



**TECHNICAL MEMORANDUM
for
PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN
PLAINS ROAD UNDERPASS
HWY 403/HWY 6 INTERCHANGE
WP 2537-09-00; SITE NO. 36-27
CENTRAL REGION, ONTARIO**

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**Technical Memorandum for
PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN**
Plains Road Underpass, Highway 403 – 6 Interchange
WP 2537-09-00; Site No.36-27
Central Region, Ontario

1. INTRODUCTION

The Foundation Engineering Services for this assignment involve the preliminary foundation investigation and design for rehabilitation/replacement of the Plains Road Underpass over Highway 403 EBL and WBL, near Hamilton, Ontario.

The study was carried out for Morrison Hershfield Ltd. on behalf of Ministry of Transportation of Ontario (MTO).

The purpose of this Technical Memorandum for Preliminary Foundation Investigation and Design is to provide a preliminary design level summary of the subsurface and groundwater conditions based on available foundation reports in order to address the foundation aspects of the proposed structural rehabilitation or replacement strategy and to update the foundation design recommendations provided in the available reports to limit state design terminology in conformance with the requirements of the Canadian Highway Bridge Design Code (CHBDC). Further, this report comments on the current relevance and adequacy of the foundation design recommendations provided in the available reports and updates the recommendations for bearing resistance to the current standard for design.

This Technical Memorandum is based on desk top level review of available foundation reports in the MTO GEOCREG Library that are related to these sites. No additional subsurface investigations were carried out. The subsurface description is inferred from the information in the Foundation Investigation Report referenced in Section 2 of this technical memorandum. The foundation assessment is inferred from the recommendations in the Foundation Design Report referenced.



Axial bearing resistance was assessed as an indicator of the adequacy of the foundations for the proposed rehabilitation. The original recommendations are summarized and translated to limit state design terminology per the “Highway Bridge Design Code” (CHBDC). In addition, Foundation Design recommendations in accordance with the requirements of the current CHBDC, based on assessment of subsurface conditions described in the previous Foundation Investigation Report, are provided.

2. SOURCES OF INFORMATION

The following report and drawings were available for review and information for the Plains Road Underpass:

1. Foundation Investigation Report, Proposed Crossing, Hwy 403 and Hwy 6, District No. 4 (Hamilton), W.P. 200-60, Hamilton, Ontario, Geocon Ltd., June 1960. In Geocon’s investigation, 27 boreholes were drilled for four structures – 8 boreholes were carried out for Plains Road Underpass. Locations and Soil Strata (Drawing No. S7033-4) dated April 1960.
2. General Arrangement (Drawing No. 1 for Contract 90-79 dated June 1998).

3. SITE BACKGROUND AND GEOLOGY

The Plains Road Underpass is located near Hamilton, Ontario. A key plan based on Google Map is shown in Figure 1.

The topography of the area is hilly and several ravines provide drainage into Hamilton harbour. The bedrock at the site consists of red shale of the Queenston formation of Ordovician age. The bedrock is overlain by glacial drift that is generally thin at this site.

The Plains Road Underpass carries the traffic over Highway 403 EBL and WBL. The general arrangement drawing for Plains Road – Bridge Deck Rehabilitation (Contract 90-79) June 1998 is shown in Appendix D.



A mass excavation of the natural ground, inferred from the differences in elevation between the original ground elevation at boreholes and the base of constructed footings, varies in depth from up to 10 m along the west side of the Hwy 403 corridor to in the order of 4 m along the east side of the Hwy 403 corridor. This mass excavation appears to have been carried out for the construction of the Hwy 403/Hwy 6 Interchange and the Plains Road Underpass.

The underpass is a five-span bridge with north and south abutments and eight piers. The span arrangement for the underpass is 18.3 m, 25.9 m, 25.9 m, 24.9 m, 11.6 m from west to east. No plans could be discovered that showed the foundation layout and elevations. Based on available information from other contracts such as electrical layout for Contract 96-66, the following approximate elevations are inferred for the indicated locations:

- West Approach 115 m
- WBL Hwy 403 106 m
- EBL Hwy 403 103 m
- East Approach 108 m

From this information, it is inferred that the abutments and piers are founded on spread footings based at the following approximate elevations:

- West Abutment 109 m
- West Pier 104 m
- West Central Pier 104 m
- East Central Pier 101 m
- East Pier 101 m
- East Abutment 104 m

It should be noted that these founding elevations are inferred and are for illustration purposes. They should be verified during the Preliminary Foundation Investigation and Design phase of the project through review of contract drawings showing footing layouts for this structure. However, from the inferred information, it is assumed that the foundations for both abutments and all piers are on spread footings on sound shale bedrock.

The provision of contract documents, if available, would permit confirmation of the foundation details for the existing structure as well as its rehabilitation history.



4. SITE RECONNAISSANCE

As part of the current foundation engineering assessment study, a site reconnaissance of the Plains Road Underpass was carried out in spring 2013. A photographic record of the site visit is attached in Appendix C. It is understood that a preliminary foundation investigation and design will be carried out as a subsequent phase of this project and include a more comprehensive foundation inspection.

The following observations are based on the photographic record. The observations and assessments are limited to performance of the foundations. They are not intended to represent a structural assessment of the bridges.

The site photos illustrate conditions at the north and south abutments and piers of the W-N ramp at the time of photography. They refer to the appearance of the structure, visual conditions relating to slope stability, bridge deck condition, expansion joint condition, drainage and vegetation (photographs 1 to 25). Some cracks were observed on the structure and the drainage system appeared to be in poor condition. The surface of the slope appeared to be in stable condition.

5. FOUNDATION INVESTIGATIONS AND SUBSURFACE CONDITIONS

Based on the foundation report completed by Geocon Ltd. in February 1960 for the proposed Plains Road Underpass (referred to as Highway 6 over Chedoke East and West-Bound Lanes (Reference 1), a general description of the foundation investigation and the subsurface conditions encountered at the site at the time of the 1960 foundation investigation follows:

- Eight (8) boreholes, numbered 14, 15, 16, 17, 18, 19, 20, and 21, were advanced. Additional bedrock core holes 18A, 19A and 21A were put down adjacent to boreholes 18, 19 and 21. Boreholes were advanced up to 8 m deep. A section illustrating the borehole locations and Soil Strata is provided in Appendix A.



- The surficial deposit at the time of the 1960 investigation was hard reddish-brown glacial till in the order of 2 m thick, underlain by reddish brown shale bedrock that was weathered its upper few metres. The mass excavation for the construction of the Hwy 403/Hwy 6 interchange altered the stratigraphy so that shale is at the surface of cut slopes and at the founding levels for footings.
- During the 1960 investigation, the water levels in the boreholes were influenced by surface water. Due to the very low permeability of the till and shale, accurate information regarding groundwater could not be obtained. Although more information was obtained by long term observations of piezometers installed at various elevations, the groundwater level information was considered to be inconclusive (Refer to Appendix B for more information).
- Refer to the Appendix A for a borehole location plan and stratigraphical profile for the 1960 foundation investigation. The Record of Borehole sheets and groundwater information of the 8 boreholes are presented in Appendix B.

Although unproven by subsurface investigation, it is inferred that the foundations for the Plains Road Underpass are in shale bedrock and that the groundwater is perched near surface.

6. DISCUSSION AND FOUNDATION RECOMMENDATIONS

6.1 1960 Report

The foundation report (Reference 1) recommended and the contract documents inferred that spread footings were used for the foundations for both abutments and all piers.

The report also recommended that exposed shale in excavations should immediately be covered by lean concrete and that measures should be taken to protect the foundation surface from exposure to water.

The report recommended that the temporary cut slopes in the shale or glacial till overburden should be no steeper than 1H:1V. It was further recommended that, due to the susceptibility of the shale to deterioration under weathering, the duration of exposure of the steep slopes be minimized by backfilling behind walls as construction progressed.



The report noted that permanent slopes in till and shale would be subject to deterioration with time and that local failures could be caused by weathering and erosion. Therefore, it was recommended that a 2H:1V grade or flatter be used for permanent cut slopes where the vertical height did not exceed 6 m. It was further recommended that the cut slopes should be benched as necessary so that no uninterrupted 2H:1V slope would be higher than 6m. Benches were to be in the order of 3 to 6 m in width and back-sloped away from the road at a slope of about 15H:1V towards an interceptor drain at the toe of the higher slope tier (at the inner end of each bench).

6.2 Current Foundation Assessment

With regard to the assessment of the existing structure foundations, axial bearing resistance was used as the indicator of the adequacy of the foundations for the proposed rehabilitation. Table 1 provides the original foundation design axial bearing recommendations in the original working stress format and converted to Limit State Design format along with preliminary PML recommendations for upper level bearing resistance values updated to reflect current industry practice.

It should be noted that the referenced foundation report recommended an allowable bearing pressure for spread footings of 1000 kPa. However, it is considered unlikely that the actual bearing resistance used for design was as high as 1000 kPa. The actual bearing pressures imposed on footings were not available at the time of reporting. It is recommended that the Structural Designer should confirm that the actual bearing pressures imposed are less than the bearing resistances recommended in this report.

In consideration of this uncertainty and in order to determine the acceptability of the existing foundations for the proposed rehabilitations, the loads imposed by the rehabilitation design should be less than whichever of the following 2 criteria that provides the lesser resistance value in conformance with the requirements of the CHBDC:

1. The PML recommended upper limit 'updated to current industry practice' values indicated in Table 1.



2. One hundred ten percent (110%) of the actual bearing resistances (that should be discovered by the Structural Engineer) used for design of the existing structure design.

The bearing resistances used for design of the rehabilitated structure should not exceed either lesser value from criteria 1 and 2 above.

It is understood that bridge rehabilitation will include lowering the grade of Hwy 406 by 0.32 m at the EBL only. No foundation issues are anticipated regarding the planned grade lowering provided that excavations do not encroach upon a 1H:1V plane projecting down from the edge of existing footings and provided that permanent slopes in bedrock are protected from weathering.

As there was a comprehensive Foundation Investigation and Design Report available along with relatively detailed contract documents, it is considered that the information from these references is of reasonably high reliability and that the recommendations for assessment of the suitability of the existing foundations for the proposed rehabilitation are reasonably reliable subject to the conditions noted above.



7. CLOSURE

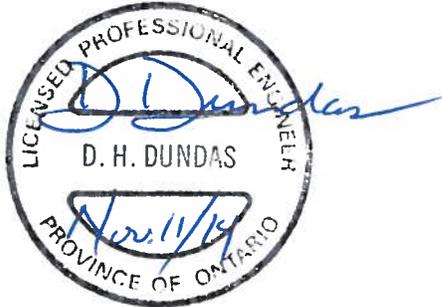
This Technical Memorandum for Preliminary Foundation Investigation and Design was prepared by Ms. Marzieh Kamranzadeh, MSc, Project Supervisor (EIT) and reviewed by Mr. David Dundas, P.Eng., Senior Engineer. Mr. C.M.P. Nascimento, P.Eng., Project Manager, MTO Designated Principal Consultant, conducted an independent review of the report.

Yours very truly,

Peto MacCallum Ltd.

A handwritten signature in blue ink, appearing to read "Marzieh Kamranzadeh".

Marzieh Kamranzadeh, MSc
Project Supervisor (EIT), Geotechnical Services



David Dundas, P.Eng
Senior Engineer



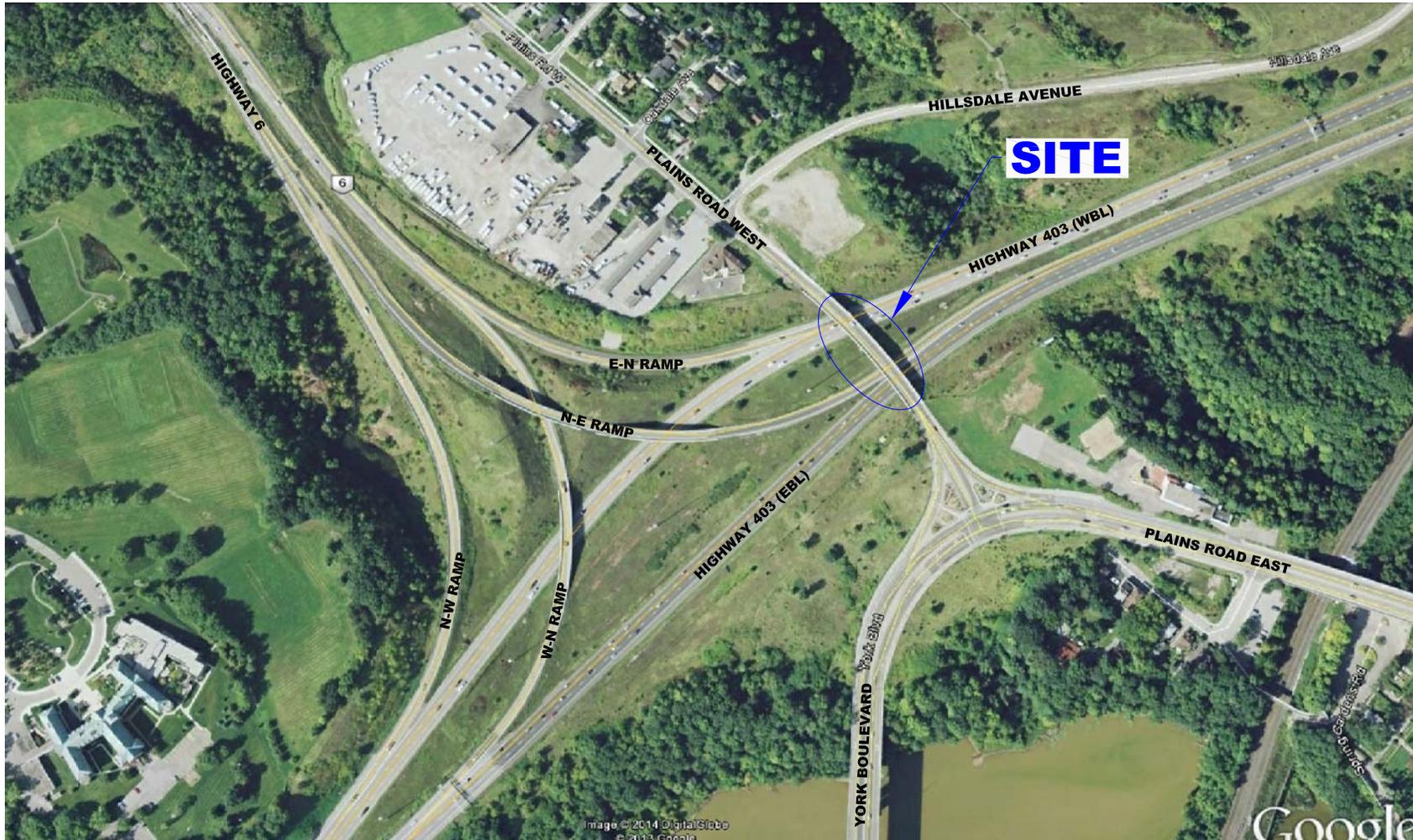
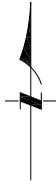
Carlos M. P. Nascimento, P.Eng
Project Manager
MTO Designated Principal Contact



TABLE 1
FOUNDATION DESIGN ASSESSMENT (Preliminary Recommendations)

Foundation	Foundation Type	Estimated Founding Elevation***		Previous Working Stress Values		Previous Equivalent Limit State Design Values*				PML upper limit Limit State Design Values updated to current industry practice**			
		(ft)	(m)	Safe Bearing Resistance (tons/sf)	Safe Load Resistance (tons)	Bearing Resistance (kPa)		Load Resistance (kN)		Bearing Resistance (kPa)		Load Resistance (kN)	
						SLS	Factored ULS	SLS	Factored ULS	SLS	Factored ULS	SLS	Factored ULS
West Abutment	Spread footing	357	109	10	N/A	1000	1500	N/A	N/A	1000	1500	N/A	N/A
West Pier	Spread footing	341	104	10	N/A	1000	1500	N/A	N/A	1000	1500	N/A	N/A
West Central Pier	Spread footing	341	104	10	N/A	1000	1500	N/A	N/A	1000	1500	N/A	N/A
East Central Pier	Spread footing	331	101	10	N/A	1000	1500	N/A	N/A	1000	1500	N/A	N/A
East Pier	Spread footing	331	101	10	N/A	1000	1500	N/A	N/A	1000	1500	N/A	N/A
East Abutment	Spread footing	341	104	10	N/A	1000	1500	N/A	N/A	1000	1500	N/A	N/A

Notes: * The converted Ultimate Limit State design values are based on the working stress values.
 **Refer to Section 6 DISCUSSION AND RECOMMENDATION – Current Foundation Assessment for conditions of use. No field verifications were made.
 *** Elevations are based on inferred information and are approximate and for illustration purposes. Elevations should be verified for use in design.



**PRELIMINARY FOUNDATION
INVESTIGATION AND DESIGN**

**PLAINS ROAD
HIGHWAY 403 / HIGHWAY 6 E-N RAMP UNDERPASS
HAMILTON, ONTARIO**

KEY MAP



Peto MacCallum Ltd.
CONSULTING ENGINEERS

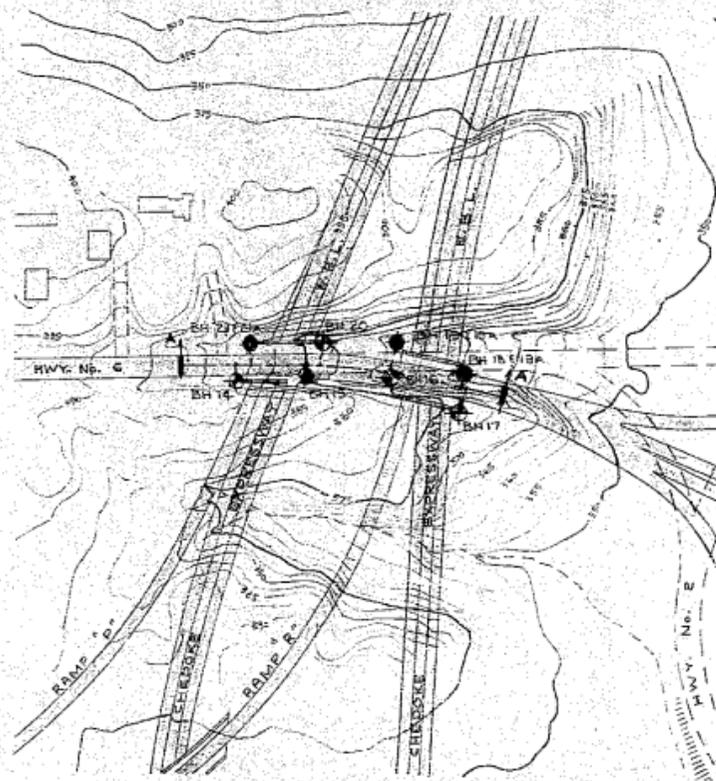
DRAWN:	N.A.	DATE	SCALE	JOB NO.	FIGURE NO.
CHECKED:	M.K.	NOV. 2014	1 : 4,000	13TF017A	1
APPROVED:	C.N.				

REFERENCE:
THIS FIGURE WAS PREPARED FROM THE GOOGLE MAP - MAPDATA @ 2013 GOOGLE.

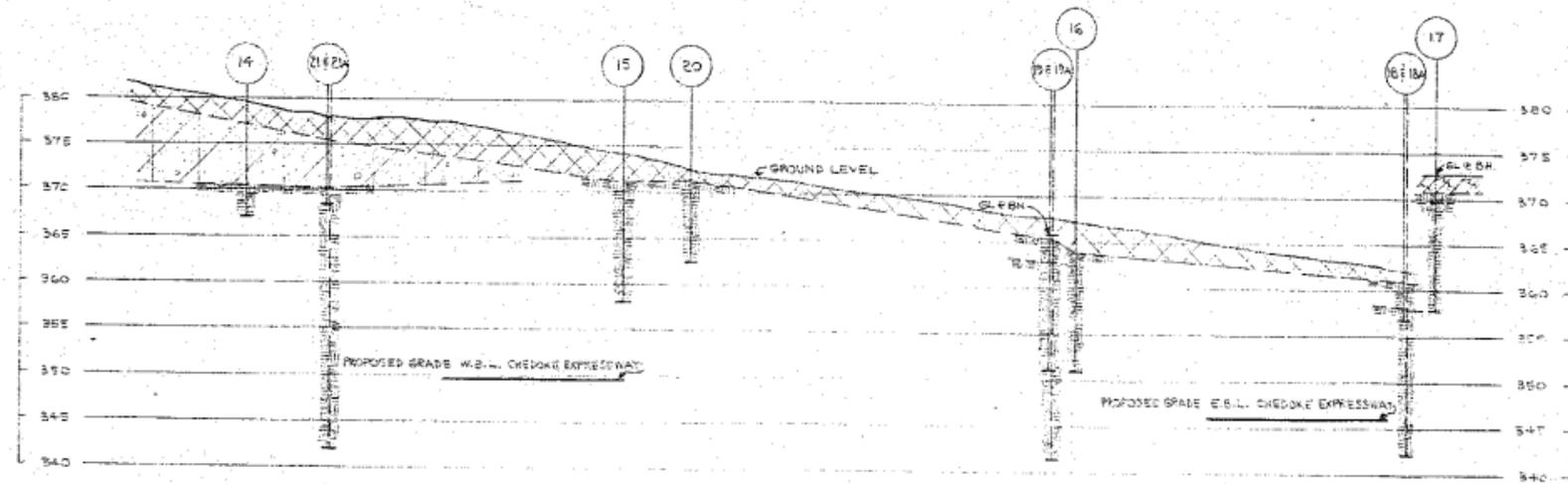
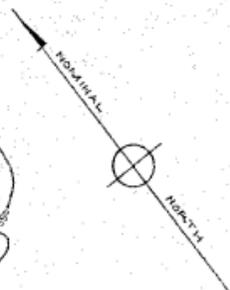


APPENDIX A

Borehole Location and Soil Stratigraphy



PLAN
SCALE 1" = 100'-0"



SECTION A-A

HORIZ. SCALE 1" = 20'-0"
VERT. SCALE 1" = 10'-0"

LEGEND

- BOREHOLE WITH INTERMITTENT SAMPLING IN PLAN
- BOREHOLE WITH INTERMITTENT SAMPLING AND ADJACENT CONTINUOUS CORE SAMPLING IN PLAN
- BOREHOLE WITH INTERMITTENT SAMPLING IN ELEVATION
- BOREHOLE WITH INTERMITTENT SAMPLING AND ADJACENT CONTINUOUS CORE SAMPLING IN ELEVATION
- END OF HOLE "INTERMITTENT SAMPLING"
- END OF HOLE "CONTINUOUS CORE SAMPLING"

STRATIGRAPHY

- ▨ SILTY TOPSOIL
- ▨ GRANULAR ROAD FILL
- ▨ HARD REDDISH-BROWN CLAYEY SILT TILL
- ▨ WEATHERED REDDISH-BROWN SHALE
- ▨ SOFT SOUND REDDISH-BROWN SHALE BEDROCK

REFERENCE: C. C. PARKER & PARTNERS, BRINDENHOFF LTD.
DRAWING OF CHEOKE EXPRESSWAY TEST BOREHOLES LOCATIONS
DATED: JAN. 8, 1960.

DEPARTMENT OF HIGHWAYS, ONTARIO
TORONTO ONTARIO
PROPOSED CHEOKE EXPRESSWAY
HIGHWAY 6 OVER CHEOKE E.W.B.L.
HAMILTON ONTARIO
BORING PLAN AND SOIL STRATIGRAPHY

GEOCON LTD

DATE APRIL 4, 1960 SCALE AS SHOWN

MADE BY M.V. CHD. APPD. No. 37035-3

Technical Memorandum for Preliminary Foundation Investigation and Design
Plains Road Underpass, Hwy 403/Hwy 6 Interchange
WP 2537-09-00, Site No. 36-27, Index No.: 068TMEM
PML Ref.: 13TF017A-3, November 10, 2014



APPENDIX B

Relevant Record of Borehole Sheets

GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT 57033 BORING # APPEX III 16 AND 17 DATUM GEODETIC CASING
 BORING DATE JAN. 18, 1960 REPORT DATE FEB. 15, 1960 COMPILED BY J. A. CHECKED BY F.
 SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN. LBS. ENERGY)

SAMPLE CONDITION



- A.S. AUGER SAMPLE
- ST. SLOTTED TUBE
- W.S. WASHED SAMPLE
- DO. DRIVE-OPEN
- DF. DRIVE-FOOT VALVE
- C.S. CHUNK SAMPLE

SAMPLE TYPES

- FS. FOIL SAMPLE
- SO. SLEEVE-OPEN
- SF. SLEEVE FOOT VALVE
- TO. THIN WALLED OPEN
- RC. ROCK CORE

ABBREVIATIONS

- V. IN-SITU VANE TEST
- M. MECHANICAL ANALYSIS
- U. UNCONFINED COMPRESSION
- QC. TRIAXIAL CONSOLIDATED QUICK
- Q. TRIAXIAL QUICK
- S. TRIAXIAL SLOW
- γ. WET UNIT WEIGHT
- K. PERMEABILITY
- C. CONSOLIDATION
- WL. WATER LEVEL IN CASING
- WT. WATER TABLE IN SOIL

SOIL PROFILE

ELEV. DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE
367.3 0.0		GROUND LEVEL		370
364.1 3.2		GRANULAR ROAD FILL	X	365
351.3 16.0	SEE REPORT	SOFT SOUND REDDISH-BROWN SHALE BEDROCK	X	360
		END OF HOLE		350
372.8 0.0		GROUND LEVEL		375
370.8 2.0		SILTY TOPSOIL	X	370
357.8 15.0	SEE REPORT	WEATHERED REDDISH-BROWN SHALE	X	365
		SOFT SOUND REDDISH-BROWN SHALE BEDROCK	X	360
		END OF HOLE		350

WATER CONTENT W ₁ NAT. L _w P _w	
DYNAMIC PENETRATION TEST BLOWS PER FOOT	
<u>16</u>	
<u>17</u>	

OTHER TESTS			
CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS FT.
X	SS	1	12
X	SO	2	>100
X	A.S.	3	>100
X	A.S.	4	>100
X	SO	7	>100
X	SO	8	>100
X	A.S.	9	—
X	P.S.O.	10	>100
X	A.S.	11	—
X	A.S.	12	—
X	P.S.O.	1	28
X	SO	2	87
X	A.S.	3	—
X	P.S.O.	4	>100
X	A.S.	5	—
X	A.S.	6	—
X	P.S.O.	7	>100
X	A.S.	8	—
X	A.S.	9	—
X	A.S.	10	—
X	A.S.	11	—
X	A.S.	12	—



APPENDIX C

Site Photographs from Field Reconnaissance



Photograph 1: North Bearings.



Photograph 2: South Side Looking North.



Photograph 3: South Side Looking South.



Photograph 4: South Joint.



Photograph 5: EBL Looking East.



Photograph 6: EBL Looking West.



Photograph 7: Highway 6 on Ramp Looking West.



Photograph 8: WBL Looking West.



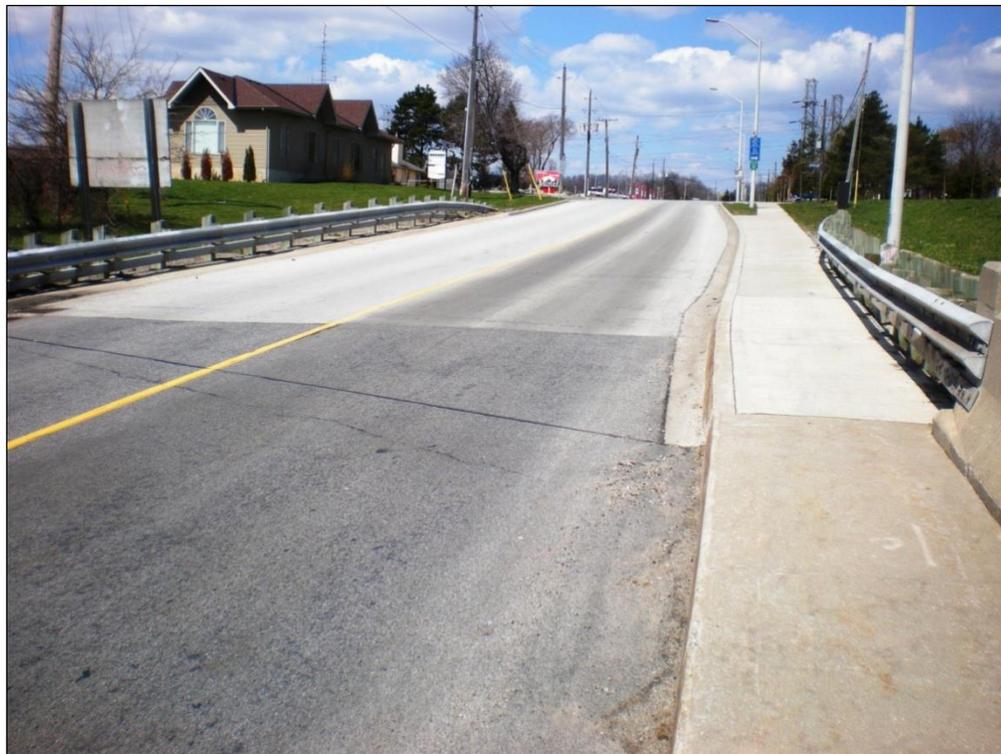
Photograph 9: WBL Looking East.



Photograph 10: North Joint.



Photograph 11: North End Looking South.



Photograph 12: North Side Looking North.



Photograph 13: East Side Looking South.



Photograph 14: South Slope Paving.



Photograph 15: South Abutment.



Photograph 16: South Bearing.



Photograph 17: SE Abutment.



Photograph 18: EBL Approach.



Photograph 19: EBL Approach.



Photograph 20: EBL Approach Underside.



Photograph 21: SW Pier.



Photograph 22: Looking North.



Photograph 23: North Slope Paving.



Photograph 24: North End.



Photograph 25: Rusted Deck Drain.



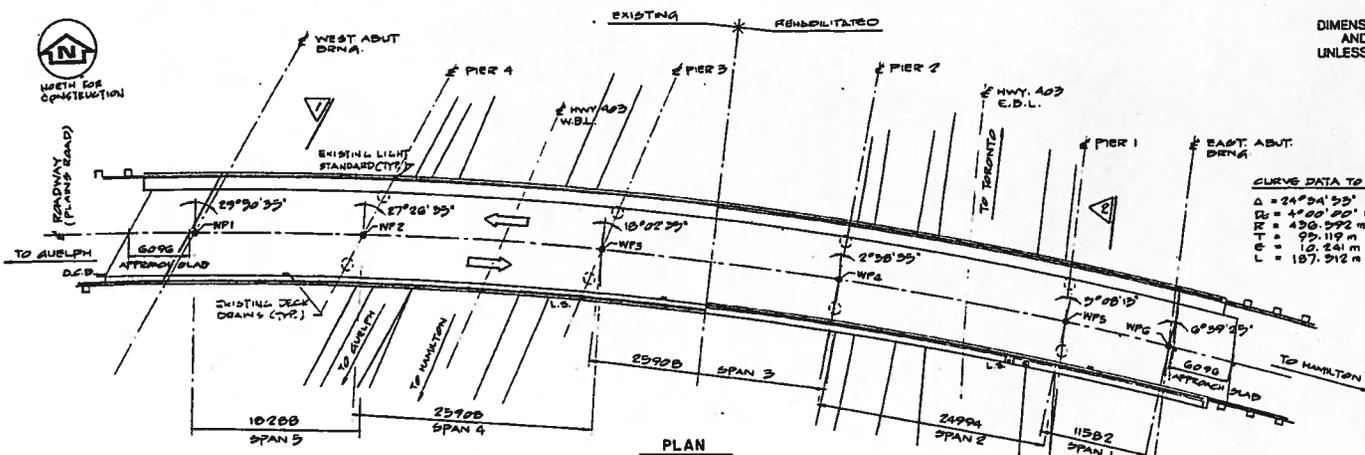
APPENDIX D

General Arrangement of Hwy 403/Hwy 6 Interchange Plains Road Underpass

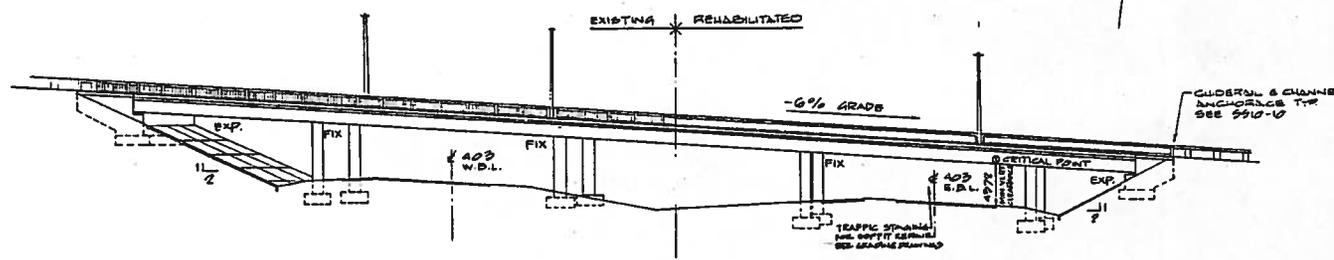


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DISTRICT 4		
CONT No	90-79	
WP No	171-87-01	SHEET 27
PLAINS ROAD BRIDGE DECK REHABILITATION GENERAL ARRANGEMENT		
DELCAN		ENGINEERING PLANNERS ARCHITECTS



CURVE DATA TO ROAD
 $\Delta = 24^{\circ}34'55''$
 $D_c = 4^{\circ}00'00''$ LT.
 $R = 430.592$ m
 $T = 93.119$ m
 $E = 10.241$ m
 $L = 187.312$ m



GENERAL NOTES:

- CLASS OF CONCRETE.**
ALL CONCRETE 30MPa (UNLESS OTHERWISE SPECIFIED).
- CLEAR COVER TO REINFORCING STEEL.**

DECK TOP	70 + 20mm
DECK BOTTOM	50 + 10mm
CURBS, BARRIERS, SIDEWALKS	70 + 20mm
ABUTMENTS AND WINGSALLS	75 + 20mm
PIERS	80 + 20mm
APPROACH SLABS	70 + 20mm

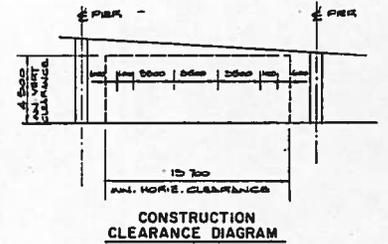
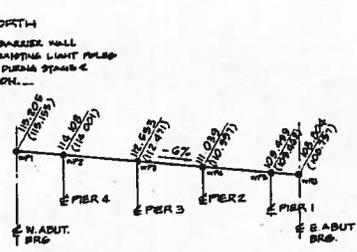
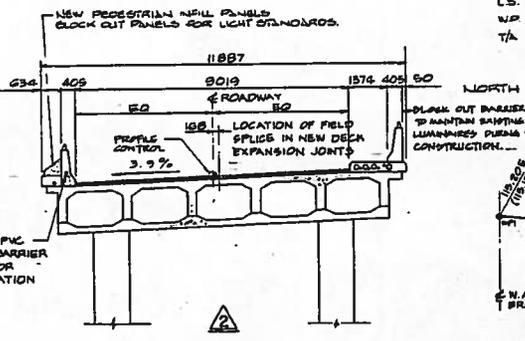
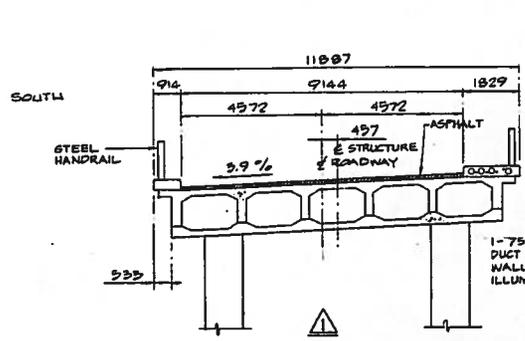
 OR AS NOTES ON THE DRAWINGS.
- REINFORCING STEEL.**
REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH SUFFIX 'C' DENOTE COATED BARS.
- CONSTRUCTION NOTES**
THE CONTRACTOR IS RESPONSIBLE FOR VERIFYING ALL RELEVANT DIMENSIONS, ELEVATIONS AND DETAILS OF EXISTING STRUCTURE AND IS TO REPORT ANY DISCREPANCIES TO THE ENGINEER BEFORE COMMENCING ANY FABRICATION OR CONSTRUCTION. ALL CONCRETE BARCASTS TO BE 25mm DEEP OR TO FIRST LAYER OF REINFORCING STEEL, WHICHEVER IS LESS, FOR SINKING DETAILS AND MAINTENANCE OF TRAFFIC SEE SHEETS 3, 4 AND 5.
- REFERENCE PLANS**
DETAILS OF EXISTING BRIDGE HAVE BEEN DERIVED FROM DRAWINGS No. TP151-27-1-4 TO TP151-27-25-4.

6. LIST OF DRAWINGS

1 GENERAL ARRANGEMENT	12 CONCRETE RESTORATION
2 SCOPE OF WORK	13 ABUTMENT REPAIRS
3 REPLACEMENT OF DECK JOINTS	14 BEARING REPAIR DETAILS
4 JOINT SINKAGE AND ANCHORING	15 ELECTRICAL EMBEDDED WORK
5 BARRIER WALL 1	16 MISCELLANEOUS DETAILS 1
6 BARRIER WALL 2	17 MISCELLANEOUS DETAILS 2
7 BARRIER WALL 3	
8 RAILING FOR BARRIER WALL 1	
9 RAILING FOR BARRIER WALL 2	
10 SOFFIT REPAIR 1	
11 SOFFIT REPAIR 2	

LEGEND

L.S. DENOTES LIGHT STANDARD
 W.P. DENOTES WORKING POINT
 T/A DENOTES TOP OF ASPHALT.



NEW PROFILE T/A ALONG & ROADWAY
ELEVATIONS IN BRACKETS REFERS TO EXISTING ELEV.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

NO.	DATE	BY	CHECK	DESCRIPTION	DATE	BY
DESIGN	E.A.M.	CHECK	K.D.P.	LOADING		
DRAWING	J.H.	CHECK	K.D.P.	DATE	NO 36-87	DWG

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