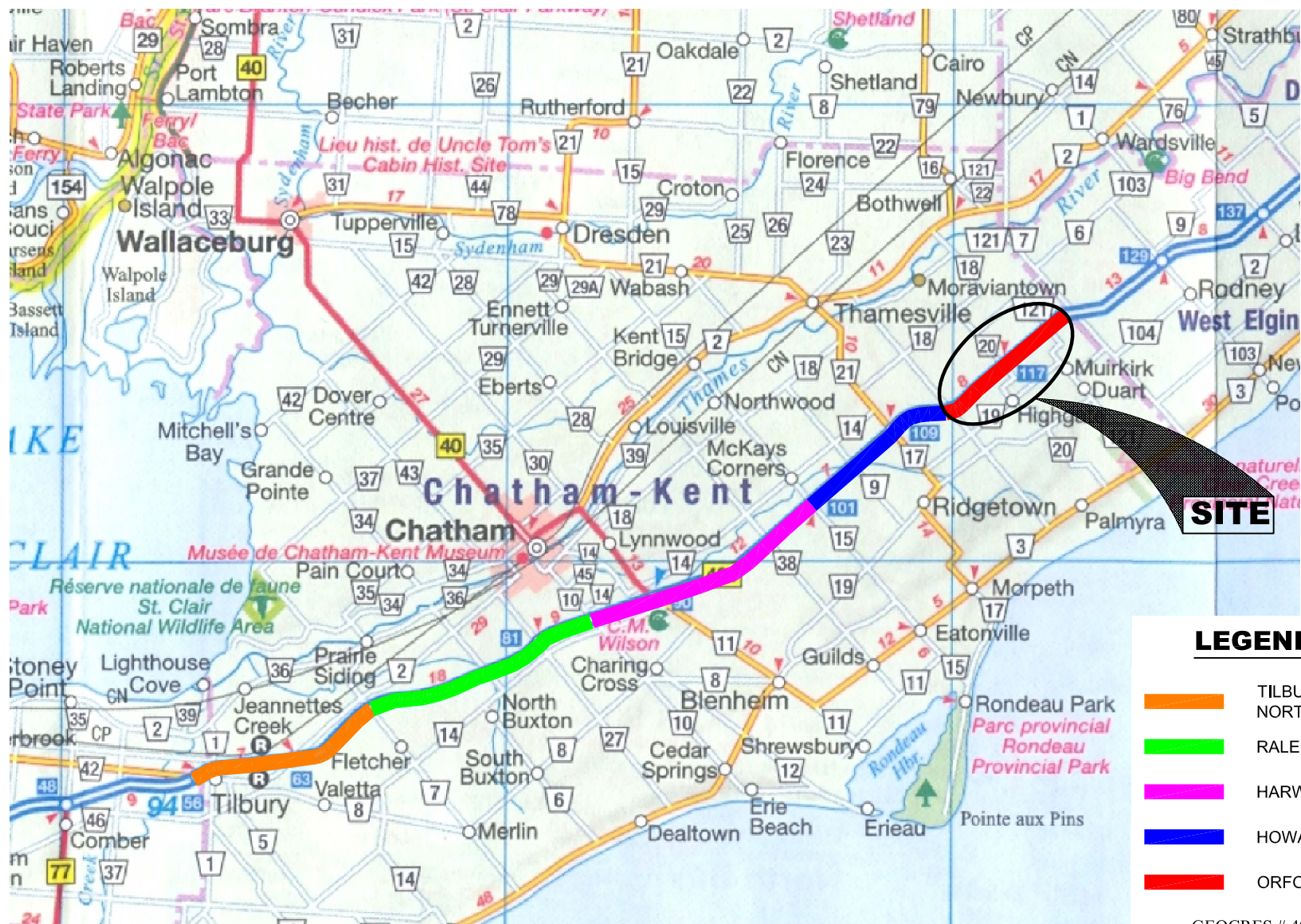


TABLE 5-2
WATER WELL RECORDS SUMMARY
(ORFORD TOWNSHIP)

CONCESSION NO.	LOT NO.	GROUND ELEV. (m)	DATE DRILLED	STATIC WATER		STRATIGRAPHY DESCRIPTION (*)	BEDROCK	
				DEPTH (m)	ELEV. (m)		DEPTH (m)	ELEV. (m)
7	1	204.2	02/48	12.5	191.7	Sand 3.7; clay 35.4; gravel 40.5	> 40.5	< 163.7
7	3	205.7	03/48	14.3	191.4	Sand 4.0; clay 29.0; fine sand 36.0; clay/gravel/sand 42.0; gravel 43.0; slate 43.6	43.0	162.7
7	7	213.4	05/63	19.8	193.6	Sand 3.7; clay 34.4; gravel/sand 38.7; hard pan 43.0; gravel 43.5	> 43.5	< 169.9
7	9	213.4	02/54	21.3	192.1	Sand 0.9; clay 36.6; sand 45.7; clay/sand/stones 51.2; shale 51.8	51.2	162.2
7	11	217.9	06/59	27.4	190.5	Gravel 4.9; clay/sand/stones 36.6; sand 43.3; gravel 44.8	> 44.8	< 173.1
7	13	213.4	09/59	33.5	179.9	Gravel 4.9; clay/stones 38.4; sand 55.5; clay 62.8; gravel 64.0	> 64.0	< 149.4
8	4	204.2	01/61	12.2	192.0	Sand 22.9; silt 27.4; sand 29.0; sand/gravel 31.7; hard pan 32.0; gravel 32.3	> 32.3	< 171.9
8	8	205.7	05/51	17.7	188.0	Sand/topsoil 3.4; clay 33.8; sand/gravel 37.5	> 37.5	< 168.2
8	9	208.8	11/51	16.5	192.3	Sand 1.8; clay 25.3; sand 26.5; clay/sand layers 42.4; gravel 49.7	> 49.7	< 159.1
8	13	213.4	05/61	29.0	184.4	Sand 0.9; clay 50.9; hard pan/gravel 60.0; rock 64.6	60.0	153.4
8	20	215.5	05/61	32.0	183.5	Sand 4.9; clay 48.8; hard pan 50.3; sand 51.8; hard pan 54.9; gravel 58.2	> 58.2	< 157.3

NOTES:

- (*) Soil and Depth (m) to Bottom of Unit
- Data taken from MOE Water Well Records for Ontario (Kent-Lambton) 1946-1974, Water Resources Bulletin 2-20 Groundwater Series.



LEGEND:

- TILBURY EAST / NORTH TWP
- RALEIGH TWP
- HARWICH TWP
- HOWARD TWP
- ORFORD TWP

GEOCRES # 40112-27

REPORT # 5 - ORFORD TOWNSHIP

**FEASIBILITY FOUNDATION INVESTIGATION DESIGN REPORTS
HIGHWAY 401 WIDENING - CHATHAM - KENT
GWP 80-00-00**

KEY MAP



**MCCORMICK RANKIN
CORPORATION**

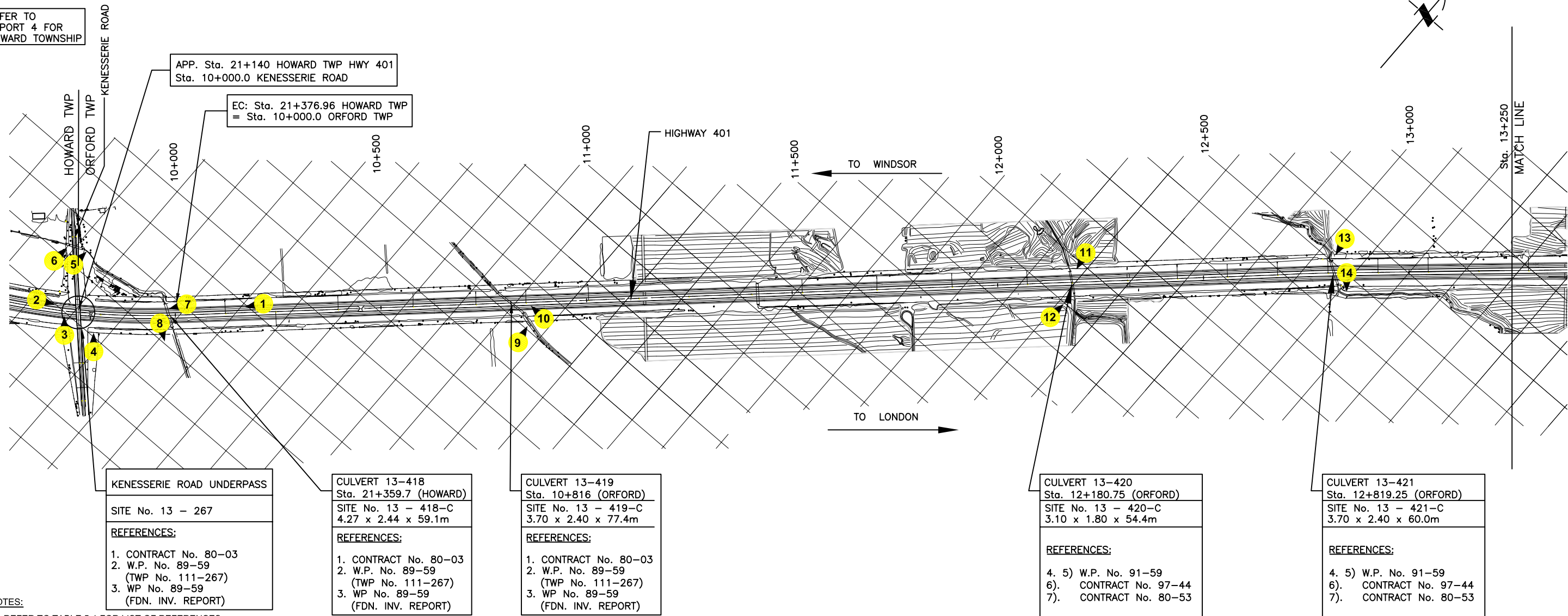


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CONSULTING ENGINEERS

DRAWN: N.A.	DATE	SCALE	JOB NO.	FIGURE NO.
CHECKED: C.N.	JAN. 2010	1 : 400,000	05TF060	5-1
APPROVED: B.R.G.				

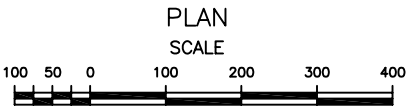
SUMMARY OF WATER WELL RECORDS						
CONCESSION 7 LOT 1	CONCESSION 7 LOT 2	CONCESSION 7 LOT 3	CONCESSION 8 LOT 4	CONCESSION 7 LOT 5	CONCESSION 7 LOT 6	CONCESSION 7 LOT 7
GROUNDWATER DEPTH 12.5m EL. 191.7 (02 / 48)	NO DATA FOUND	GROUNDWATER DEPTH 14.3m EL. 191.4 (03 / 48)	GROUNDWATER DEPTH 12.2m EL. 192.0 (01 / 61)	NO DATA FOUND	NO DATA FOUND	GROUNDWATER DEPTH 19.8m EL. 193.6 (05 / 63)
BEDROCK DEPTH >40.5m EL. <163.7	NO DATA FOUND	BEDROCK DEPTH 43.0m EL. 162.7	BEDROCK DEPTH >32.3m EL. <171.9	NO DATA FOUND	NO DATA FOUND	BEDROCK DEPTH >43.5m EL. <169.9

REFER TO
REPORT 4 FOR
HOWARD TOWNSHIP



NOTES:

- REFER TO TABLE 5-1 FOR LIST OF REFERENCES.
- REFER TO TABLE 5-2 FOR SUMMARY OF WATER WELL RECORDS.
- REFERENCE PLANS PROVIDED BY McCORMICK RANKIN CORPORATION.
- FOR SECTION BETWEEN STATIONS 13+250 AND 20+464.4 REFER TO DRAWINGS 5-2 AND 5-3.
PHOTOGRAPH LOCATIONS AND DIRECTIONS SHOWN THUS
- PREFIX '5-' WAS OMITTED FROM PHOTOGRAPH NUMBER FOR CLARITY.



GEOCRES No. 40112-27

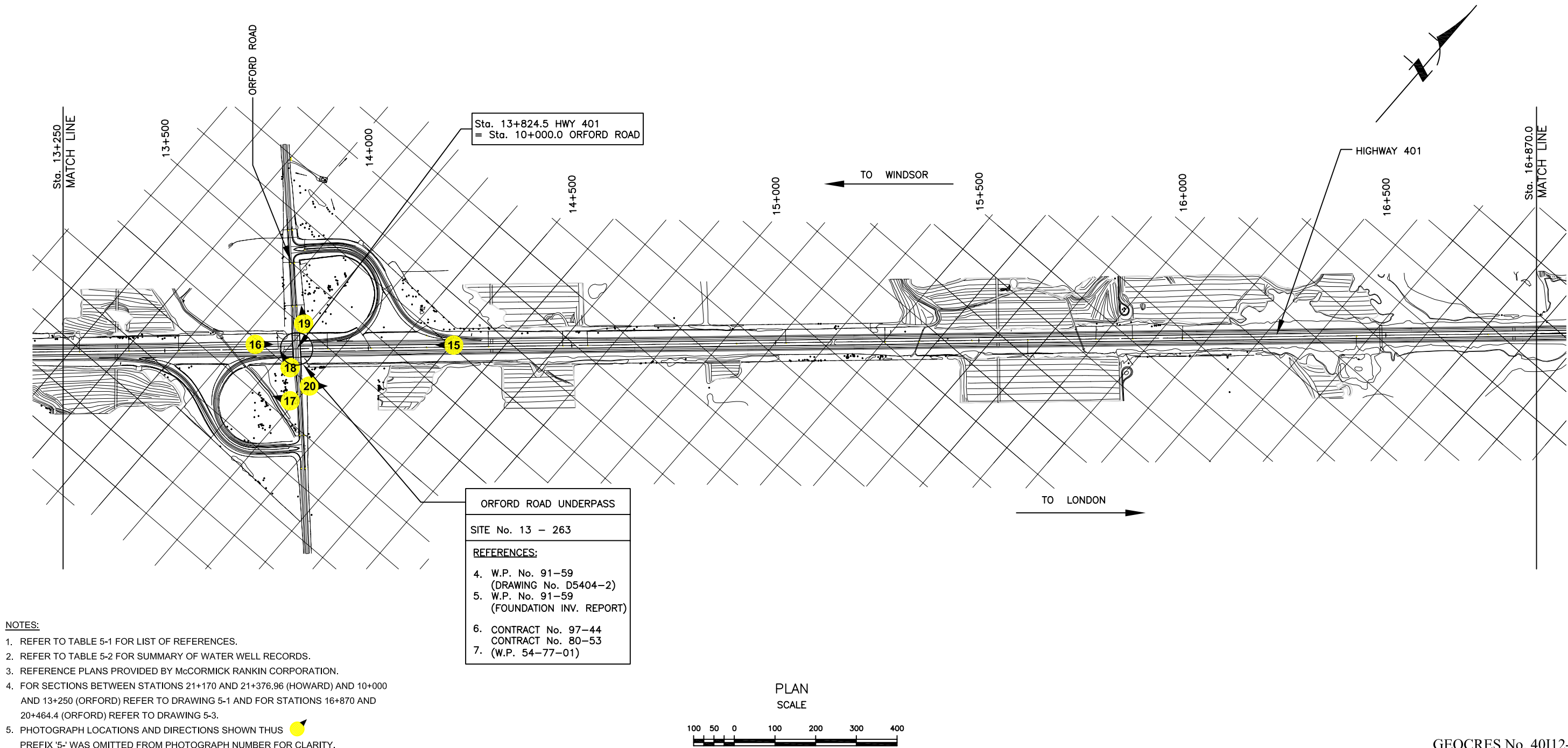
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DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES



PML Peto MacCallum Ltd. CONSULTING ENGINEERS	
DATE JANUARY 2010	DRAWN BY: N.A.
CHECKED BY: C.N.	APPROVED BY: B.R.G.

CONT No GWP No 80-00-00	
HIGHWAY 401 WIDENING THROUGH KENT COUNTY ORFORD TOWNSHIP SECTION SITE PLAN	
DRAWING 5-1	

SUMMARY OF WATER WELL RECORDS								
CONCESSION 8 LOT 8	CONCESSION 7 LOT 9	CONCESSION 8 LOT 9	CONCESSION 7 LOT 10	CONCESSION 7 LOT 11	CONCESSION 7 LOT 12	CONCESSION 7 LOT 13	CONCESSION 8 LOT 13	CONCESSION 7 LOT 14
GROUNDWATER DEPTH 17.7m EL. 188.0 (05 / 51)	GROUNDWATER DEPTH 21.3m EL. 192.1 (02 / 54)	GROUNDWATER DEPTH 16.5m EL. 192.3 (11 / 51)	NO DATA FOUND	GROUNDWATER DEPTH 27.4m EL. 190.5 (06 / 59)	NO DATA FOUND	GROUNDWATER DEPTH 33.5m EL. 179.9 (09 / 59)	GROUNDWATER DEPTH 29.0m EL. 184.4 (05 / 61)	NO DATA FOUND
BEDROCK DEPTH >37.5m EL. <168.2	BEDROCK DEPTH 51.2m EL. 162.2	BEDROCK DEPTH >49.7m EL. <159.1	NO DATA FOUND	BEDROCK DEPTH >44.8m EL. <173.1	NO DATA FOUND	BEDROCK DEPTH >64.0m EL. <149.4	BEDROCK DEPTH 60.0m EL. 153.4	NO DATA FOUND



GEOCRES No. 40112-27

METRIC

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AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES



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DATE **JANUARY 2010**

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APPROVED BY: **B.R.G.**

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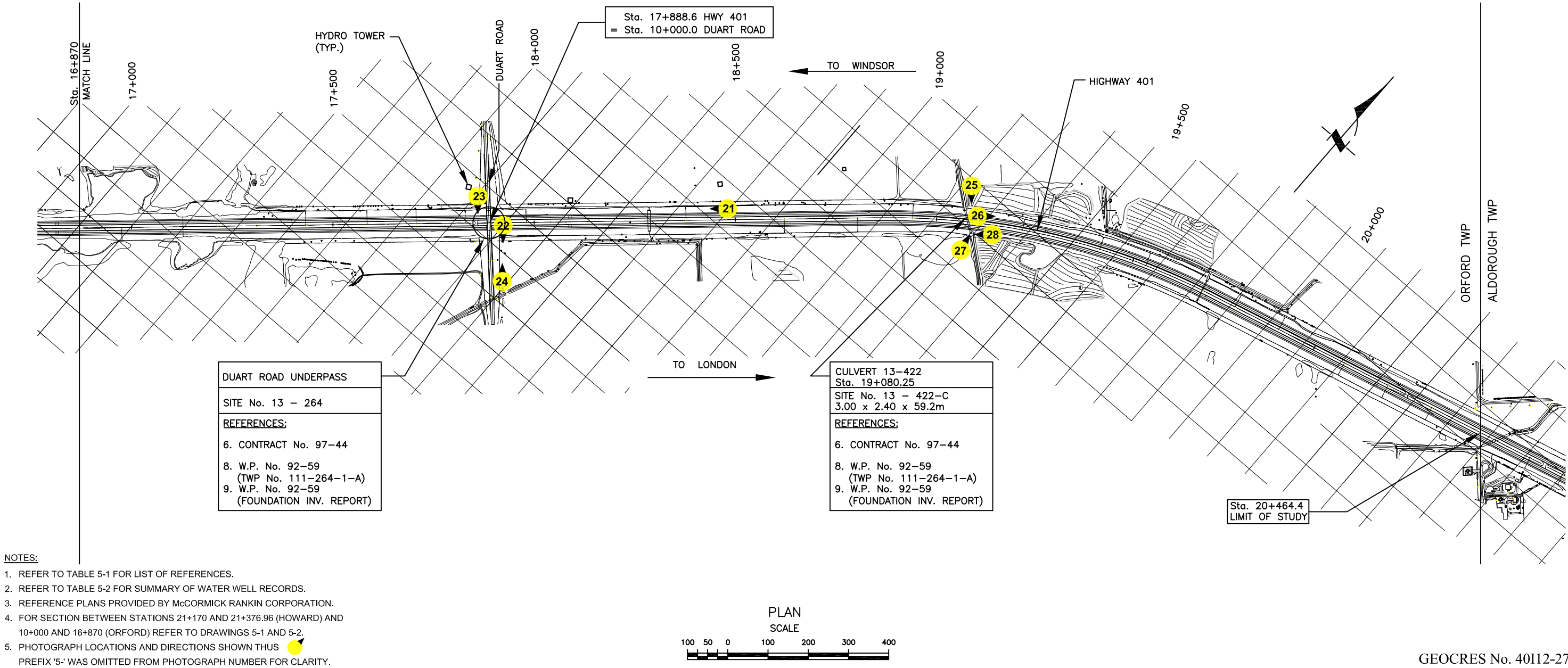
HIGHWAY 401
WIDENING THROUGH KENT COUNTY
ORFORD TOWNSHIP SECTION
SITE PLAN



DRAWING

5-2

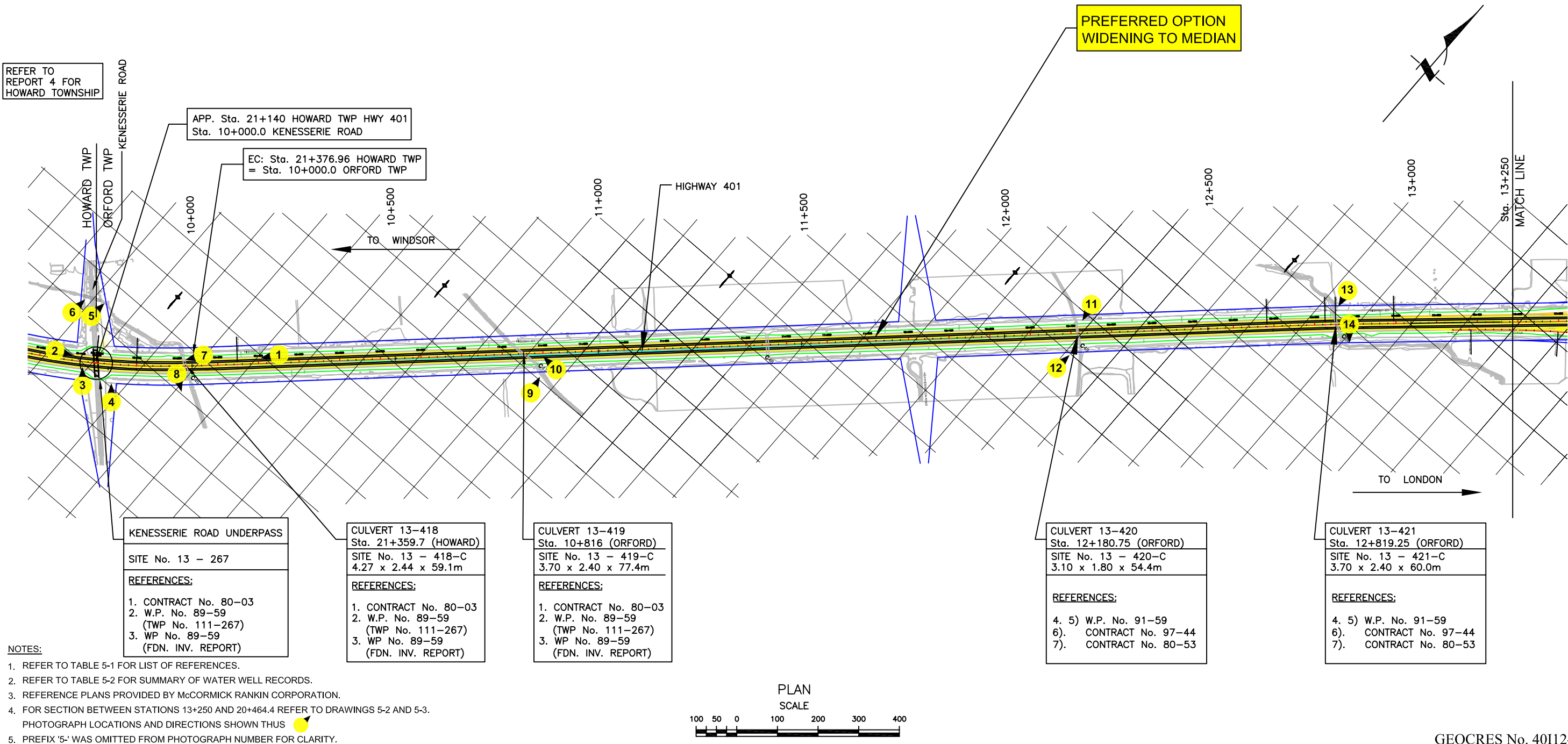
SUMMARY OF WATER WELL RECORDS						
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NO DATA FOUND	NO DATA FOUND	NO DATA FOUND	NO DATA FOUND	NO DATA FOUND	GROUNDWATER DEPTH 32.0m EL. 183.5 (05 / 61)	NO DATA FOUND
NO DATA FOUND	NO DATA FOUND	NO DATA FOUND	NO DATA FOUND	NO DATA FOUND	BEDROCK DEPTH >58.2m EL. <157.3	NO DATA FOUND



GEOCRES No. 40112-27

METRIC DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES	 Ontario  McCORMICK RANKIN CORPORATION A member of  MMM GROUP	 Peto MacCallum Ltd. CONSULTING ENGINEERS	CONT No GWP No 80-00-00 HIGHWAY 401 WIDENING THROUGH KENT COUNTY ORFORD TOWNSHIP SECTION SITE PLAN	 DRAWING 5-3
		DATE JANUARY 2010 CHECKED BY: C.N.	DRAWN BY: N.A. APPROVED BY: B.R.G.	

SUMMARY OF WATER WELL RECORDS						
CONCESSION 7 LOT 1	CONCESSION 7 LOT 2	CONCESSION 7 LOT 3	CONCESSION 8 LOT 4	CONCESSION 7 LOT 5	CONCESSION 7 LOT 6	CONCESSION 7 LOT 7
GROUNDWATER DEPTH 12.5m EL. 191.7 (02 / 48)	NO DATA FOUND	GROUNDWATER DEPTH 14.3m EL. 191.4 (03 / 48)	GROUNDWATER DEPTH 12.2m EL. 192.0 (01 / 61)	NO DATA FOUND	NO DATA FOUND	GROUNDWATER DEPTH 19.8m EL. 193.6 (05 / 63)
BEDROCK DEPTH >40.5m EL. <163.7	NO DATA FOUND	BEDROCK DEPTH 43.0m EL. 162.7	BEDROCK DEPTH >32.3m EL. <171.9	NO DATA FOUND	NO DATA FOUND	BEDROCK DEPTH >43.5m EL. <169.9



GEOCRES No. 40112-27

METRIC

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

PREFERRED OPTION



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DATE **JANUARY 2010**

CHECKED BY: **C.N.**

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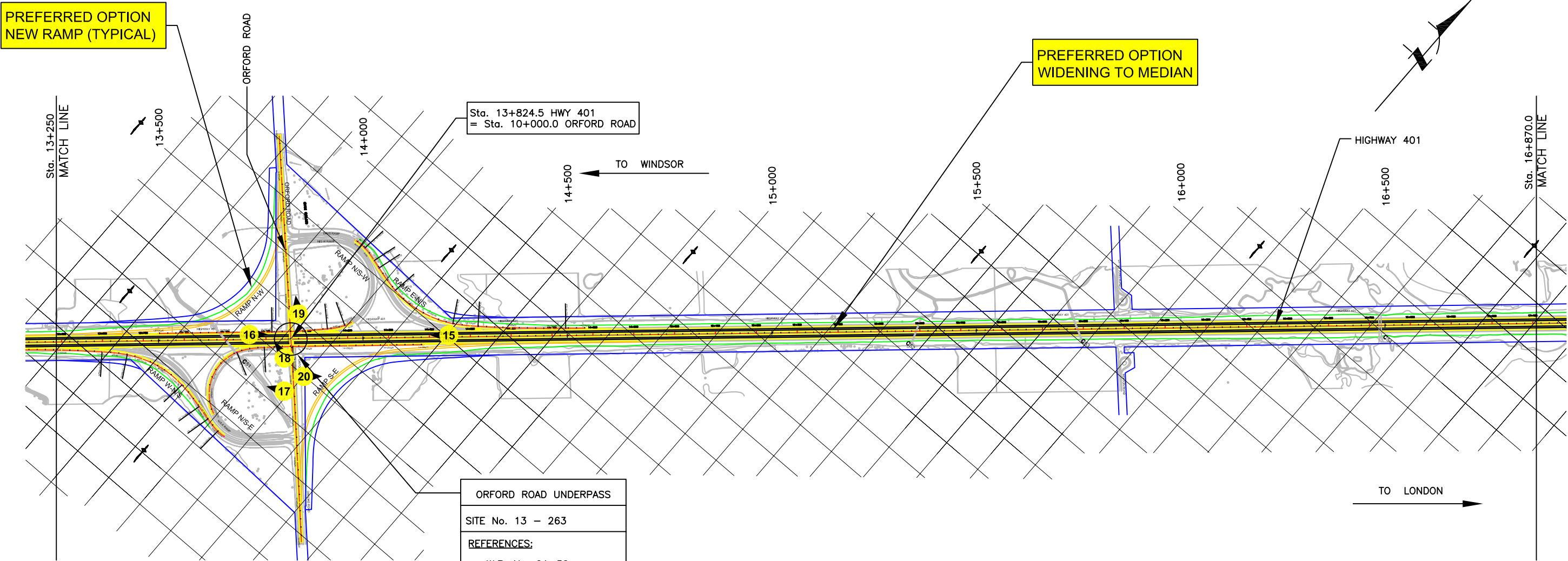
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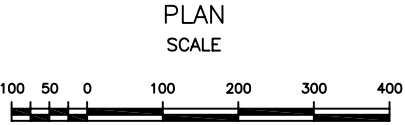
HIGHWAY 401
WIDENING THROUGH KENT COUNTY
ORFORD TOWNSHIP SECTION
SITE PLAN

DRAWING
P5-1

SUMMARY OF WATER WELL RECORDS								
CONCESSION 8 LOT 8	CONCESSION 7 LOT 9	CONCESSION 8 LOT 9	CONCESSION 7 LOT 10	CONCESSION 7 LOT 11	CONCESSION 7 LOT 12	CONCESSION 7 LOT 13	CONCESSION 8 LOT 13	CONCESSION 7 LOT 14
GROUNDWATER DEPTH 17.7m EL. 188.0 (05 / 51)	GROUNDWATER DEPTH 21.3m EL. 192.1 (02 / 54)	GROUNDWATER DEPTH 16.5m EL. 192.3 (11 / 51)	NO DATA FOUND	GROUNDWATER DEPTH 27.4m EL. 190.5 (06 / 59)	NO DATA FOUND	GROUNDWATER DEPTH 33.5m EL. 179.9 (09 / 59)	GROUNDWATER DEPTH 29.0m EL. 184.4 (05 / 61)	NO DATA FOUND
BEDROCK DEPTH >37.5m EL. <168.2	BEDROCK DEPTH 51.2m EL. 162.2	BEDROCK DEPTH >49.7m EL. <159.1	NO DATA FOUND	BEDROCK DEPTH >44.8m EL. <173.1	NO DATA FOUND	BEDROCK DEPTH >64.0m EL. <149.4	BEDROCK DEPTH 60.0m EL. 153.4	NO DATA FOUND



- NOTES:
- 1. REFER TO TABLE 5-1 FOR LIST OF REFERENCES.
 - 2. REFER TO TABLE 5-2 FOR SUMMARY OF WATER WELL RECORDS.
 - 3. REFERENCE PLANS PROVIDED BY McCORMICK RANKIN CORPORATION.
 - 4. FOR SECTIONS BETWEEN STATIONS 21+170 AND 21+376.96 (HOWARD) AND 10+000 AND 13+250 (ORFORD) REFER TO DRAWING 5-1 AND FOR STATIONS 16+870 AND 20+464.4 (ORFORD) REFER TO DRAWING 5-3.
 - 5. PHOTOGRAPH LOCATIONS AND DIRECTIONS SHOWN THUS  PREFIX '5-' WAS OMITTED FROM PHOTOGRAPH NUMBER FOR CLARITY.



METRIC

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

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CHECKED BY:	C.N.	APPROVED BY:	B.R.G.

CONT No	GWP No 80-00-00
HIGHWAY 401 WIDENING THROUGH KENT COUNTY ORFORD TOWNSHIP SECTION SITE PLAN	

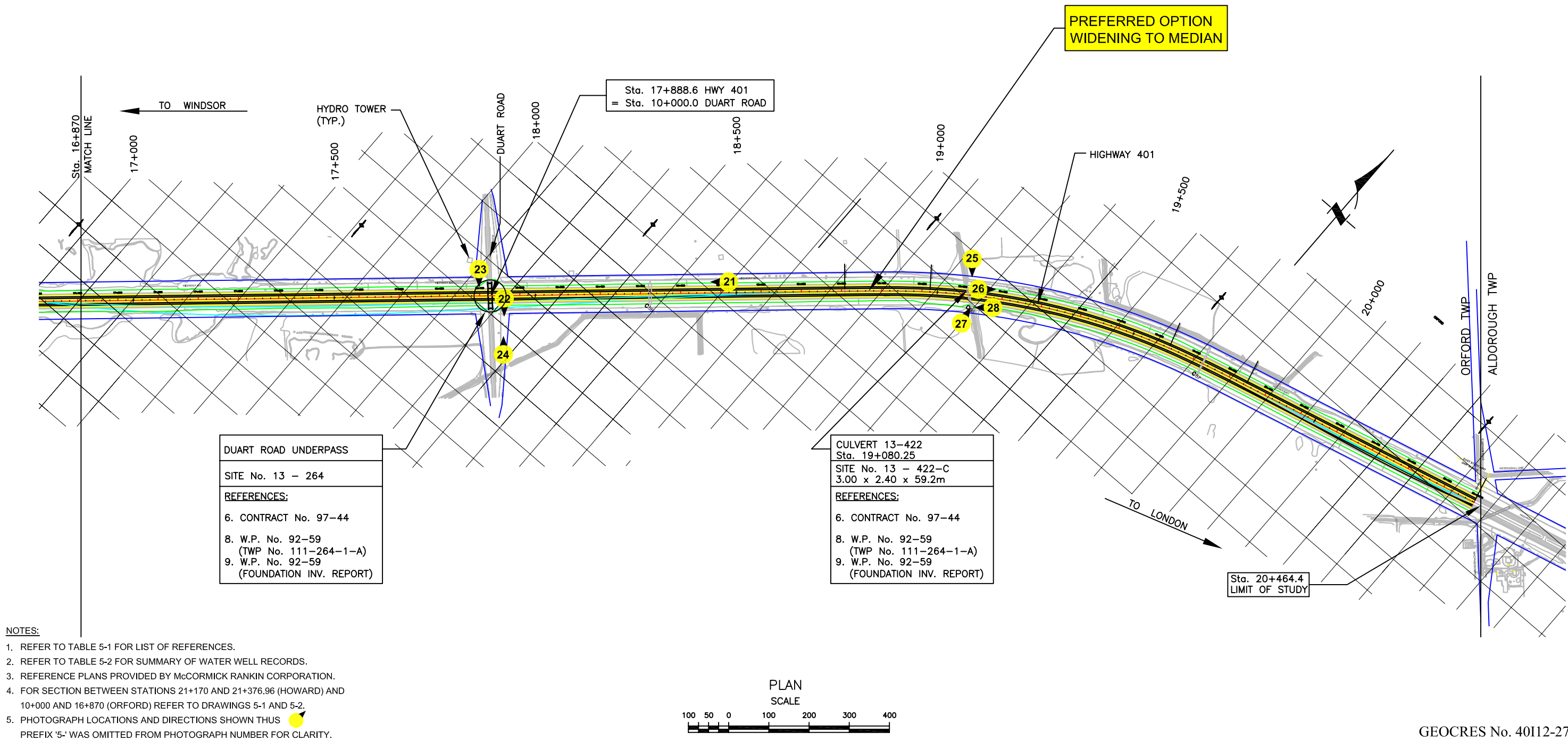


DRAWING

P5-2

GEOCRES No. 40112-27

SUMMARY OF WATER WELL RECORDS						
CONCESSION 7 LOT 15	CONCESSION 7 LOT 16	CONCESSION 7 LOT 17	CONCESSION 7 LOT 18	CONCESSION 8 LOT 19	CONCESSION 8 LOT 20	CONCESSION 7 LOT 21
NO DATA FOUND	NO DATA FOUND	NO DATA FOUND	NO DATA FOUND	NO DATA FOUND	GROUNDWATER DEPTH 32.0m EL. 183.5 (05 / 61)	NO DATA FOUND
NO DATA FOUND	NO DATA FOUND	NO DATA FOUND	NO DATA FOUND	NO DATA FOUND	BEDROCK DEPTH >58.2m EL. <157.3	NO DATA FOUND



GEOCRES No. 40112-27

METRIC

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AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
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CONSULTING ENGINEERS

DATE **JANUARY 2010**

CHECKED BY: **C.N.**

DRAWN BY: **N.A.**

APPROVED BY: **B.R.G.**

CONT No

GWP No 80-00-00

HIGHWAY 401
WIDENING THROUGH KENT COUNTY
ORFORD TOWNSHIP SECTION
SITE PLAN



DRAWING

P5-3



APPENDIX A

Site Photographs 5-1 to 5-28

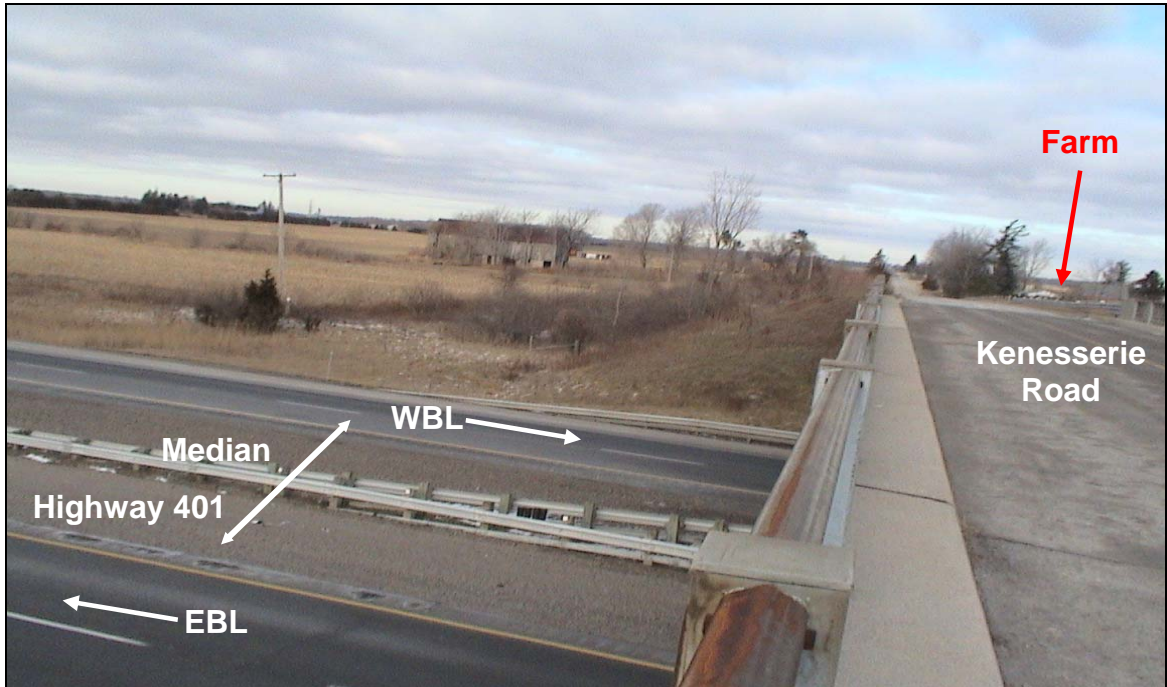
Photographs 5-1 to 5-6	–	Kenesserie Road Underpass
Photographs 5-7, 5-8	–	Culvert Site 13-418
Photographs 5-9, 5-10	–	Culvert Site 13-419
Photographs 5-11, 5-12	–	Culvert Site 13-420
Photographs 5-13, 5-14	–	Culvert Site 13-421
Photographs 5-15 to 5-20	–	Orford Road I/C
Photographs 5-21 to 5-24	–	Duart Road Underpass
Photographs 5-25 to 5-28	–	Culvert Site 13-422



PHOTOGRAPH 5-1: Kenesserie Road Underpass. Looking west from north shoulder of Highway 401. Note both approach embankments built on fill over nearly flat terrain. (January 27, 2006)



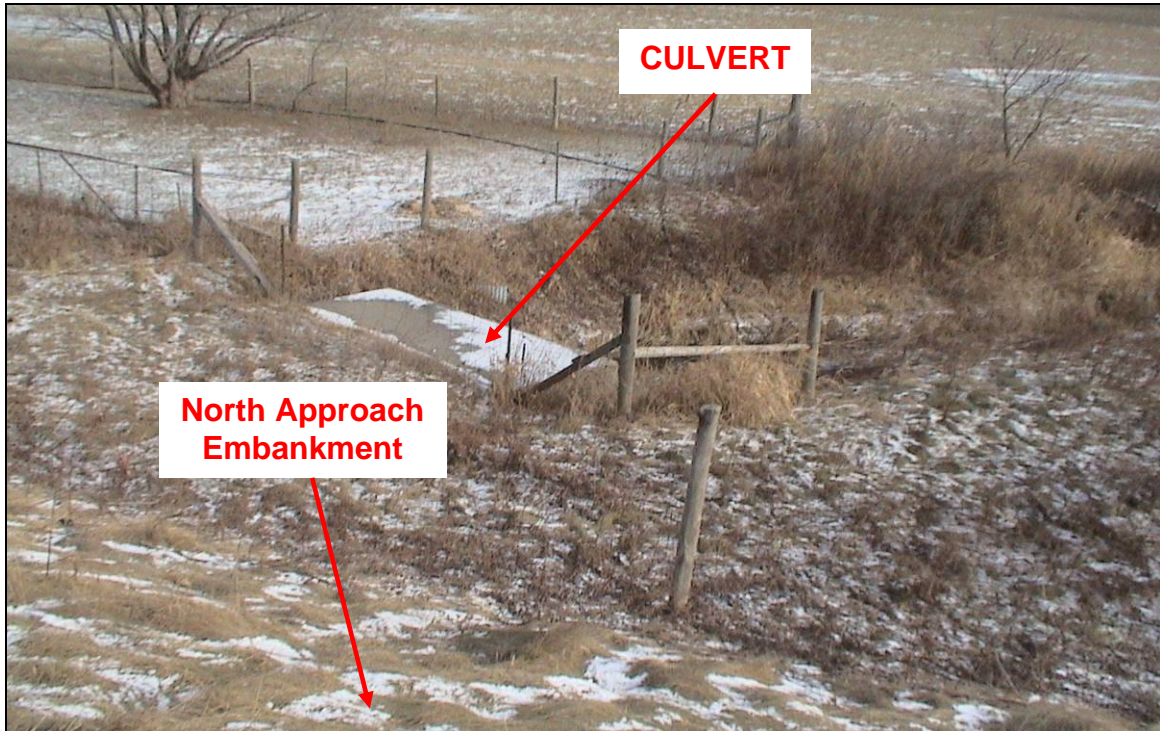
PHOTOGRAPH 5-2: Kenesserie Road Underpass. Looking east across bridge structure span from north abutment to north pier. (January 27, 2006)



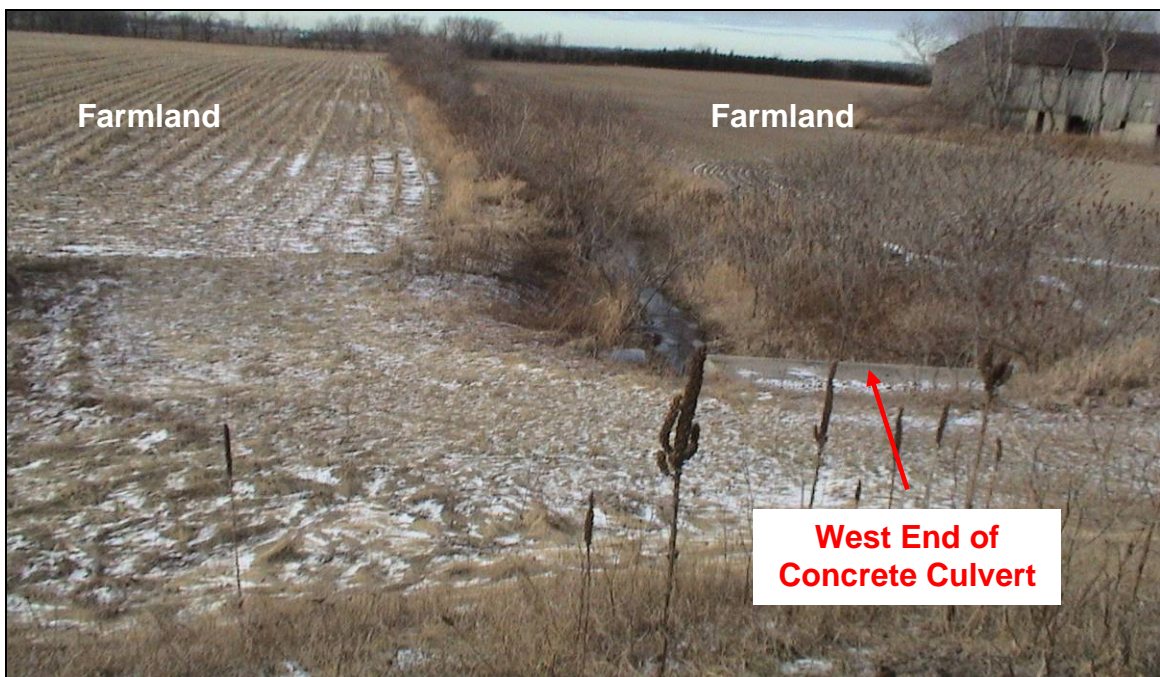
PHOTOGRAPH 5-3: Kenesserie Road Underpass. Looking north from west corner of bridge deck. Note wide median. Note gently rolling terrain and farmland beyond bridge. (January 26, 2006)



PHOTOGRAPH 5-4: Kenesserie Road Underpass. Looking north from top of north approach embankment, east side. Note farm buildings and gently rolling terrain. End of culvert crossing road is visible at toe of slope. (January 26, 2006)



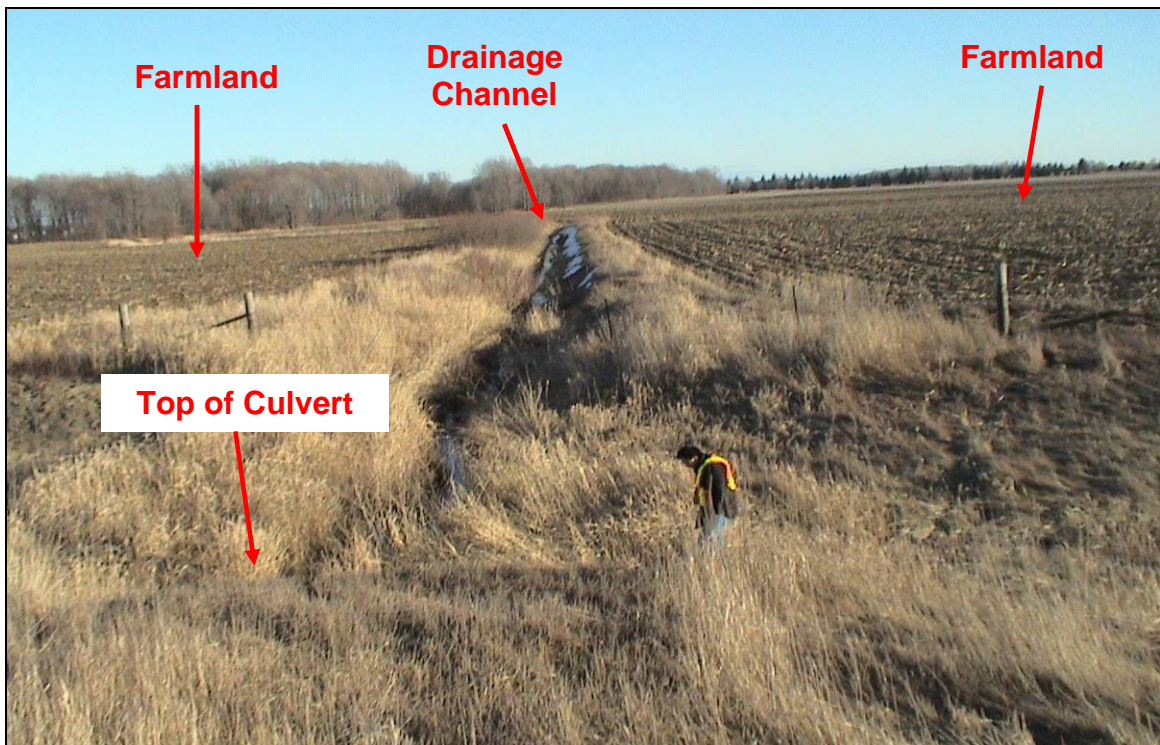
PHOTOGRAPH 5-5: Kenesserie Road Underpass. View of east end of culvert across the north approach embankment of the existing structure. (January 26, 2006)



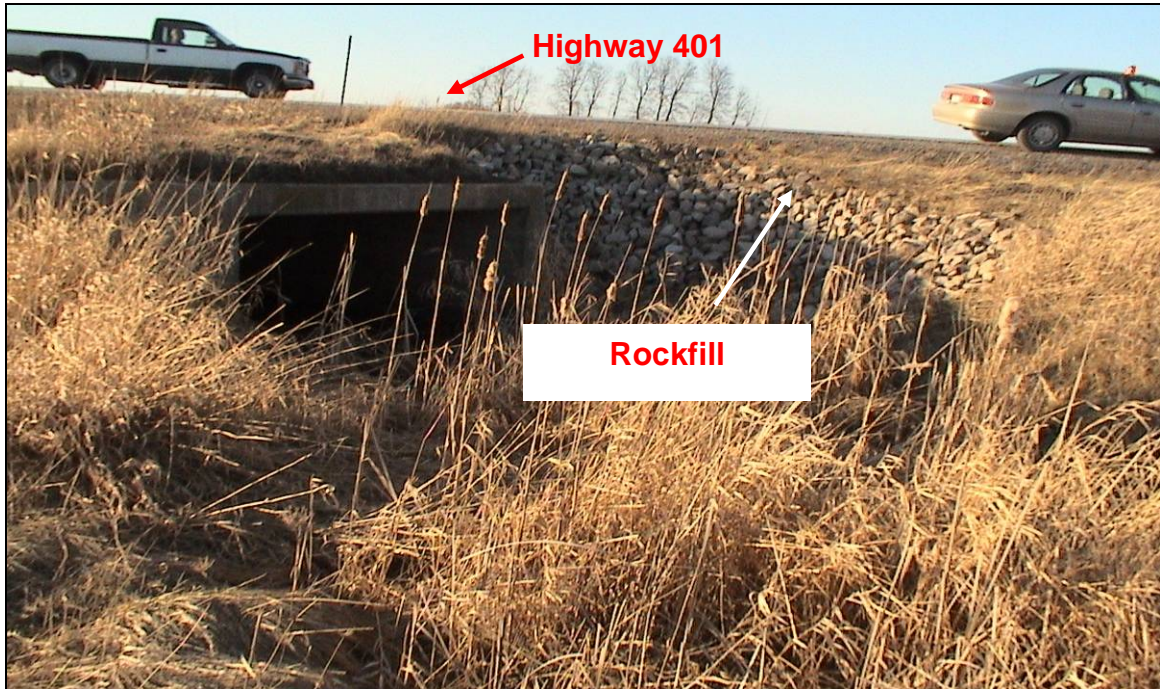
PHOTOGRAPH 5-6: Kenesserie Road Underpass. Looking west from north approach embankment at west end of concrete culvert. (January 26, 2006)



PHOTOGRAPH 5-7: Culvert Site 13-418. Looking west across top of north end of culvert and wing walls. Kenesserie Road Underpass in the distance. Note flat roadside ditch beyond channel. Note displacement of wing walls. (January 27, 2006)



PHOTOGRAPH 5-8: Culvert Site 13-418. Looking south across south end of concrete culvert. Note gently rolling terrain and agricultural land use beyond culvert and grass covered channel. (January 26, 2006)



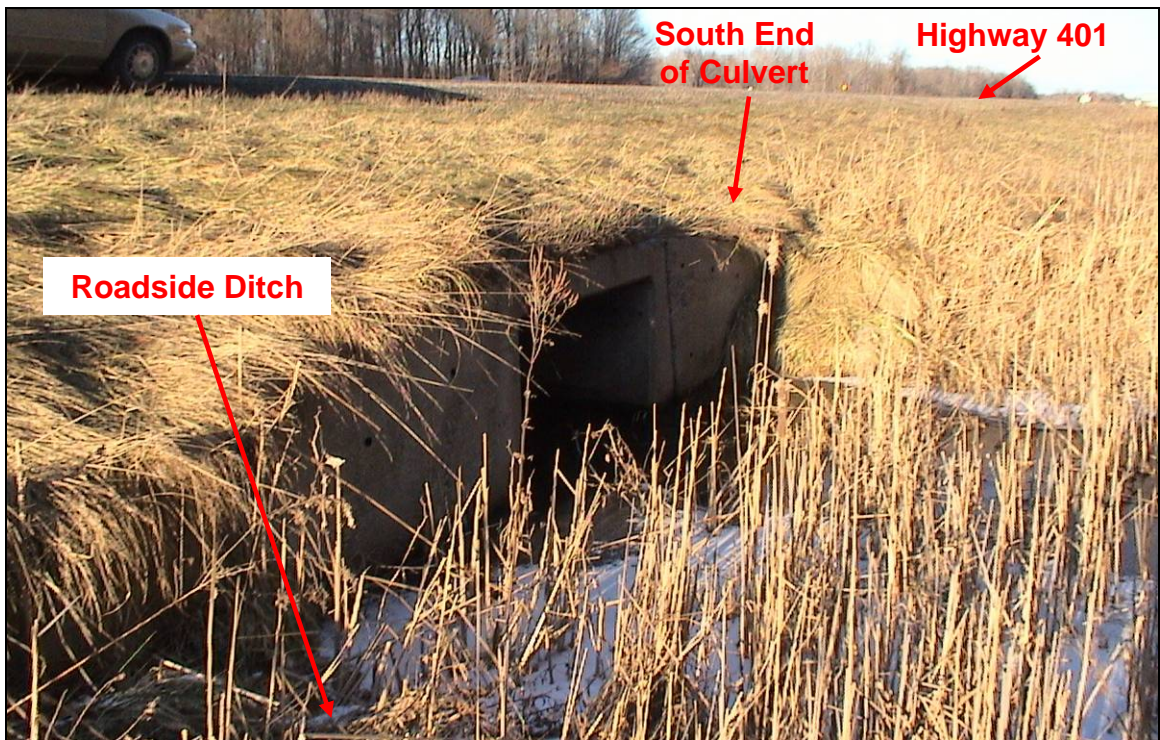
PHOTOGRAPH 5-9: Culvert Site 13-419. Looking northeasterly at south end of concrete culvert. Showing extent of rock protection used to control embankment erosion. (January 26, 2006)



PHOTOGRAPH 5-10: Culvert Site 13-419. Looking north-westerly at south end of culvert. Note erosion controlled with rockfill cover. (January 26, 2006)



PHOTOGRAPH 5-11: Culvert Site 13-420. Looking southwesterly at north end of culvert. Note siltation of channel possibly caused by sloughing of west side of earth channel. (January 27, 2006)



PHOTOGRAPH 5-12: Culvert Site 13-420. Looking north-easterly at south end of culvert (below grass cover). Note wet and grass covered roadside ditch (foreground). (January 26, 2006)



PHOTOGRAPH 5-13: Culvert Site 13-421. Looking south-westerly at north end of culvert. Note partly blocked channel. (January 27, 2006)



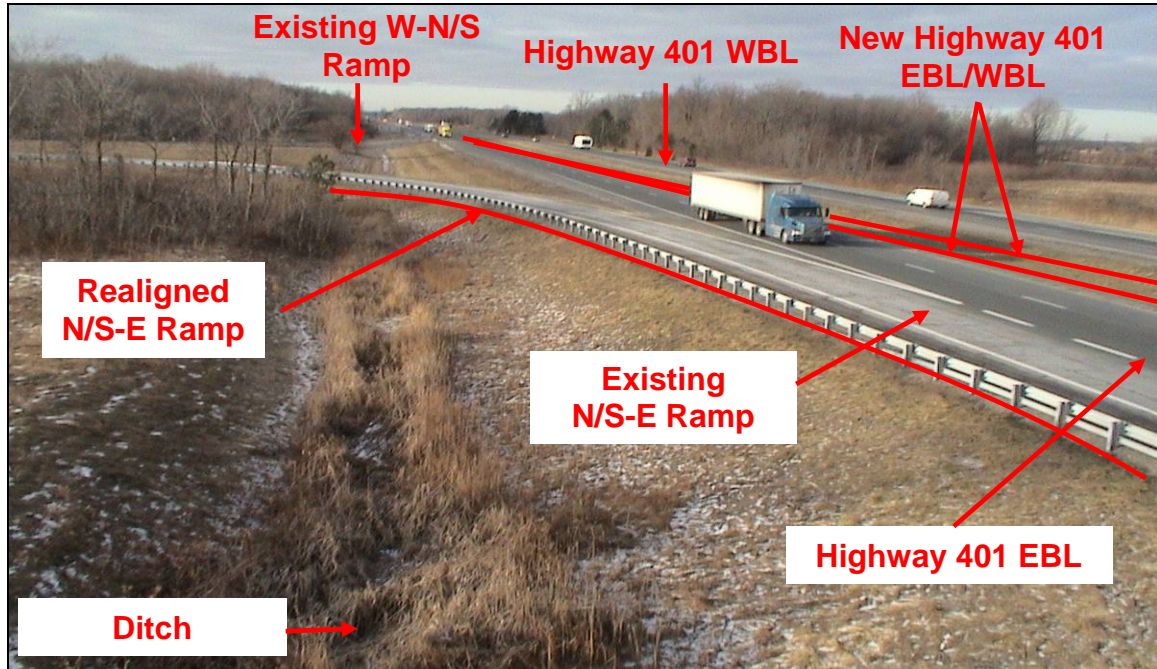
PHOTOGRAPH 5-14: Culvert Site 13-421. Looking south across top of south end of culvert. Note silted-in channel and possible sloughing of west bank. (January 26, 2006)



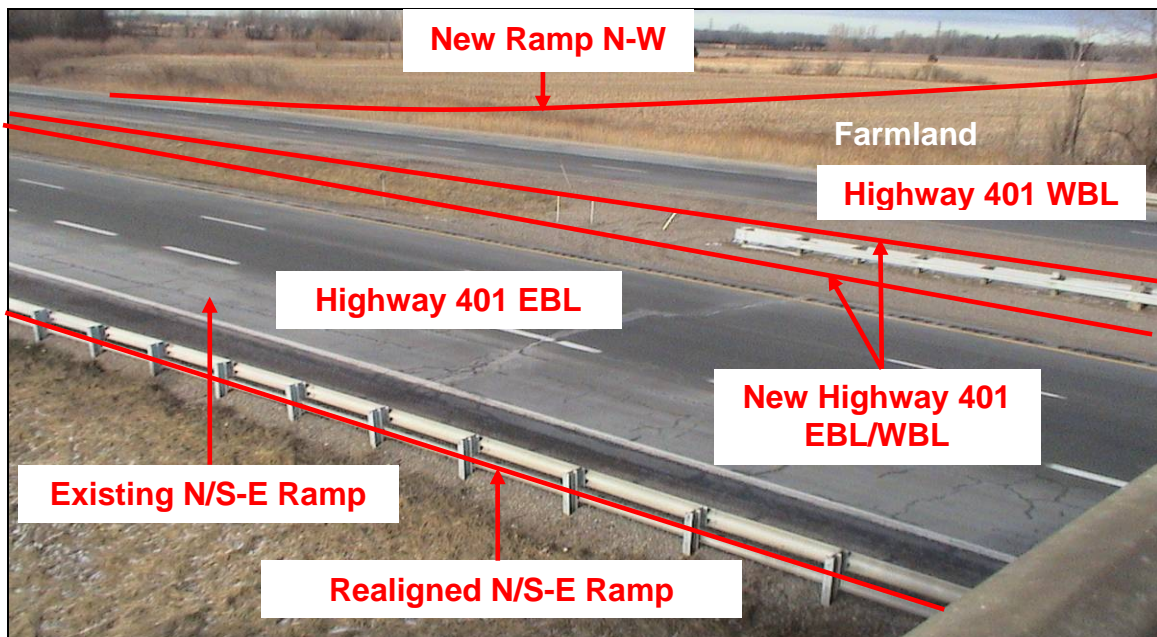
PHOTOGRAPH 5-15: Orford Road I/C. Looking west at interchange from the E-N/S exit ramp. Note high approach embankment fills and generally level terrain. Preferred Option: Future Highway 401 EBL and WBL depicted. (January 27, 2006)



PHOTOGRAPH 5-16: Orford Road I/C. Looking east at Orford Road underpass structure. Note typical 4-span steel girder structure and N/S-W on ramp. (January 27, 2006)



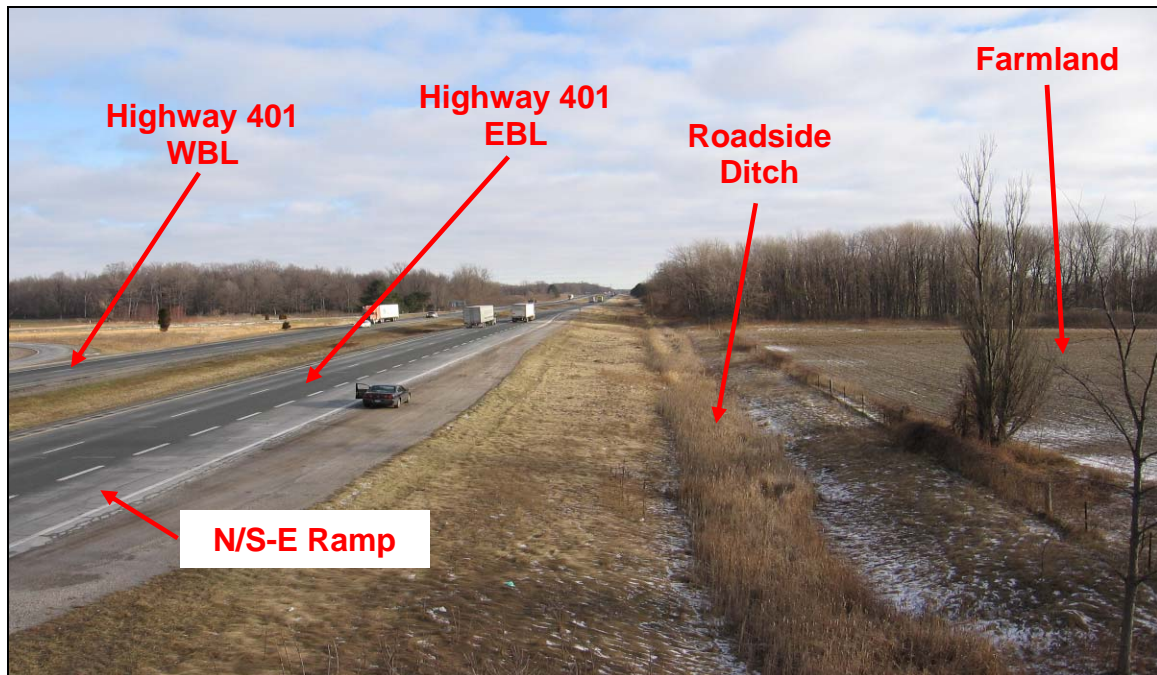
PHOTOGRAPH 5-17: Orford Road I/C. Looking west from south of structure at W-N/S and N/S-E ramps. Note gently undulating terrain and isolated stands of trees in background. Tall grasses in ditch (foreground). Preferred Option: Future Highway 401 EBL and WBL and realignment of N/S-E ramp are depicted. (January 27, 2006)



PHOTOGRAPH 5-18: Orford Road I/C. Looking north-westerly from southwest corner of bridge deck. Note wide median, N/S-E ramp, flat terrain beyond highway (farmland). Preferred Option: Future Highway 401 EBL and WBL, N-W ramp and realignment of N/S-E ramp are depicted. (January 26, 2006)



PHOTOGRAPH 5-19: Orford Road I/C. Looking north from north end of bridge deck at embankment of N/S-W and E-N/S ramps. Note generally flat terrain. (January 26, 2006)



PHOTOGRAPH 5-20: Orford Road I/C. Looking easterly from south end of bridge deck. Note N/S-E on-ramp beside stopped vehicle, deep roadside ditches, grassed median and generally flat terrain. (January 26, 2006)



PHOTOGRAPH 5-21: Duart Road Underpass. Looking west from north shoulder of Highway 401. Note relatively flat terrain in foreground and approach embankment fill both sides of bridge. Also note line of hydro towers north of highway. (January 27, 2006)



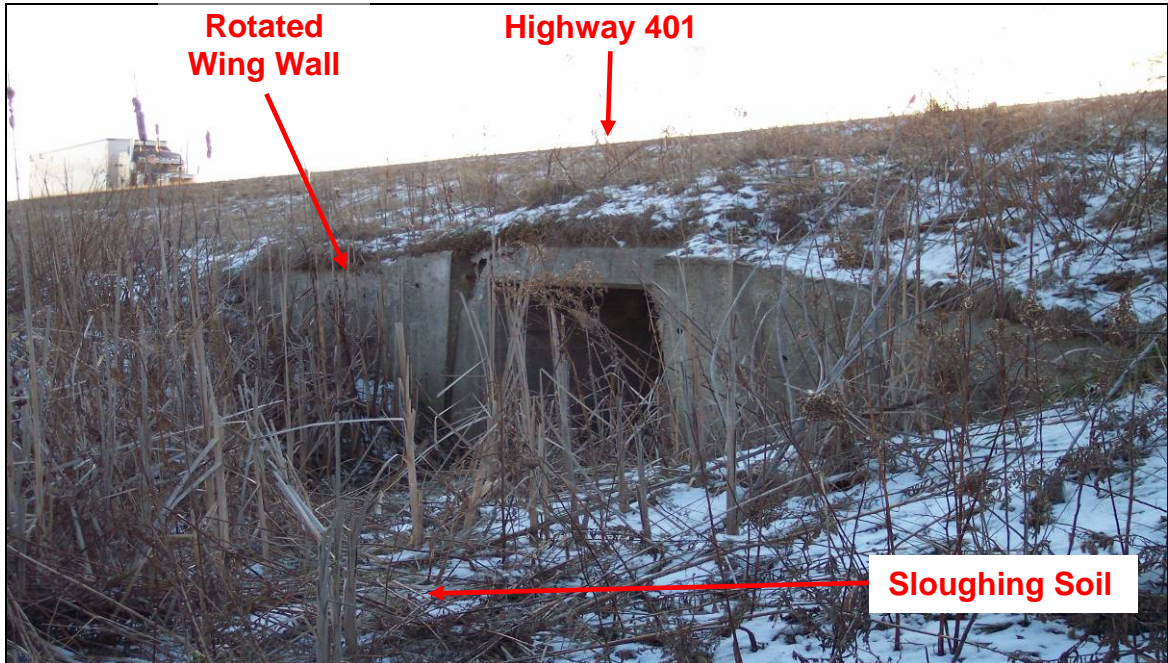
PHOTOGRAPH 5-22: Duart Road Underpass. Looking south across Highway 401 from north abutment. Note wide median shoulder and four-span structure type. (January 27, 2006)



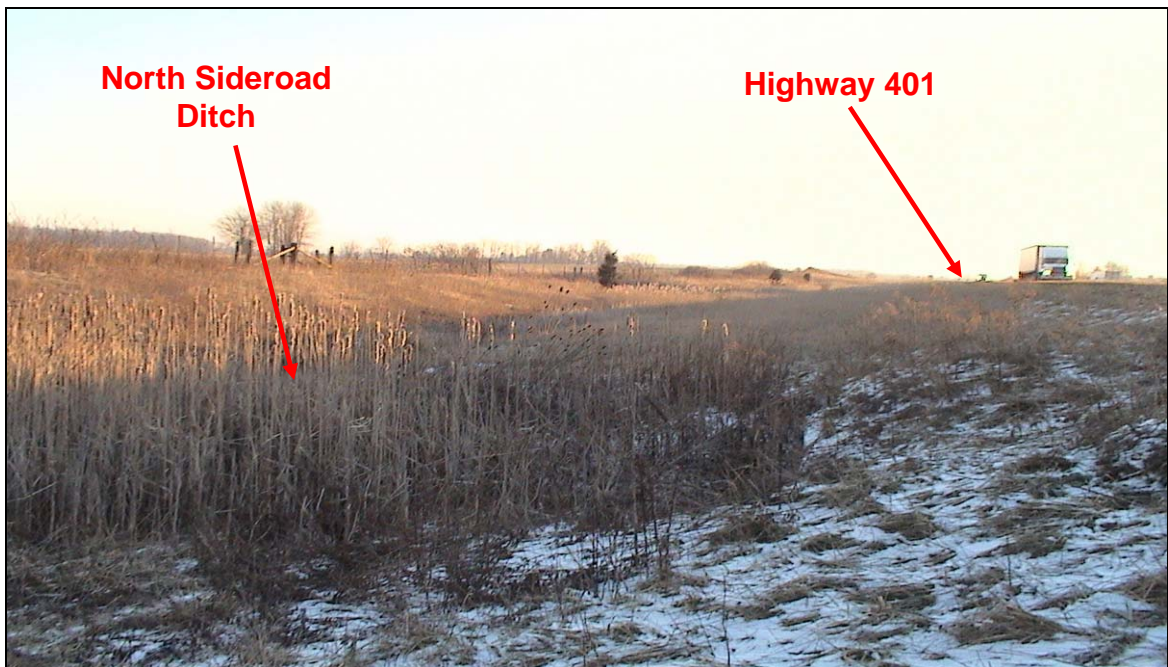
PHOTOGRAPH 5-23: Duart Road Underpass. Looking south along west side of north approach embankment. Note farmer's field and hydro pole in foreground, generally flat terrain in background. Tall grass is in wet ground near roadside ditch. (January 26, 2006)



PHOTOGRAPH 5-24: Duart Road Underpass. Looking north along east side of south approach embankment. Note farmland in foreground right and generally flat terrain beyond Hydro tower is on north side of Highway 401. (January 26, 2006)



PHOTOGRAPH 5-25: Culvert Site 13-422. Looking south-easterly at north end of culvert. Note soil sloughing on west side of channel and rotated wing wall. (January 26, 2006)



PHOTOGRAPH 5-26: Culvert Site 13-422. Looking east along north roadside ditch east of culvert. Note bullrush weeds in ditch and generally flat terrain. (January 26, 2006)



PHOTOGRAPH 5-27: Culvert Site 13-422. Looking northwesterly at south end of culvert. Note shallow embankment over top of culvert. (June 29, 2006)



PHOTOGRAPH 5-28: Culvert Site 13-422. Looking easterly at north end of culvert. (June 29, 2006)



APPENDIX B

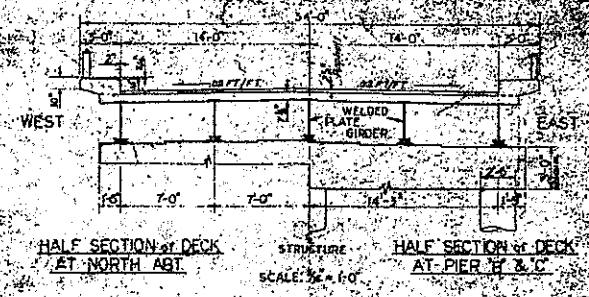
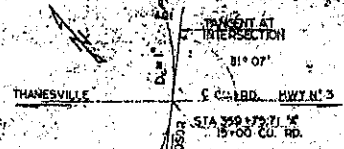
Previous Soil Data and Records of Boreholes

- (1) Contract Drawing for Contract 80-3 (Kenesserie Road) - same drawing as (2)
- (2) Construction Drawing for WP 89-59 (Kenesserie Road)
- (3) Foundation Investigation Report for WP 89-59, Geocres 40I5-5 (Kenesserie Road)
- (4) Construction Drawings for WP 91-59 (Orford Road)
- (5) Foundation Investigation Report for WP 91-59 Geocres 40I12-012 (Orford Road)
- (6) Contract Drawings for Contract No. 97-44, WP 601-93-01, WP 601-93-00
(considered no useful soil data)
- (7) Soil data from Contract 80-53, WP 54-77-01 (Orford Road)
- (8) Construction Drawing for WP 92-59 (Duart Road)
- (9) Foundation Investigation Report for WP 92-59 (Duart Road) Geocres 40I12-011



- (1) Contract Drawings for Contract No. 80-03 for Highway 401, from 0.6 km west of interchange No. 12 (Kent Bridge Road) easterly to 1.1 km west of interchange No. 14 (Kenesserie Road), August 1979. (Essentially same drawing as (2))
- (2) Construction Drawings for Highway 401 Underpass at Co. Road 16 (Kenesserie Road) site 13-267, File No. 60 F 289, WP 89-59 (TWP No. 111-267) dated December 1960

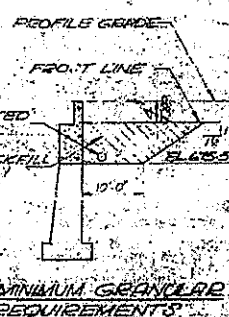
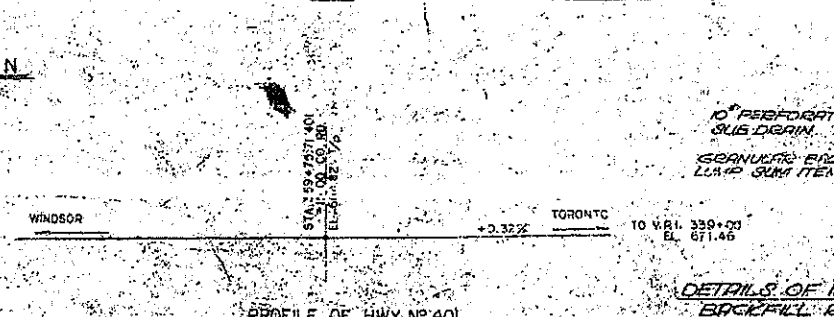
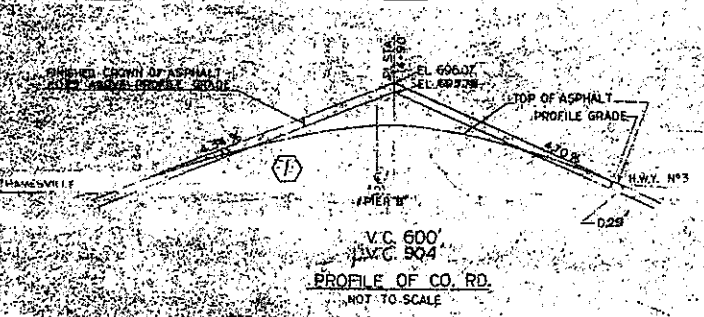
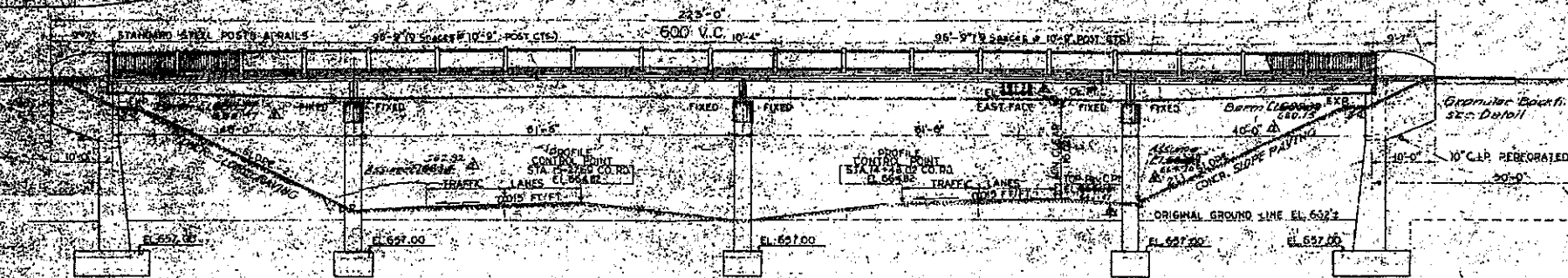
DATA FOR SKEW 89.53
 SKEW 89.53
 COS 11.723
 TAN 0.208103
 COT 4.756293
 SEC 1.012141



SOIL DATA

BORE HOLE	SOIL DATA
BORE HOLE 1	Medium grey brown fine sand, gravel size up to 3/8" below 2 ft. 65.3
	50 ft. grey silty clay with gravel streaks 63.2
BORE HOLE 2	Very stiff grey silty clay with gravel streaks 62.2
BORE HOLE 3	Very stiff grey silty clay with gravel streaks 62.2
BORE HOLE 4	Very stiff grey silty clay with gravel streaks 62.2

NOTES:
 1. THE SOIL DATA WAS OBTAINED FROM BORINGS MADE BY THE KENT COUNTY ROAD DEPARTMENT. THE BORINGS WERE MADE AT THE FOLLOWING LOCATIONS:
 BORE HOLE 1 - NORTH ABUTMENT
 BORE HOLE 2 - PIER 'C'
 BORE HOLE 3 - PIER 'C'
 BORE HOLE 4 - SOUTH ABUTMENT
 2. THE SOIL DATA IS FOR INFORMATION ONLY. IT IS NOT TO BE USED FOR DESIGN PURPOSES.
 3. THE SOIL DATA IS SUBJECT TO CHANGE WITHOUT NOTICE.
 4. THE SOIL DATA IS NOT TO BE USED FOR ANY OTHER PURPOSES.
 5. THE SOIL DATA IS NOT TO BE USED FOR ANY OTHER PURPOSES.



LIST OF DRAWINGS

- D-4619-1 General Layout
- D-4619-2 Abutments & Piers
- D-4619-3 Structural Steel
- D-4619-4 Deck Details
- D-4619-5 Handrail Details
- D-4619-6 APPROACH SLAB
- D-4619-7 REIN. BAR LISTS
- D-4619-8 REIN. BAR LISTS
- D-4619-9 Gravel Slope Paving

DEPARTMENT OF HIGHWAYS
 KENT COUNTY ROAD
 2.3 MILES EAST OF LUTHERVILLE
 CO. KENT
 TWP. INDIAN
 GENERAL



- (3) Foundation Investigation Report for Highway 401 Underpass at Co. Road 16 (Kenesserie Road) Site 13-267, File No. 60 F 289, WP 89-59, Geocres 40I5-5 prepared by William A. Trow and Associates Ltd., dated March 25, 1960.

PROJECT NO. J 478

WILLIAM A. TROW & ASSOCIATES LTD.

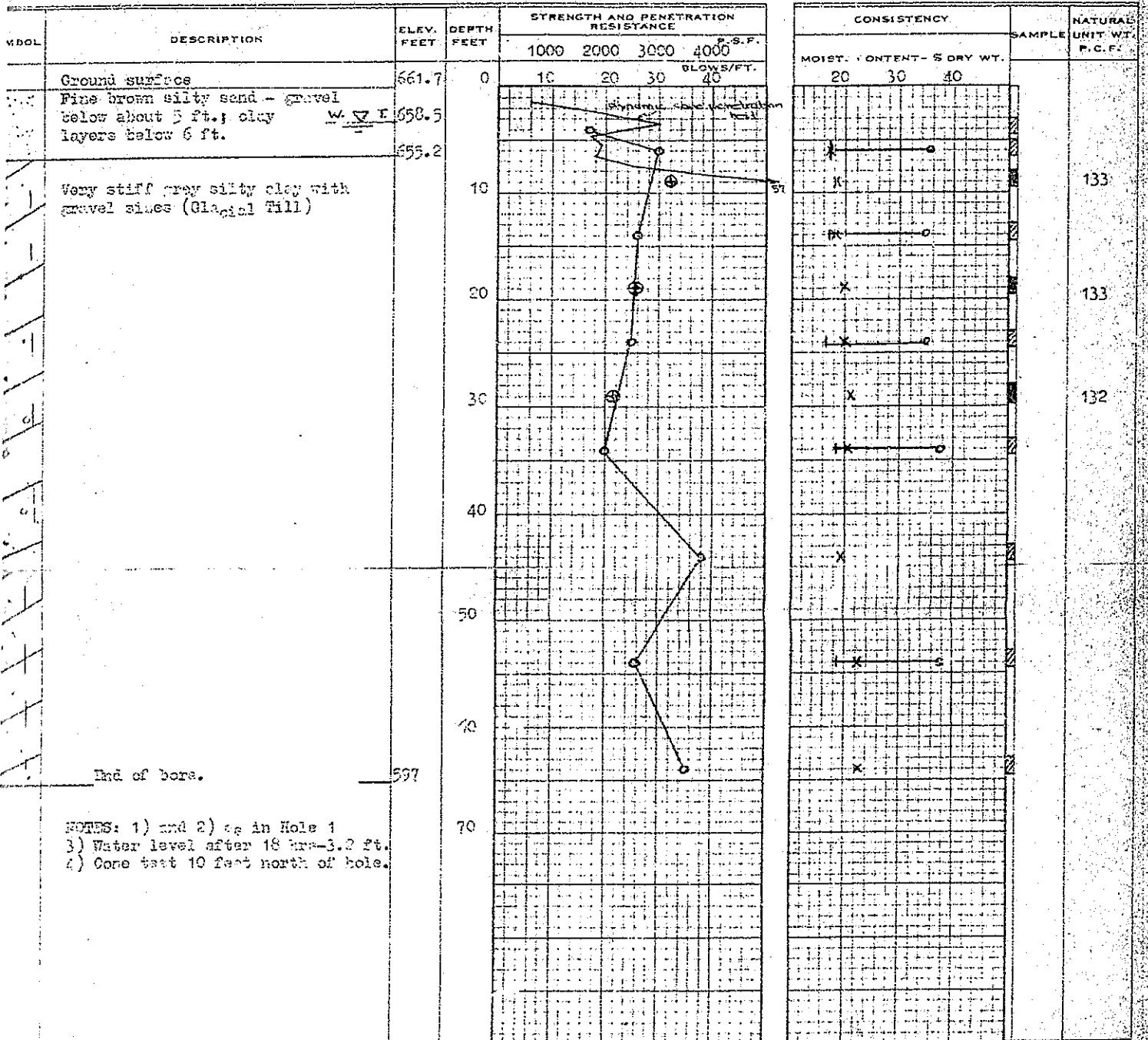
SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT County Road Underpass WP 39-59
 LOCATION North of Ridgeway, Ont.
 HOLE LOCATION See Dag. 1
 HOLE ELEVATION AND DATUM 661.7

BOREHOLE NO. 2
 FIELD SUPERVISOR
 DRILLER
 PREP.

DRAWING NO. 3

LEGEND
 2" DIA. SPLIT TUBE
 2" SHELBY TUBE
 2" SPLIT TUBE
 2" DIA. CONE
 CASING
 2" SHELBY
 1/2 UNCONFINED COMPRESSION (Qu)
 VANE TEST (C) AND SENSITIVITY (S)
 NATURAL MOISTURE AND
 LIQUIDITY INDEX
 LIQUID LIMIT
 PLASTIC LIMIT



PROJECT NO. J 478

DRAWING NO. 4

WILLIAM A. TROW & ASSOCIATES LTD.

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

LEGEND

2" DIA. SPLIT TUBE
 2" SHELBY TUBE
 2" SPLIT TUBE
 2" DIA. CONC.
 CASING
 2" SHELBY
 1/2 UNCONFINED COMPRESSION (QU)
 VANE TEST (C) AND SENSITIVITY (S)
 NATURAL MOISTURE AND
 LIQUIDITY INDEX
 LIQUID LIMIT
 PLASTIC LIMIT

PROJECT County Road Underpass WP 89-59

LOCATION North of Ridgeway, Ont.

HOLE LOCATION See Dwg. 1

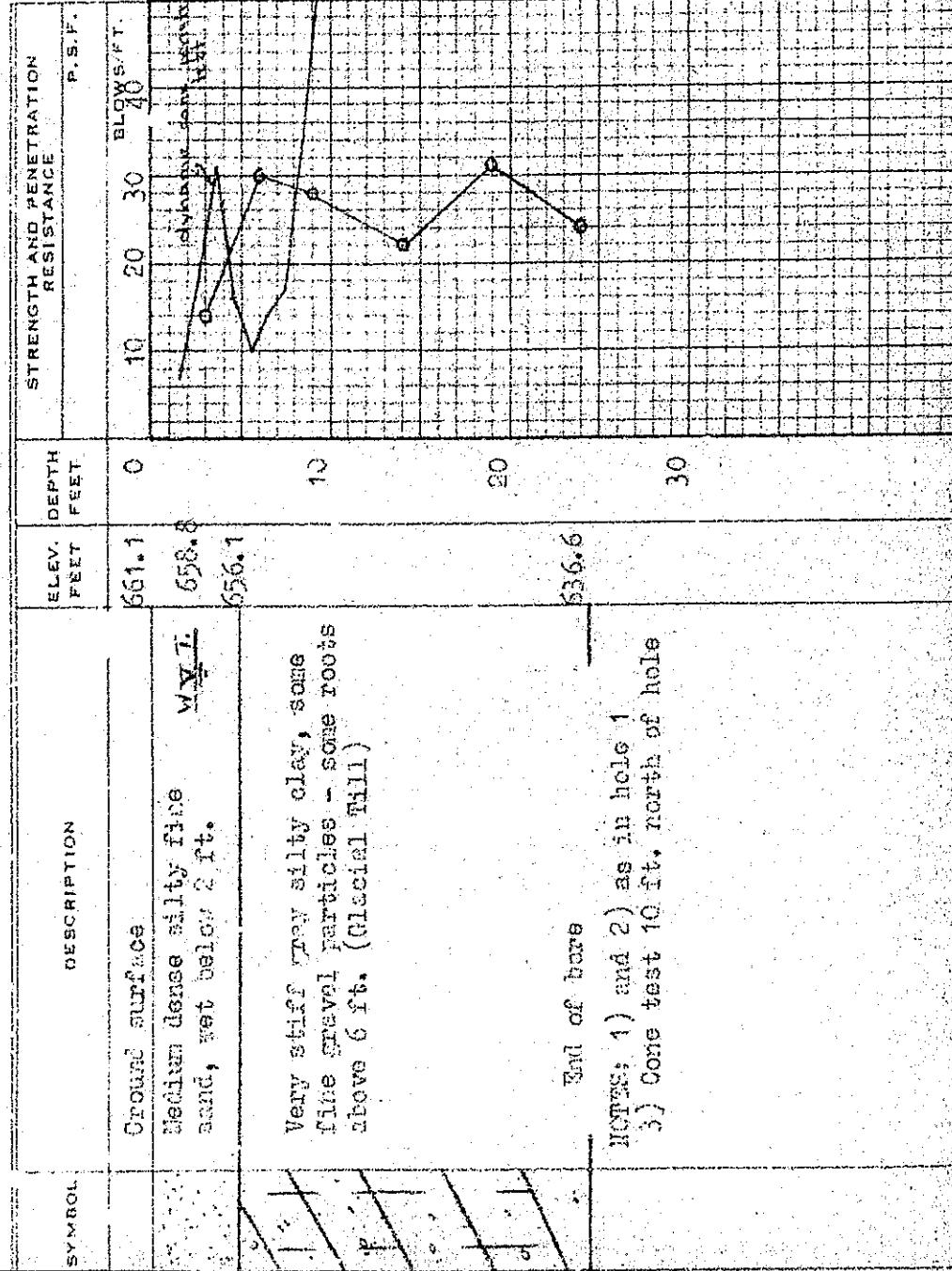
HOLE ELEVATION AND DATUM 661.1

BOREHOLE NO. 3

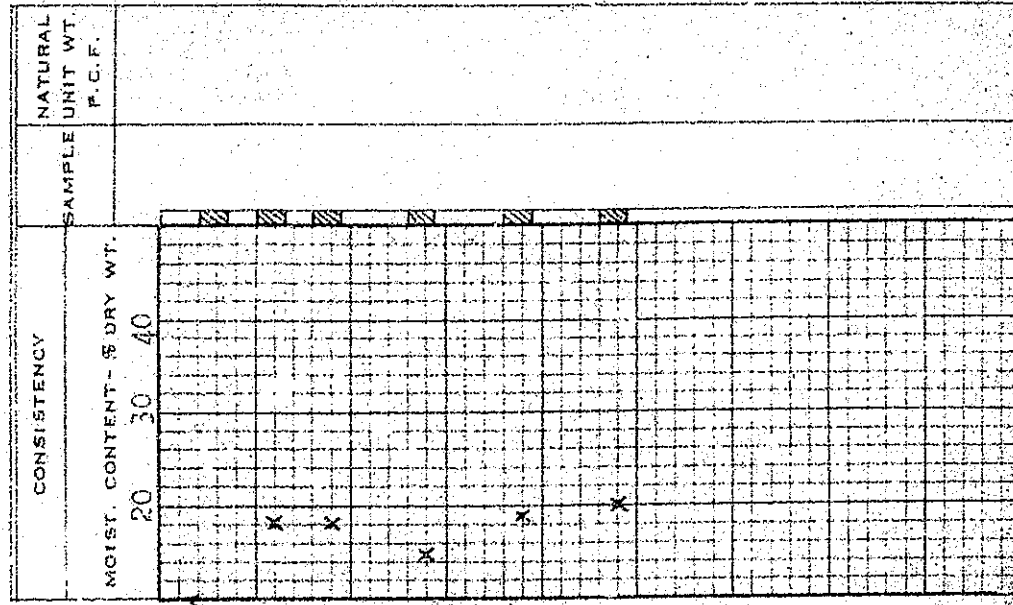
FIELD SUPERVISOR

DRILLER

PREP.



NOTES: 1) and 2) as in hole 1
 3) Cone test 10 ft. north of hole



PROJECT NO. J 478

WILLIAM A. TROW & ASSOCIATES LTD.

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

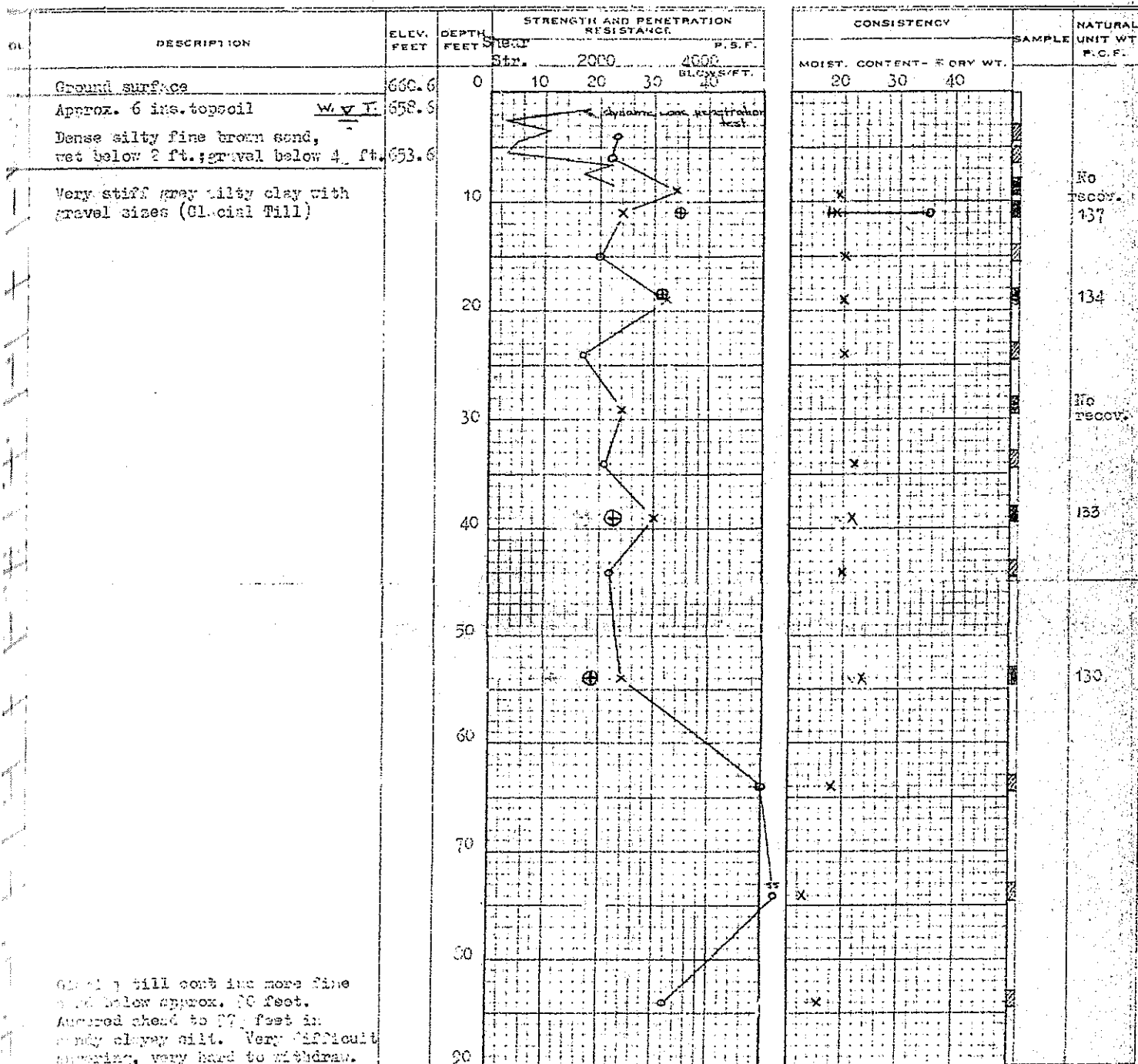
PROJECT: County Road Underpass WP 39-59
 LOCATION: North of Ridgeway, Ont.
 HOLE LOCATION: See Map. 1
 HOLE ELEVATION AND DATUM: 660.5

BOREHOLE NO. 4
 FIELD SUPERVISOR
 DRILLER
 PREP.

DRAWING NO. 5

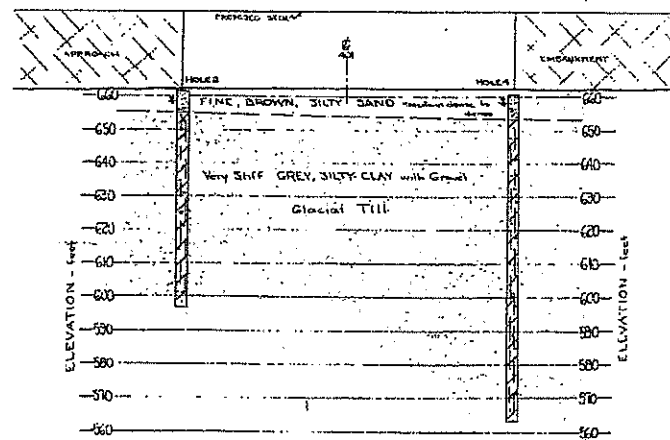
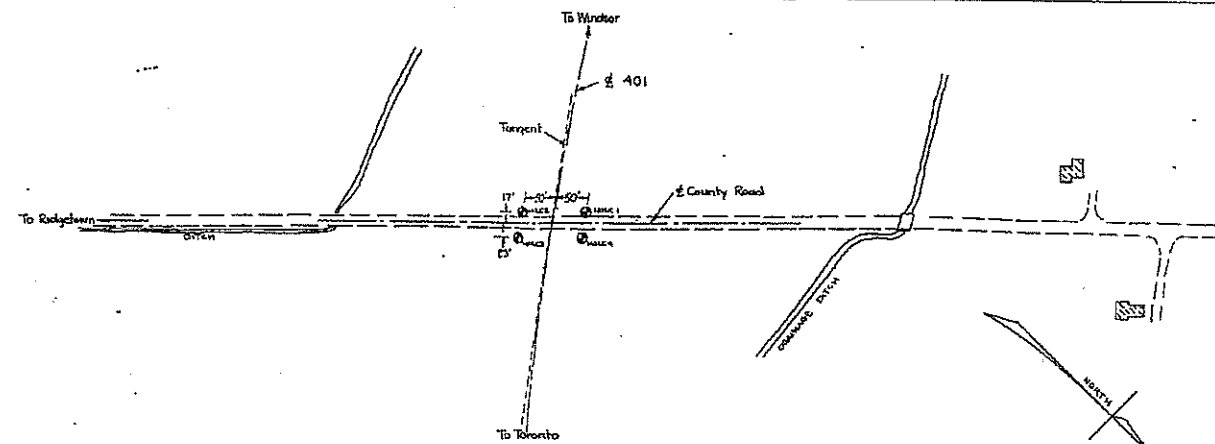
LEGEND

2" DIA. SPT TUBE
 2" SHELBY TUBE
 2" SPLIT TUBE
 2" DIA. CONE
 CASING
 2" SHELBY
 1/2 UNCONFINED COMPRESSION (Cu)
 VANE TEST (C) AND SENSITIVITY (S)
 NATURAL MOISTURE AND
 LIQUIDITY INDEX
 LIQUID LIMIT
 PLASTIC LIMIT



Bored hole 100 feet

565

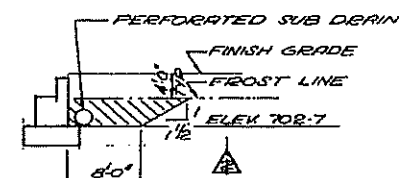
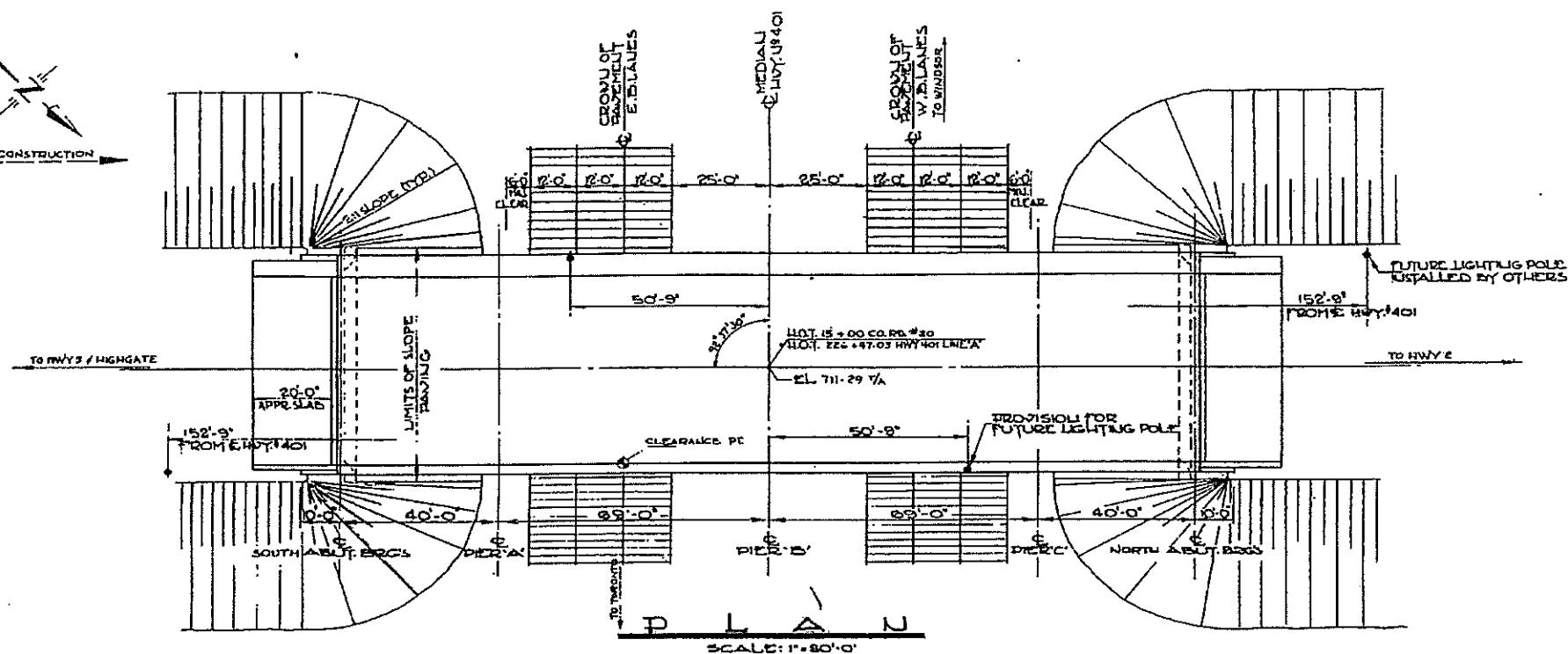
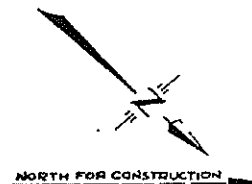


B.M. Nail & Washer in NW Corner of
2 1/4 A. Maple 24 ft. Left of Sta. 351+45
664.31

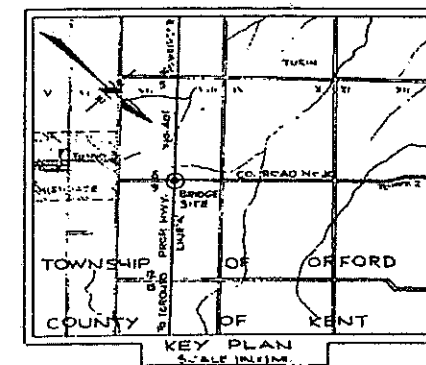
PROPOSED UNDERPASS
W.P. 89-59
FOUNDATION INVESTIGATION by
W. A. TROW & ASSOCIATES, U.S.



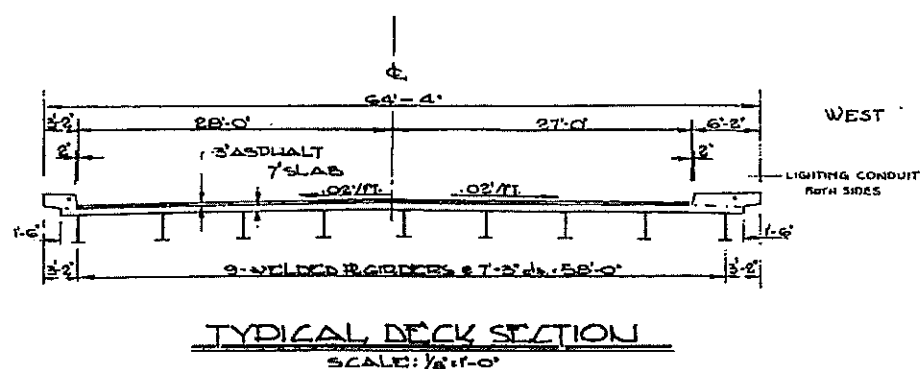
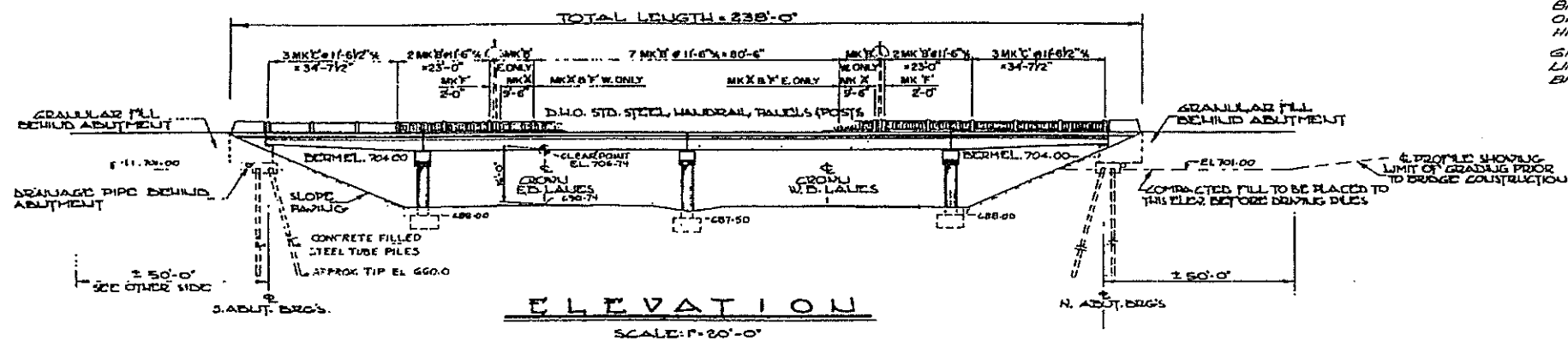
- (4) Construction Drawing for Highgate Side Road (Orford Road) Interchange Structure,
Site 13-263, File No. 60 F 250C, WP 91-59.



NOTE: SECTION 1 TO ABUTMENTS
LATERAL LIMITS- ENDS OF ABUTMENT.
THE LUMP SUM BID FOR GRANULAR BACKFILL TO STRUCTURE SHALL INCLUDE ONLY THAT PORTION SHOWN CROSS HATCHED ON THE ABOVE DRAWING.
GRANULAR MATERIAL ABOVE THE FROST LINE SHALL BE INCLUDED IN THE PRICE BID FOR SAND CUSHION.

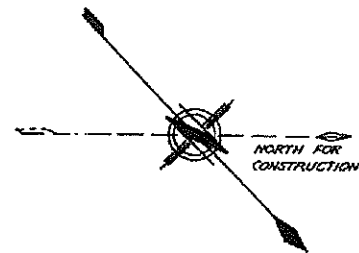


NOTES
TO ENGINEER
CONCRETE WORK ON THIS STRUCTURE MUST NOT BE COMMENCED UNTIL MONUMENTS TO FIX CONTROL POINTS HAVE BEEN ERECTED & CHECKED BY THE ENGINEER.
TO CONTRACTOR
STRUCTURE TO BE BUILT IN ACCORDANCE WITH FORM NO. 9 & THE SPECIAL PROVISIONS, EXTRA COPIES OF WHICH MAY BE OBTAINED FROM THE ENGINEER.
CONCRETE MIX
MINIMUM STRENGTH @ 28 DAYS = 3000 P.S.I.
APPROVED ADMIXTURES SUPPLIED BY THE CONTRACTOR WILL BE ADDED TO ALL CONCRETE AS SPECIFIED BY THE ENGINEER.
CLEAR COVER ON REINFORCING STEEL
FOOTINGS ABUTMENTS PIERS DECK CURB HANDRAIL & ENDPOSTS
OR AS NOTED ON DRAWINGS
CONSTRUCTION NOTES
ALL EXPOSED EDGES TO BE CHAMFERED 1" x 1" EXCEPT AS NOTED.
ALL CONSTRUCTION JOINTS MUST BE APPROVED BY THE ENGINEER.
THE GENERAL CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF $\pm 1/8"$.
NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL CONCRETE IN THE DECK HAS BEEN PLACED.



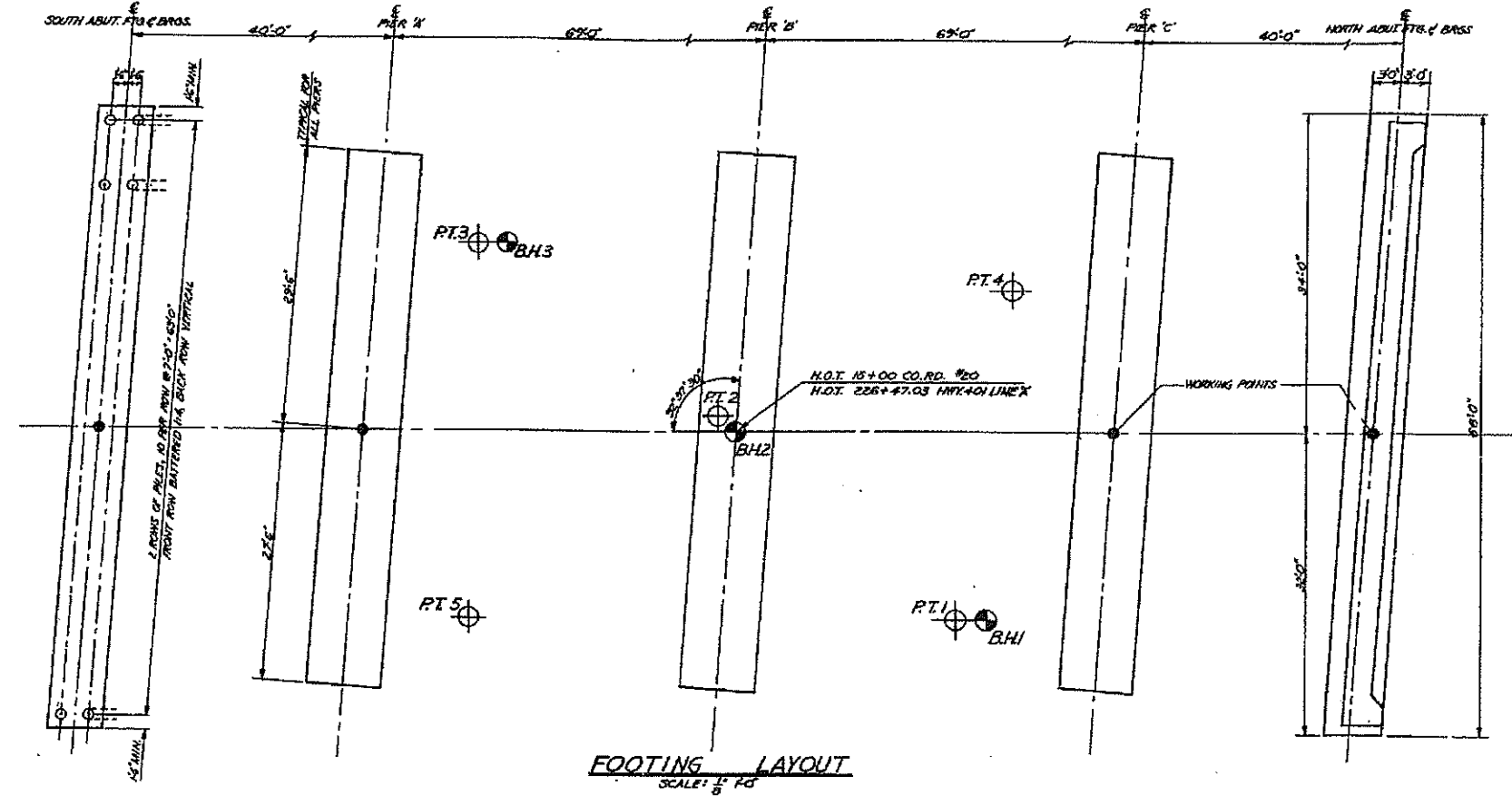
- LIST OF DRAWINGS**
- 1 GENERAL PLAN
 - 2 FOOTING LAYOUT AND SOIL DATA
 - 3 ABUTMENTS, MINOR WALLS AND ENDPOSTS
 - 4 PIERS
 - 5 STRUCTURAL STEEL
 - 6 BEARINGS
 - 7 DECK
 - 8 APPROACH SLAB
 - 9 SLOPE PAVING
 - 10 BRIDGE LIGHTING DETAILS
 - 11 STEEL HANDRAIL DETAILS
 - 12 REINFORCING STEEL SCHEDULE (Approx. 5:00)
 - 13 REINFORCING STEEL SCHEDULE

DEPARTMENT OF HIGHWAYS ONTARIO BRIDGE DIVISION			
HIGHWAY 401 INTERCHANGE 4.0 MI. EAST OF HWY 27			
KING'S HIGHWAY No. 401		DIST. No. 1	
CO. KENT		SECTION THE BRIDGE # 6	
TWP. CROCK		LOT 6 & 9 COR. VII	
APPROVED: [Signature] DATE: 11-26-91			
DESIGN: J.L.K.	CHECK: J.L.K.	CONTRACT: 14-263	W.P. No. 91-59
DRAWING: E.A.	CHECK: J.L.K.	CONTRACT: 14-263	W.P. No. 91-59
DATE: 11-26-91	LOADING: 1-20	DRAWING: 14-263	D5404-1

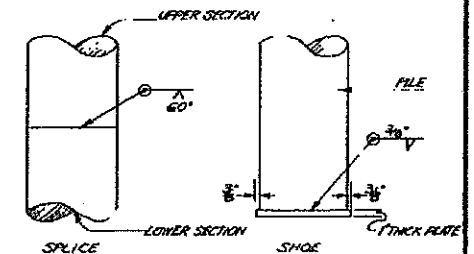


DATA FOR 2°37'30" SKEW

SIN. 0.045799
COS. 0.998950
TAN. 0.045847
SEC. 1.001050

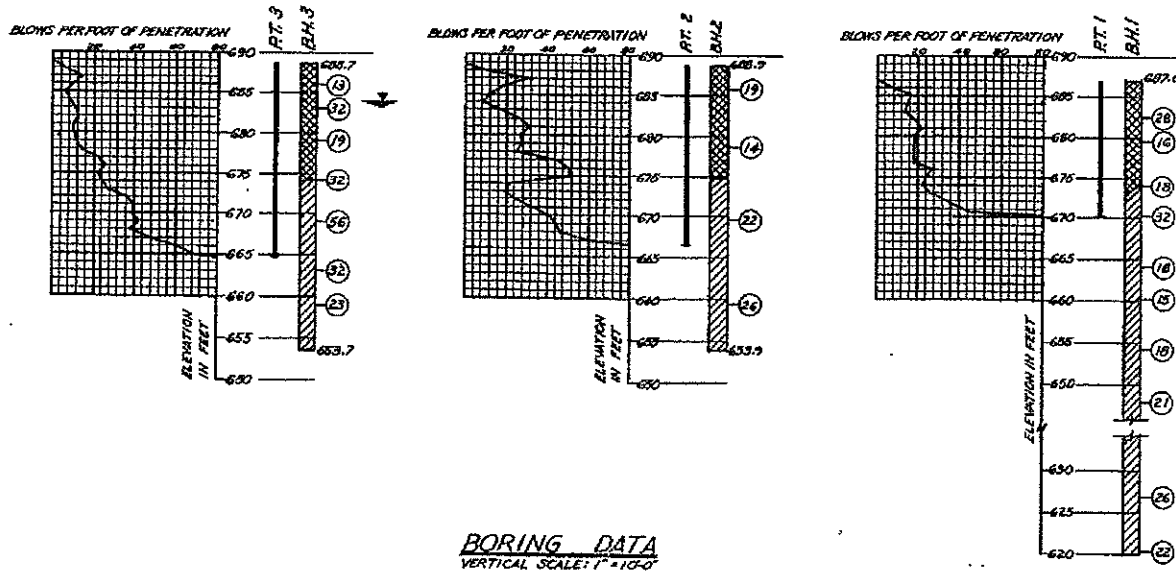


PILE ARRANGEMENT FOR NORTH ABUTMENT SIMILAR TO SOUTH ABUT.



PILE SPLICE & SHOE DETAILS

- FILES ARE 12 3/4" O.D. STEEL TUBE, 0.250" THICK WALL.
- FILE LENGTH 42' 40 PILES REQUIRED
- AFTER PILES HAVE BEEN INSTALLED AND INSPECTED THEY SHALL BE FILLED WITH CONCRETE OF 3000 p.s.i. 28 DAY STRENGTH
- DESIGN LOAD FOR PILES 40 TONS
- APPROX. PILE TIP ELEVATION 600.0



BORING DATA

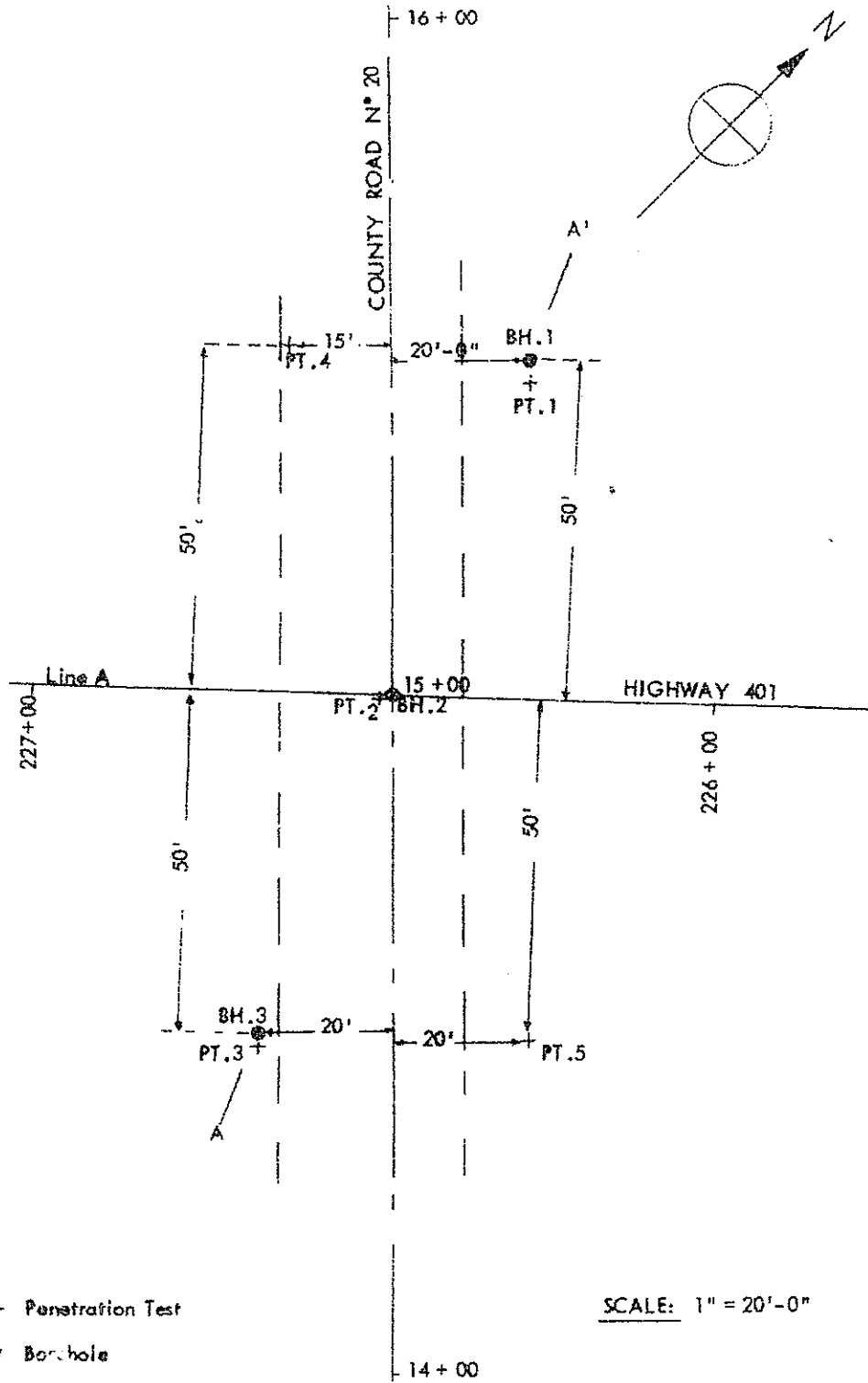
LEGEND

- EXPLORATORY DRILL HOLE.
 - PENETRATION DONE TEST HOLE.
 - BLOWS PER FOOT FOR STD. PENETRATION TEST.
 - WATER TABLE.
 - FINE SAND
 - TILL
- NOTES:
- STANDARD PENETRATION TESTS WERE PERFORMED USING A 2 INCH OUTSIDE DIAMETER SPLIT-SPHOON AND A 140 LB. WEIGHT DROPPING 30 INCHES.
 - PENETRATION RESISTANCE OBTAINED USING UGL TYPE 200/60 CONE PENETROMETER WITH A 140 LB. HAMMER DROPPING 30 INCHES.

DEPARTMENT OF HIGHWAYS ONTARIO BRIDGE DIVISION			
HIGHGATE SIDEROAD INTERCHANGE 4.9 MI. EAST OF HWY 21			
KING'S HIGHWAY No. 401 CO. KENT TWP. OXFORD		DIST. No. 1 OXFORD TWP. BRIDGE #6 LOT 8 & 7 CON. VIII	
FOOTING LAYOUT AND SOIL DATA			
APPROVED: <i>[Signature]</i> J.L.E.	DESIGNED: <i>[Signature]</i> J.L.E.	CHECKED: <i>[Signature]</i> J.L.E.	DATE: JAN. 64
SHEET No. 14-268		W.P. No. 91-59	
CONTRACT No.		DRAWING No.	
DATE: JAN. 64		DRAWING No. D5404-2	



- (5) Foundation Investigation Report for Highgate Side Road Interchange (Orford Road) Structure, Site 13-263, File No. 60 F 250C, WP 91-59. Geocres 40I12-012 prepared by Universal Geotechnique Limited Report No. 428/60, undated.



+ Penetration Test
● Borehole

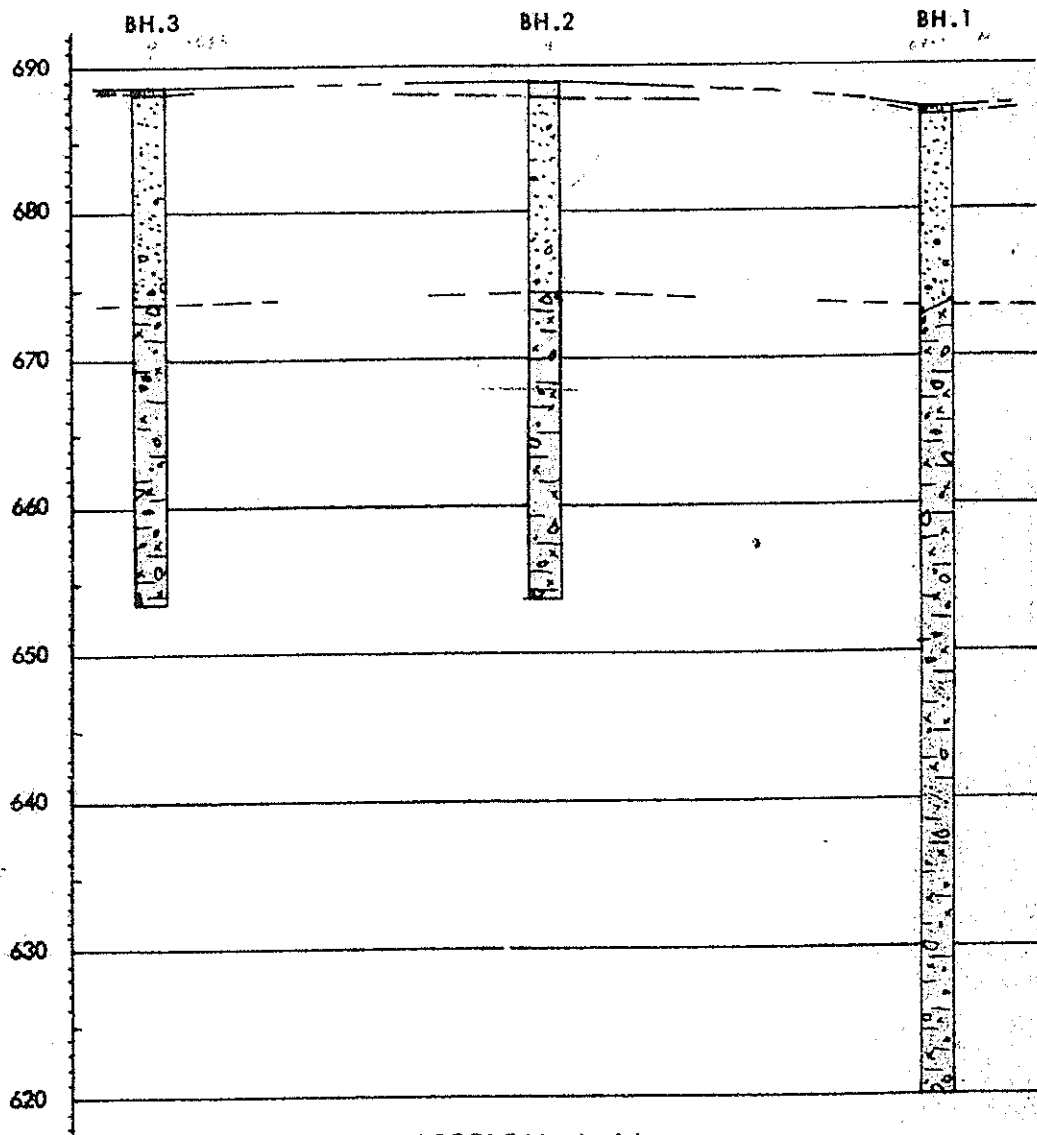
SCALE: 1" = 20'-0"

This sketch is an enlargement of part of plan N° F3531-4 supplied by D.H.O.

PROJECT Interchange County Road to Highgate
 TITLE Borehole Location Plan (W.P. 91-59)
 DRG. NO. 2 ORDER NO. T.428/60







UNIVERSAL
GEOTECHNIQUE
LIMITED



SECTION A-A'

LEGEND

-  FILL
-  TOP SOIL
-  SAND
-  TILL

SCALE

Horizontal 1" = 20'-0"
Vertical 1" = 10'-0"

PROJECT Interchange County Road to Highway
(W.P. 91-59)

TITLE Geological Section

DRG. NO. 3 ORDER NO. T.428/60



UNIVERSAL
GEOTECHNIQUE
LIMITED

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOGPROJECT Interchange County Road to Highgate & Hwy. 401 (W.P. 91-59) ORDER NO. I.428/60CLIENT Ontario Department of HighwaysBOREHOLE NO. BH.1 DIAMETER 2-1/2" CASING 2-1/2"BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING

FORM 9-1A 800
UNIVERSAL GEOTECHNIQUE

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Brown sandy loam with organic matter.	687.0			Zero			Damp.
Firm brown fine silty SAND with occasional fine gravel.	686.5		• 1	0'-6"		17	Low to medium dry strength.
do			• 2			28	Moist.
							Low to medium dry strength.
Firm brown fine somewhat silty SAND, some fine gravel.	680		• 3			16	Wet.
do			• 4			17	Low dry strength.
do			• 5			18	do
Greyish brown clay with gravel.			• 6			32	No recovery.
Hard greyish brown silty CLAY with fine to medium subangular gravel.	670		• 7			32	No recovery.
							Damp.
							High dry strength.
Stiff do			• 8			16	do
do			• 9			15	do
do	660		• 10			16	do
do			• 11			18	do
Stiff greyish brown silty CLAY with fine to medium subangular gravel and sand pockets.	650		• 12			21	do
	647.0			40'-0"			












SCALE: 1" = 5'-0" • DISTURBED SAMPLE

☐ UNDISTURBED SAMPLE

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOGPROJECT Interchange County Road to Highgate & Hwy. 401 (W.P. 91-59) ORDER NO. I.428/60CLIENT Ontario Department of HighwaysBOREHOLE NO. BH.1 DIAMETER 2-1/2" CASING 2-1/2"BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Stiff greyish brown silty CLAY with fine to medium subangular gravel, occasional sand pockets.	647.0		• 13	40'-0"		20	Damp. High dry strength.
do			• 14			18	do
do	640		• 15			16	do
do							
do							
do							
do							
do	630		• 16			26	do
Contains large pocket of grey fine to coarse sand.							
Stiff greyish brown silty CLAY with fine to medium subangular gravel.	620		• 17	67'-0"		22	do
				End of Borehole			

FORM G-1A 500
UNIVERSITY

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Interchange County Road to Highgate & Hwy. 401 (W.P. 91-59) ORDER NO. T.428/60

CLIENT Ontario Department of Highways

BOREHOLE NO. BH.2 DIAMETER 2-1/2" CASING 2-1/2"

BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING

FORM G-1A BOD
UNITED STATES OF AMERICA

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Brown sand and gravel. FILL.	688.9			Zero			
Firm brown fine silty SAND, slight iron staining and occasional fine gravel.	687.9		• 1	1'-0"		19	Damp. Low to medium dry strength.
do			• 2			18	Moist. Low to medium dry strength.
Firm brown somewhat silty fine SAND with fine gravel.	680		• 3			14	Wet. Low dry strength.
Very stiff greyish brown silty CLAY with fine to medium subangular gravel.	674.9		• 4	14'-0"		22	Damp. High dry strength.
do	670		• 5			22	do
Stiff do			• 6			24	do
do	660		• 7			26	do
do	653.9		• 8	35'-0"		27	do
				End of Borehole			

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

SOIL MECHANICS LABORATORY

BOREHOLE LOGPROJECT Interchange County Road to Highway & Hwy. 401 (W.P.91-59) ORDER NO. T.428/60CLIENT Ontario Department of HighwaysBOREHOLE NO. BH.3 DIAMETER 2-1/2" CASING 2-1/2"BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING

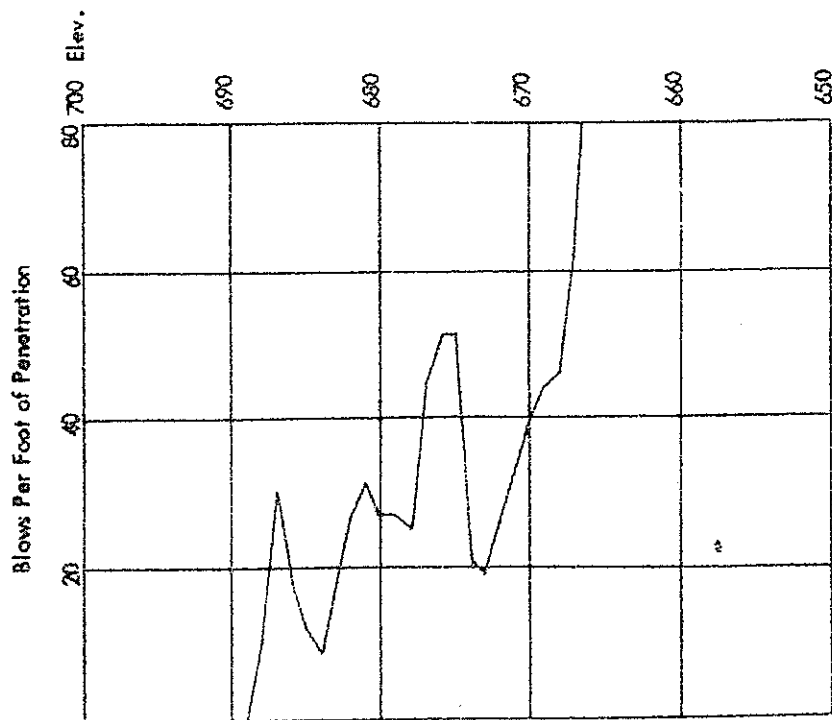
FORM G-1A 900
INTRODUCTION BY (U)

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Brown sandy loam with organic matter. Firm brown fine silty SAND, some iron staining, occasional fine gravel.	688.7			Zero			
			• 1	0'-6"		13	Damp. Low to medium dry strength
do			• 2			32	Moist. Low to medium dry strength
Firm brown somewhat silty fine SAND with fine gravel.	680		• 3			19	Wet. Low dry strength.
Grey do Hard greyish brown silty CLAY with fine to medium subangular gravel.	674.2		• 4	14'-6"		32	do Damp. High dry strength.
do	670		• 5			56	do
Very stiff do			• 6			32	do
Stiff do	660		• 7			23	do
do	653.7		• 8	35'-0"		21	do
				End of Borehole			

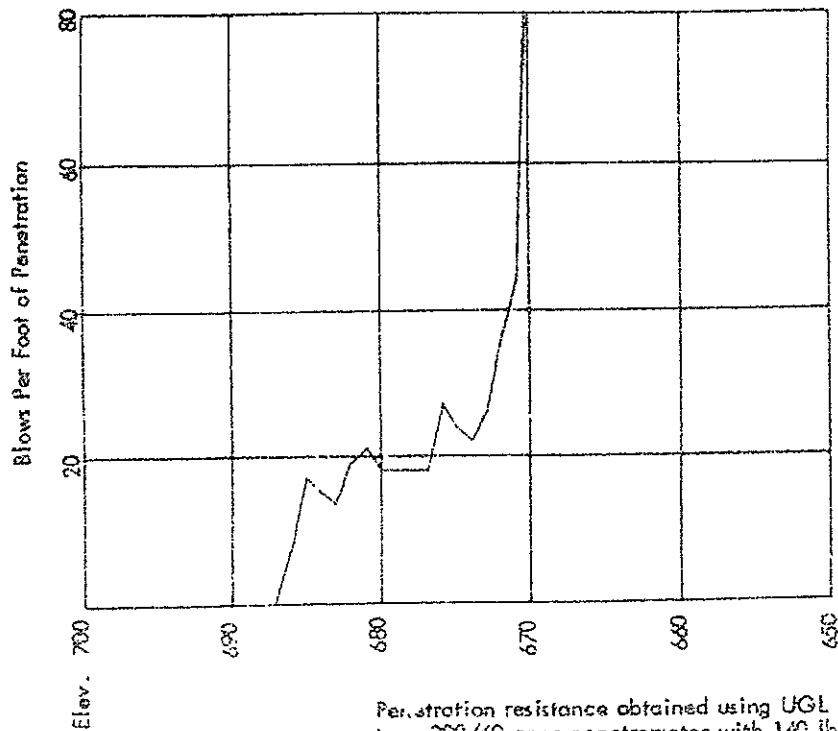
SCALE: 1" = 5'-0" * DISTURBED SAMPLE

UNDISTURBED SAMPLE

PT. 2



PT. 1



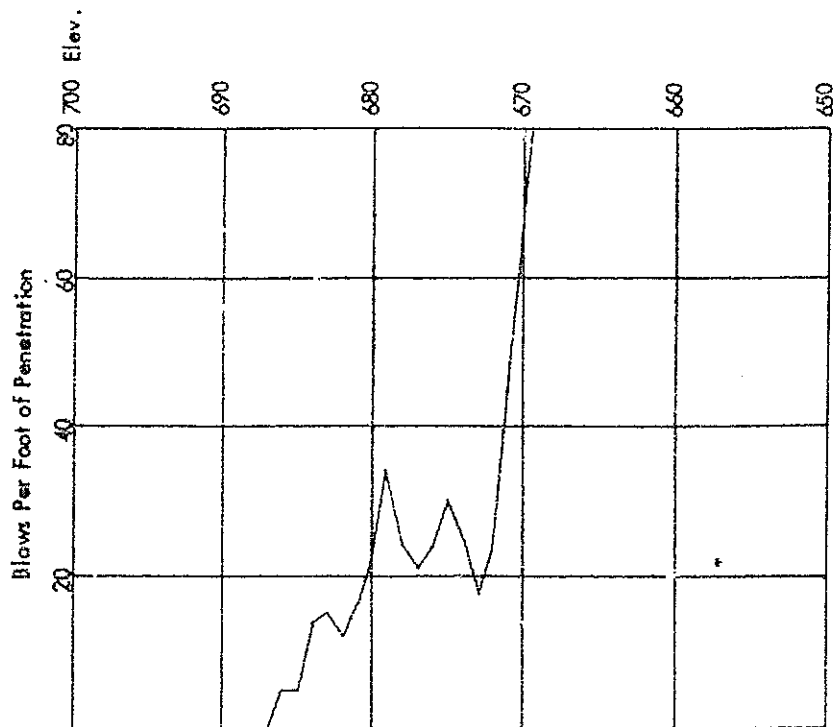
Penetration resistance obtained using UGL
type 2^{1/2}/60 cone penetrometer with 140 lb.
hammer falling 30".

PROJECT Interchange County Road to Highgate
(W.P. 91-59)
TITLE Dynamic Penetration Test Diagrams
DRG. NO. 4 ORDER NO. T. 428/60

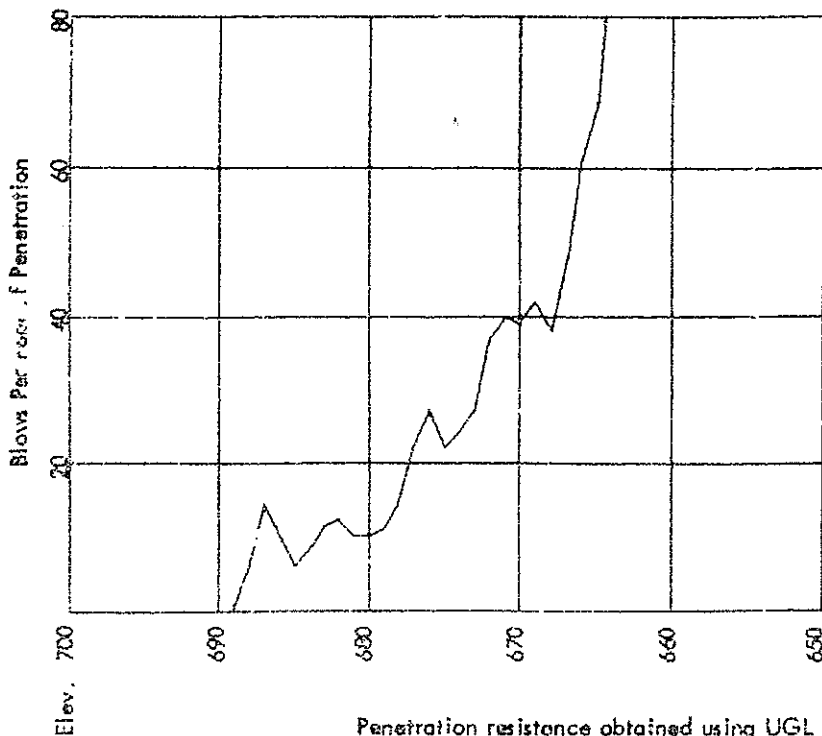


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PT. 4



PT. 3



Penetration resistance obtained using UGL
type 200/60 cone penetrometer with 140 lb.
hammer falling 30".

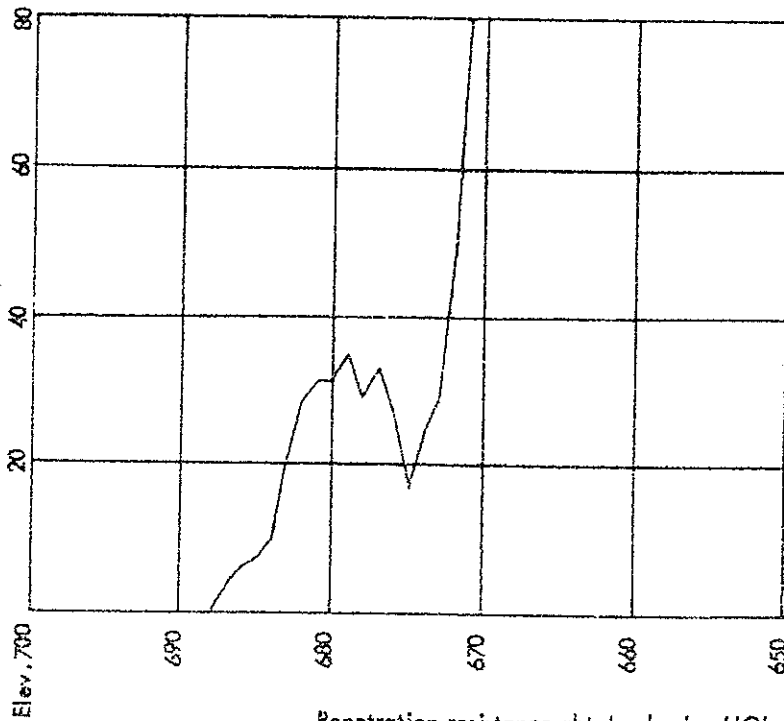
PROJECT Interchange County Road to Highgate
(W.P. 91-59)
TITLE Dynamic Penetration Test Diagrams
ORG. NO. 5 ORDER NO. T.428/40



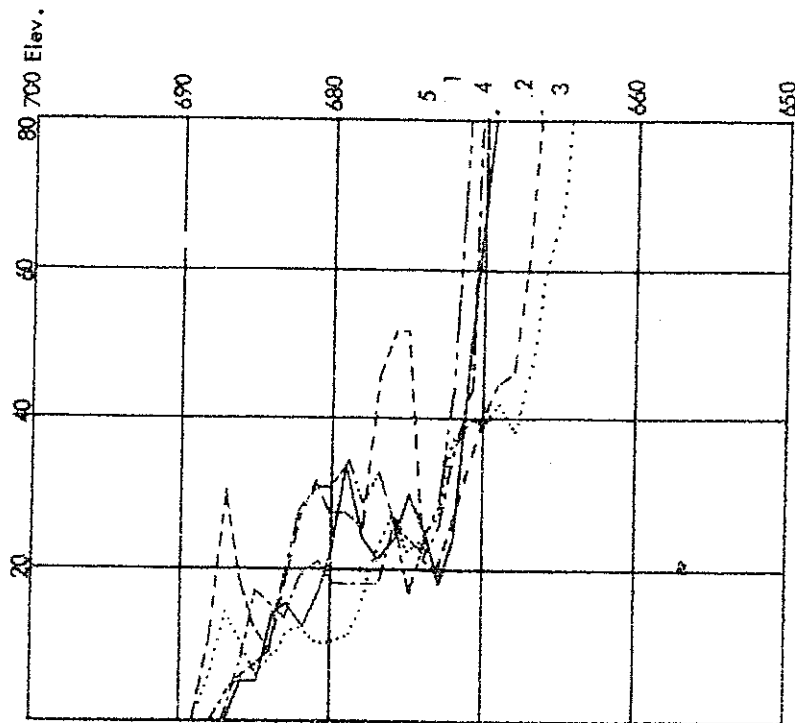
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PT. 5

Blows Per Foot of Penetration



Penetration resistance obtained using UGL
type 200/60 cone penetrometer with 140 lb.
hammer falling 30".



COMBINED PLOTTING OF PENETRATION TESTS

PROJECT Interchange County Road to Highgate
(W.P. 91-59)

TITLE Dynamic Penetration Test Diagrams

DRG. NO. 6 ORDER NO. I. 428/60



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SOIL MECHANICS LABORATORY MECHANICAL ANALYSIS

T. 428/60

PROJECT: Exchange County Road in Highgate, (W.P. 21-52) BORING NO. BH.1 SAMPLE NO. 2 & 4 DATE OF TEST 13th April, 1960.

DESCRIPTION

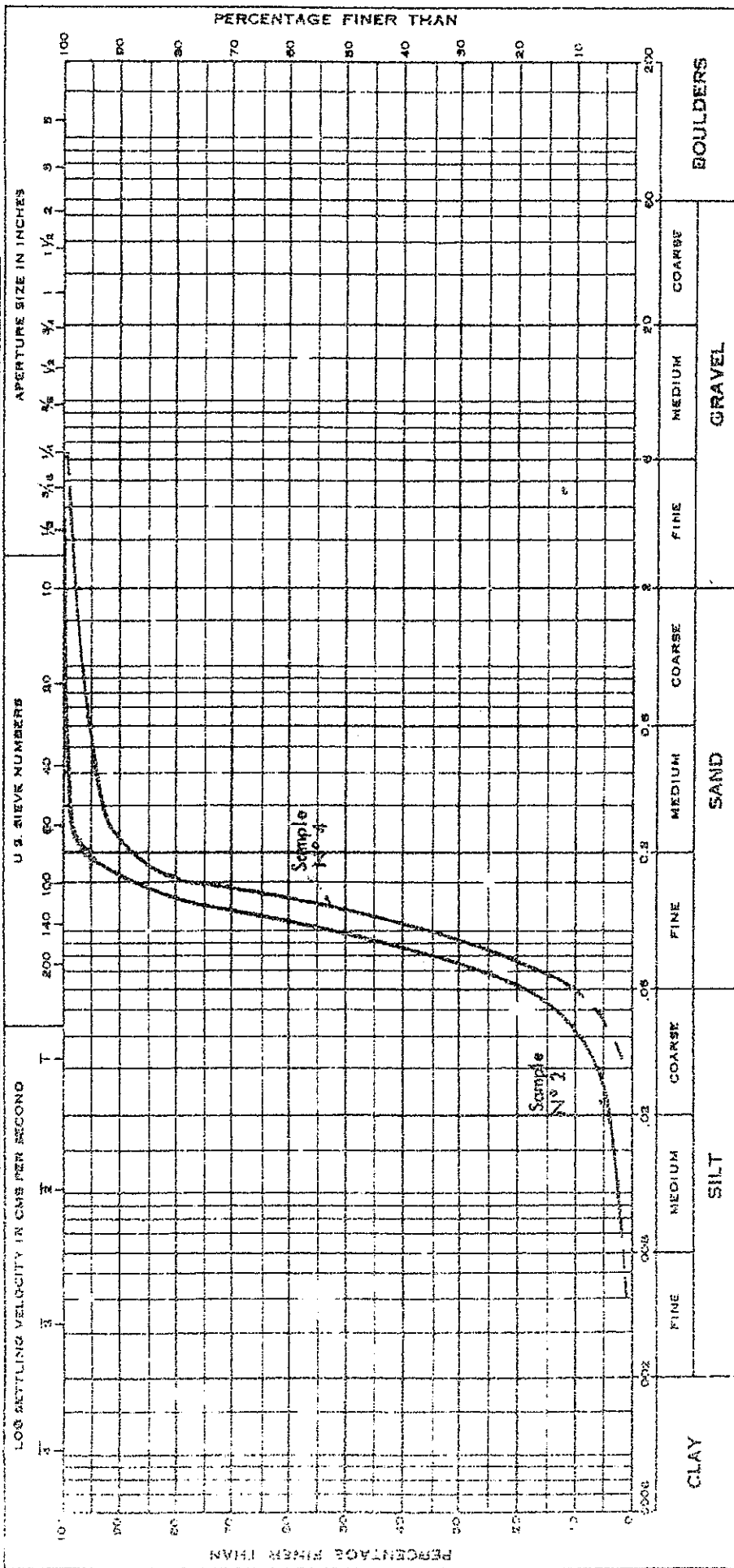


TABLE N° 1
SUMMARY OF LABORATORY TESTS

Borehole N°	Sample N°	Sample Type	Elevation	Natural Density lbs./cu.ft.	Natural Moisture Content %	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compression Strength lbs./sq. ft.
BH.1	2	S.B.	682		17.6				
	6	"	672		16.5				
	8	"	665		20.8				
	9	"	660		20.4				
	11	"	654		19.2				
	12	"	648		20.9				
	15	"	637		19.0				
	16	"	626		17.4				
	17	"	621		17.4				
	4	"	674	132	17.6				8000
BH.2	5	"	668	138	18.3	32.5	17.9	15	* 6400
					17.9		17.2		
	6	"	664		19.8				* 5200
					20.1				* 4000 (remould)
7		"	659	139	20.7	30.2	15.7	14	* 4000
					20.2		16.6		* 2800 (remould)

* At 20% Strain

S.B. = 2" O.D. Split Barrel Sampler

PROJECT Interchange County Road to Highgate
(W.P. 91-591)
TITLE Laboratory Tests
DRG. NO. _____ ORDER NO. 1



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- (6) Hot mix paving of Highway 401 from 1.8 km West of County Road 20 (Orford Road) easterly to 2.5 km east of County Road 3 (Furnival Road). WP No. 601-93-00 and 601-93-01, Contract No. 97-44, dated April 18, 1997 prepared by Dillon Consulting.

Note: Document considered for general data – no soil stratigraphy found.



- (7) Soil data from resurfacing of Highway 401 from 1.0 km west of interchange #14 (Orford Road) easterly to 2.5 km east of intersection #15 (Furnival Road), WP No. 54-77-01, Contract No. 80-53, dated July 18, 1979.

W.P. 54-77-01,

Highway #401

Highgate Road Interchange #14 West. (Orford Rd)

14+750 3.67 m Lt & WBL.

0	-	200 mm	Conc
200	-	290	Gr - A
290	-	570	Gr - B
570	-	800	Br VF Sa

78AX102 FMC = 6.5%

Same by aspg?

14+500 7 m Lt & WBL

0	-	230 mm	Gr - A
230	-	520	Gr - B
520	-	800	Br Sa Cl Lo

78AX103

Br Sa	Cl Lo	- Lt Cl
F Gr		13
Co&M Sa		26
F&VF Sa		16
Si		17
Cl		28
VF Sa&Si		19
FMC		8.8%

14+420 7.5 m Lt & WBL (Taper)

0	-	35 mm	Asph
35	-	240	Conc
240	-	310	Gr - A
310	-	590	Gr - B
590	-	800	Br VF Sa - sat.

13+700 7.5 m Lt & WBL (Taper)

0	-	30 mm	Asph
30	-	170	Conc
170	-	580	Gr - B
580	-	800	Br VF Sa

13+600 7 m Lt & WBL

0	-	130 mm	Gr - A
130	-	540	Gr - B
540	-	800	Br VF Sa - sat.

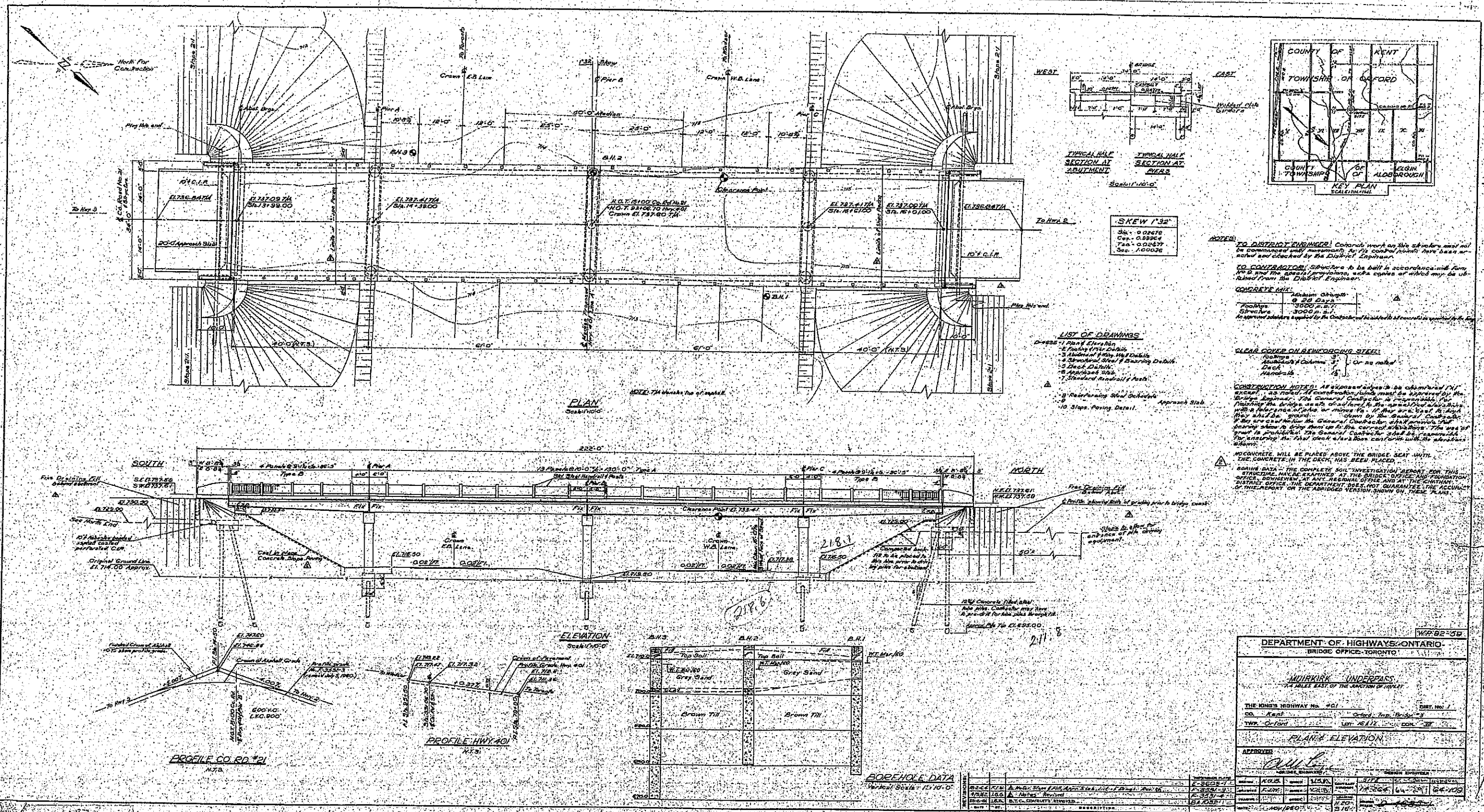
13+530 3.67 m Lt & WBL

0	-	220 mm	Conc
220	-	340	Gr - A
340	-	590	Gr - B
590	-	800	Br VF Sa

Same by aspg?



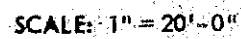
- (8) Construction Drawings for Muirkirk Underpass Structure (Duart Road), Site No. 13-264, File No. 60 F 249C, WP 92-59.



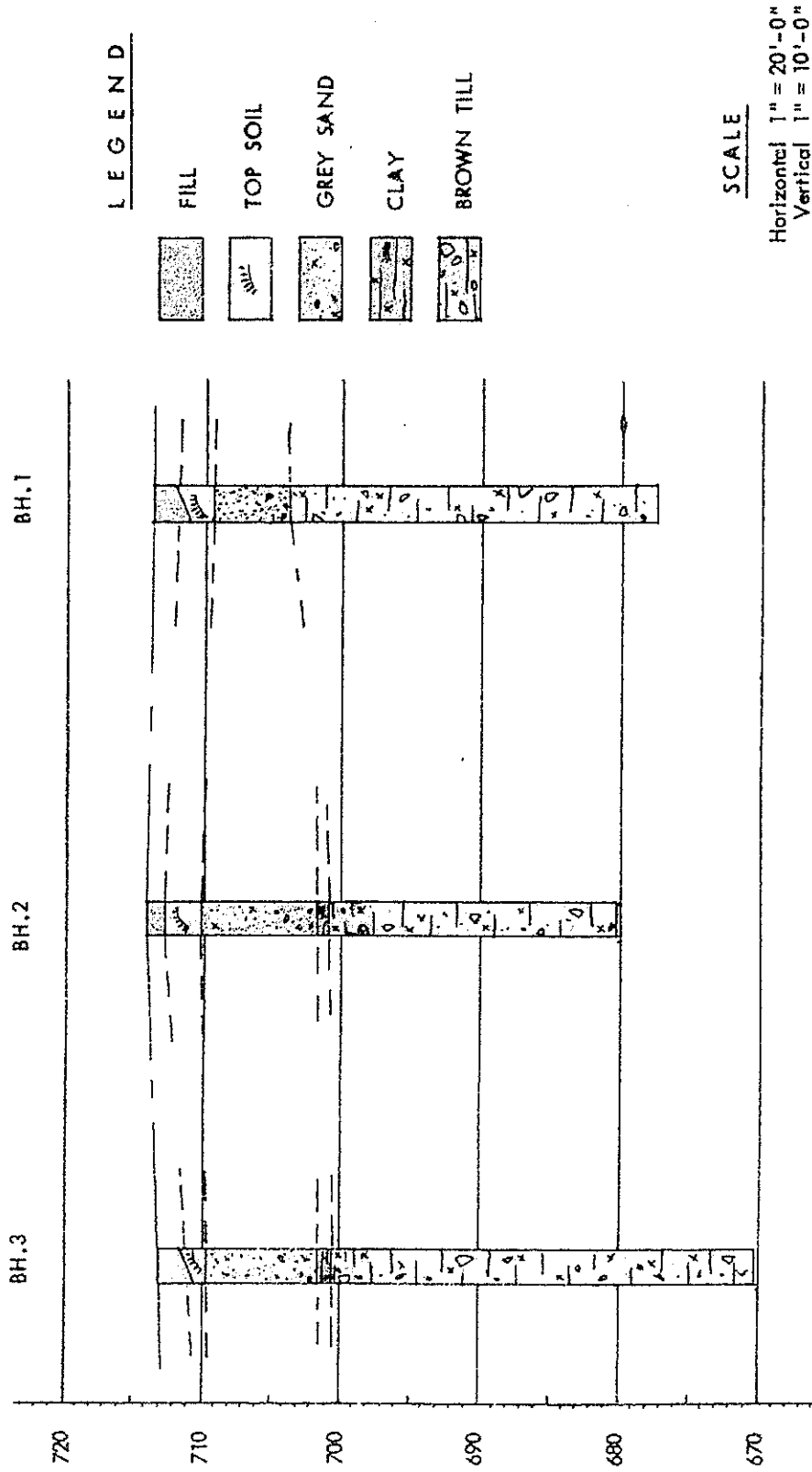
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- (9) Foundation Investigation Report for Muirkirk Underpass Structure (Duart Road), Site No. 13-264, File No. 60 F 249C, WP 92-59. Geocres 40I12-011 prepared by Universal Geotechnique Limited, Report No. T 429/60, undated.



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PROJECT Crossing County Road to Duart & Hwy. 401
(W.P. 92-59)
TITLE Geological Section
DRG. NO. 3 ORDER NO. T.429/60



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LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOGPROJECT Crossing County Road to Duart & Hwy. 401 (W.P. 92-59) ORDER NO. T.429/60CLIENT Ontario Department of HighwaysBOREHOLE NO. BH.1 DIAMETER 2-1/2" CASING 2-1/2"BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING FORM G-1A 800
UNITED STATES GEOLOGICAL SURVEY

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Brown sand with gravel, FILL.	713.9			Zero			
Loose brown loam with some organic matter. TOP SOIL.			• 1	4'-3"	Free Water	10	Damp.
Loose grey fine to medium SAND.			• 2			7	Moist. No dry strength.
Loose to firm grey fine to medium SAND with some fine gravel.			• 3	9'-9"		15	Wet. No dry strength.
Hard brown silty CLAY with fine to medium subangular gravel.			• 4			26	Damp. High dry strength.
Very stiff do			• 5			13 (9")	do
do			• 6			13	do
Stiff do			• 7			13	do
do			• 8			14	do
do			• 9			13	do
do			• 10	36'-0" End of Borehole		12	do

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Crossing County Road to Duart & Hwy. 401 (W.P. 92-59) ORDER NO. T.429/60

CLIENT Ontario Department of Highways

BOREHOLE NO. BH.1A DIAMETER 2-1/2" CASING 2-1/2"

BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING

FORM G-1A 500
UNITED STATES OF AMERICA

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Same as BH.1	713.9			Zero			
				14'-0"			
Very stiff brown silty CLAY with fine to medium subangular gravel.		• 1				20	Damp. High dry strength. No recovery
		□ ST1					
		• 2				13	No recovery
		□ ST2					No recovery
Stiff brown silty CLAY with fine to medium subangular gravel.		• 3				13	No recovery
				31'-0"			Moist. High dry strength.
				End of Borehole			

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Crossing County Road to Duart & Hwy. 401 (W.P. 92-59) ORDER NO. T.429/60

CLIENT Ontario Department of Highways

BOREHOLE NO. BH.2 DIAMETER 2-1/2" CASING 2-1/2"

BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING

FORM G-1A 500
UNITED STATES GEOLOGICAL SURVEY

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Brown sand and gravel. FILL.	714.2			Zero			
Loose dark brown loam with organic matter. TOP SOIL.			1	1'-3"		9	Damp.
Loose dark grey fine to medium somewhat silty SAND.			2	Free Water		7	Moi. Low dry strength.
do			3			6	Wet. Low dry strength.
With some fine gravel.			4	11'-3"		13	Moist. High dry strength.
Firm dark grey brown silty CLAY with black organic concentrations.			5	11'-9"		33	Damp. High dry strength.
Hard brown silty CLAY with fine to medium subangular gravel.			6			32	do
do			7			18	do
Very stiff do			8			14	Moist. High dry strength.
Stiff do							do
do			ST1	34'-0"			3" recovery

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

SOIL MECHANICS LABORATORY

BOREHOLE LOGPROJECT Crossing County Road to Duart & Hwy. 401 (W.P. 92/59) ORDER NO. T.429/60CLIENT Ontario Department of HighwaysBOREHOLE NO. BH.3 DIAMETER 2-1/2" CASING 2-1/2"BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING FORM 9-1A 800
UNION STATION CO.

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Brown silty sand with gravel, some organic matter. FILL. Loose brown sandy clay, organic concentrations, probably TOP SOIL	713.2			Zero			
Firm dark brown somewhat silty fine SAND.			• 1	3'-3"		6	Damp.
do			• 2	Free Water		17	Moist. Low dry strength.
With fine gravel.			• 3			18	Wet. No dry strength.
do			• 4	11'-3"		13	do Moist. High dry strength.
Stiff gray silty CLAY with some shells, traces of bedding.			• 5	11'-9"		33	Damp High dry strength.
Hard brown silty CLAY with fine to medium subangular gravel.			• 6			32	do
Very stiff do			• 7			26	do
do			• 8			23	do
Stiff to very stiff do			• 9			15	do
Stiff do			• 10			17	No recovery
do			• 11			20	Damp.
do			• 12	43'-0"		14	High dry strength. do
				End of Borehole			

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

UNDISTURBED SAMPLE

SOIL MECHANICS LABORATORY

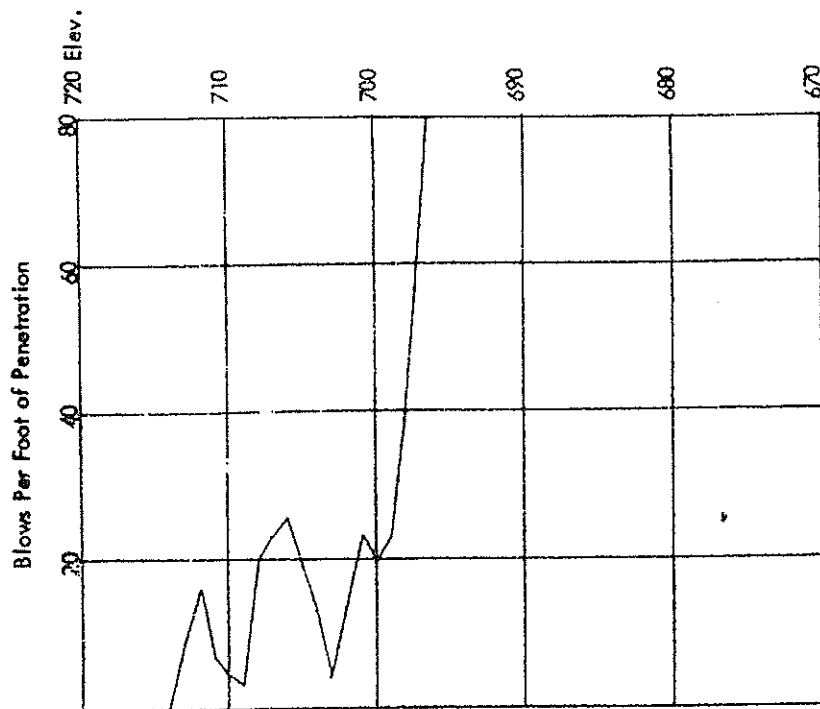
BOREHOLE LOGPROJECT Crossing County Road to Duart & Hwy. 401 (W.P. 92-59) ORDER NO. T.429/60CLIENT Ontario Department of HighwaysBOREHOLE NO. BH.4 DIAMETER 2-1/2" CASING 2-1/2"BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING ---FORM G-1A 100
UNION STATIONERY CO.

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Dark brown silty sand and gravel. FILL.	713.5			Zero			
Brown clayey sand and gravel iron stained. Probably FILL.			• 1	2'-6"		8	Damp.
Firm grey fine to medium somewhat silty SAND.			• 2	Free Water		17	Moist. Low dry strength.
Loose grey SAND with layers of grey silty clay with dark organic concentrations.			• 3	9'-0"		12	Clay: Moist. High dry strength.
do			• 4	12'-0"		23	do Clay: Damp. High dry strength.
Stiff to very stiff brown silty CLAY with fine to medium subangular gravel.			• 5			23	Damp. High dry strength.
do			• 6			20	do
Stiff do			• 7			19	No recovery Damp. High dry strength.
do			• 8			19	No recovery Damp. High dry strength.
do			• 9			17	do No recovery.
			• 10	41'-0"		19	No recovery.
				End of Borehole			

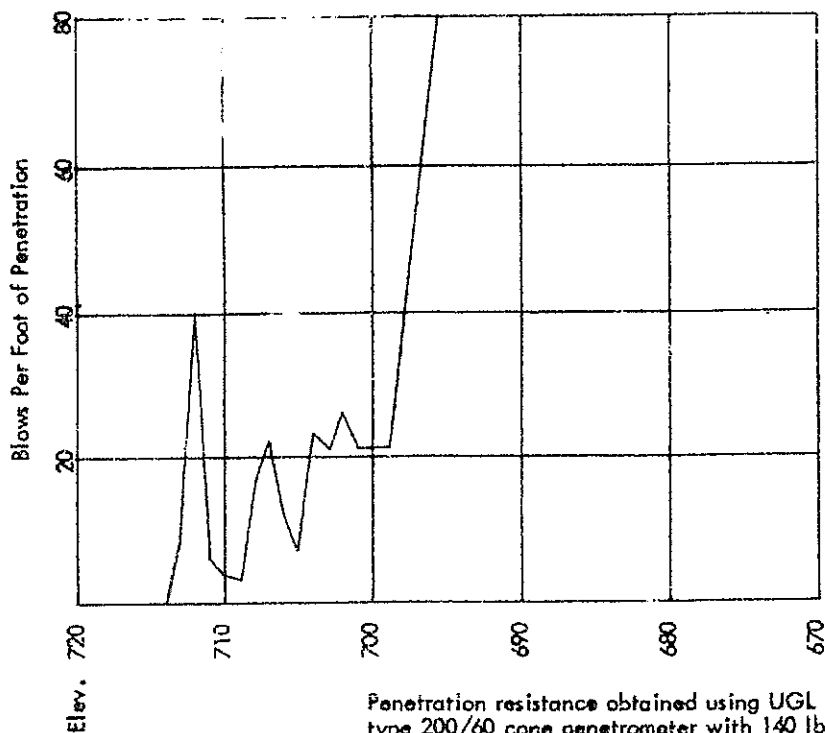
SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

PT. 2



PT. 1



Penetration resistance obtained using UGL
type 200/60 cone penetrometer with 140 lb.
hammer falling 30".

PROJECT Crossing County Road to Quart & Hwy. 401
(W.P. 92-59)

TITLE Dynamic Penetration Test Diagrams

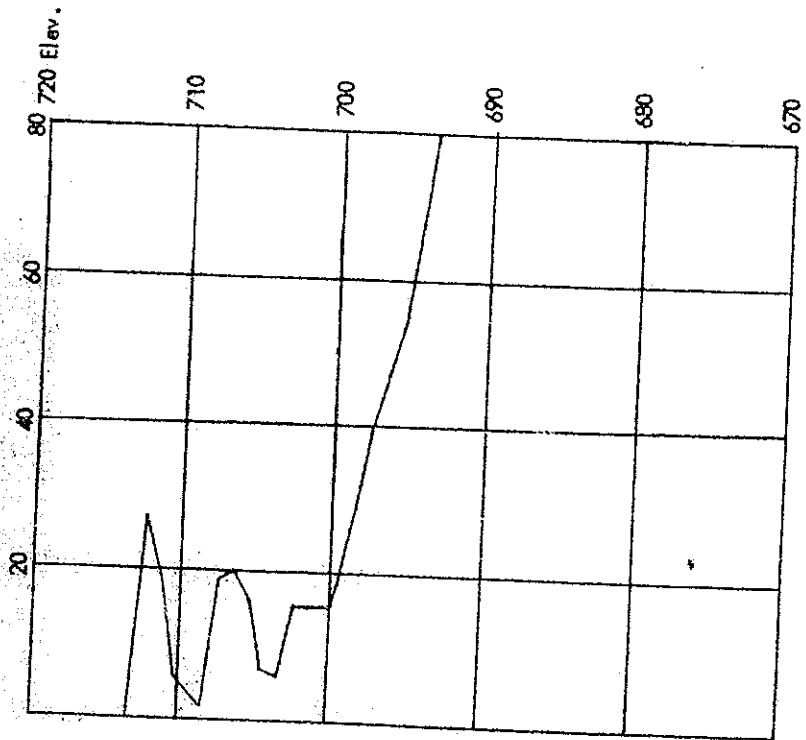
DRG. NO. 4 ORDER NO. I. 92/60



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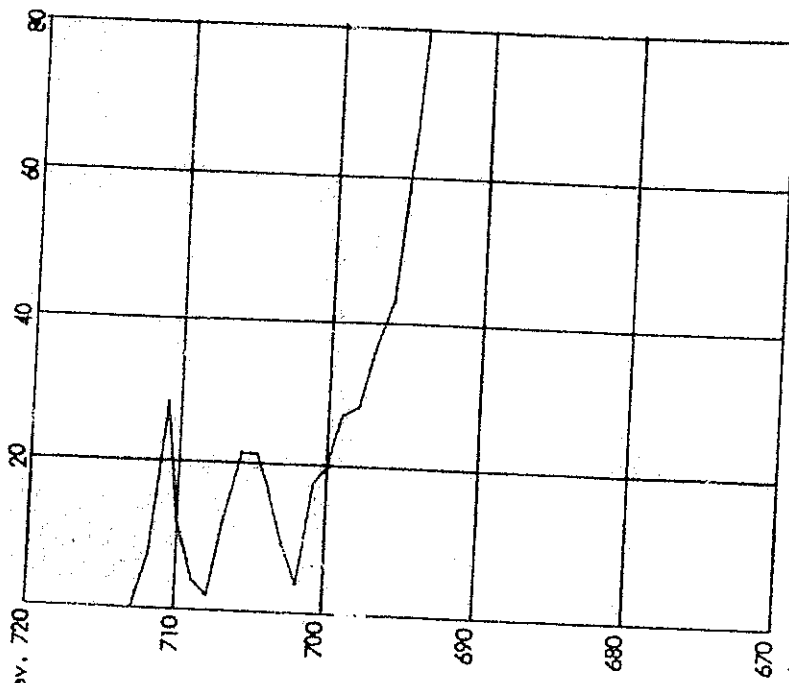
PT. 4

Blows Per Foot of Penetration



PT. 3

Blows Per Foot of Penetration



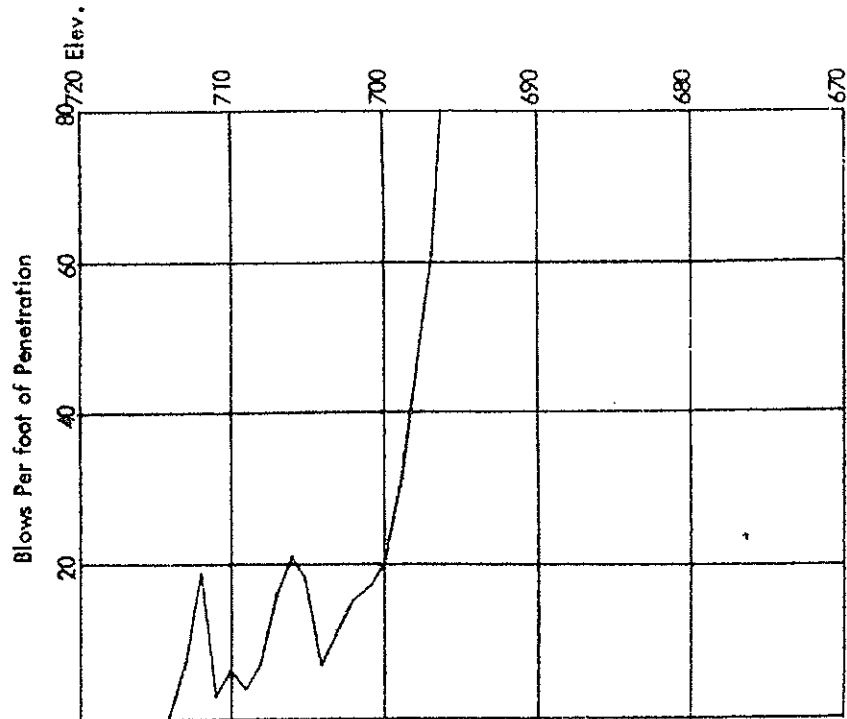
Penetration resistance obtained using UGL type 200/60 cone penetrometer with 140 lb. hammer falling 30".

PROJECT Crossing County Road to Duart & Hwy. 401
 TITLE Dynamic Penetration Test Diagrams
 (W.P. 92-59)
 DRG. NO. 5 ORDER NO. T.429/60

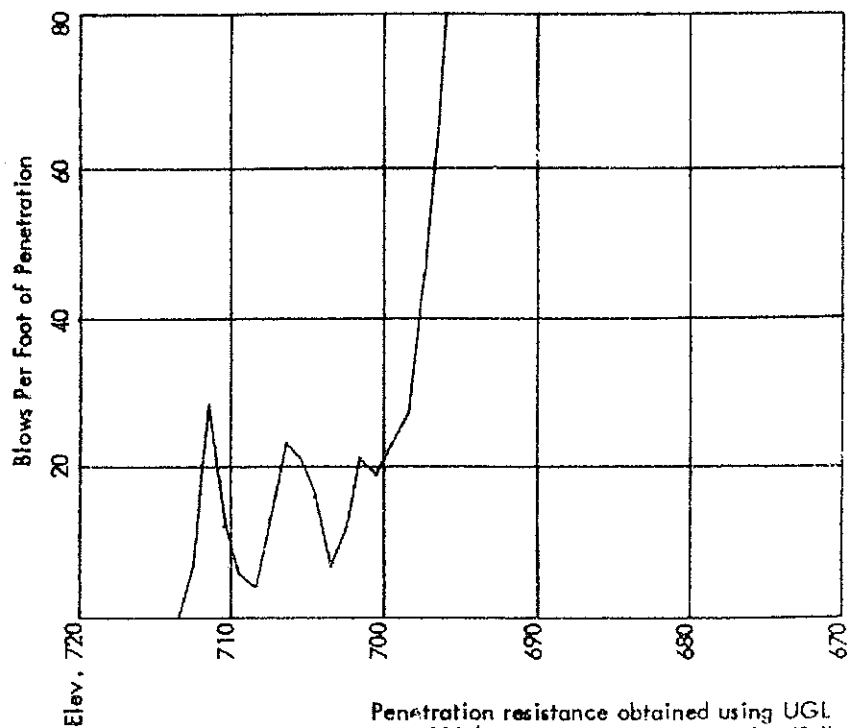


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PT. 6



PT. 5



Penetration resistance obtained using UGL type 200/60 cone penetrometer with 140 lb. hammer falling 30".

PROJECT Crossing County Road to Duart & Hwy. 401
(W.P. 92-59)
TITLE Dynamic Penetration Test Diagrams
DRG. NO. 6 ORDER NO. T.429/60



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