

APPENDIX C: TECHNICAL SUPPORTING DOCUMENTS

APPENDIX C-8: GEOTECHNICAL B-LINE

PART 1/1



Memorandum

To	Peter Olak, P.Eng.	Page 1
CC	Dean Simpson, P.E., Zaineb Al Mumayez, P.Eng.	
Subject	Geotechnical Review- Hamilton Rapid Transit Preliminary Design and Feasibility Study (B-line), September 2011	
From	Gwangha Roh, P.Eng., Ph.D., Eric Tiedje, EIT, Ph.D., Miln Harvey, P.Eng., Ph.D.	
Date	October 14, 2016	Project Number 60507521

1. Introduction

Metrolinx is working with the City of Hamilton to develop rapid transit through a Light Rail Transit (LRT) system. An Engineering and Environmental Assessment (EA) has been conducted by Steer Davis and Gleave (September 2011) for the initial proposed LRT consisting of a 14 km east-west B-Line. As part of the EA engineering support (requested by SDG and Metrolinx), the previous geotechnical EA assessment (Appendix B.7 of SDG EA report) prepared by Thurber Engineering Ltd. for the B-line only was reviewed by AECOM.

This memorandum presents a review summary of geotechnical evaluation and provides additional preliminary recommendations to finalize the B-line geotechnical EA report.

2. Project Changes after EA Submission in 2011

The following changes were made after submission of the SDG EA report (September 2011)

- Total B-line length was reduced from approximately 14 km to approximately 11 km; and,
- Number of stops on the B-line was reduced from 18 to 13.

3. Subsurface and Groundwater Conditions

Since the proposed LRT alignment is not changed, the previous geotechnical EA findings on the subsurface and groundwater conditions are still applicable. Eight (8) additional boreholes close to the proposed B-Line corridor were found in a review of the City of Hamilton's geotechnical database, but there is no significant impact on the provided subsurface and groundwater conditions in the 2011 geotechnical EA report.

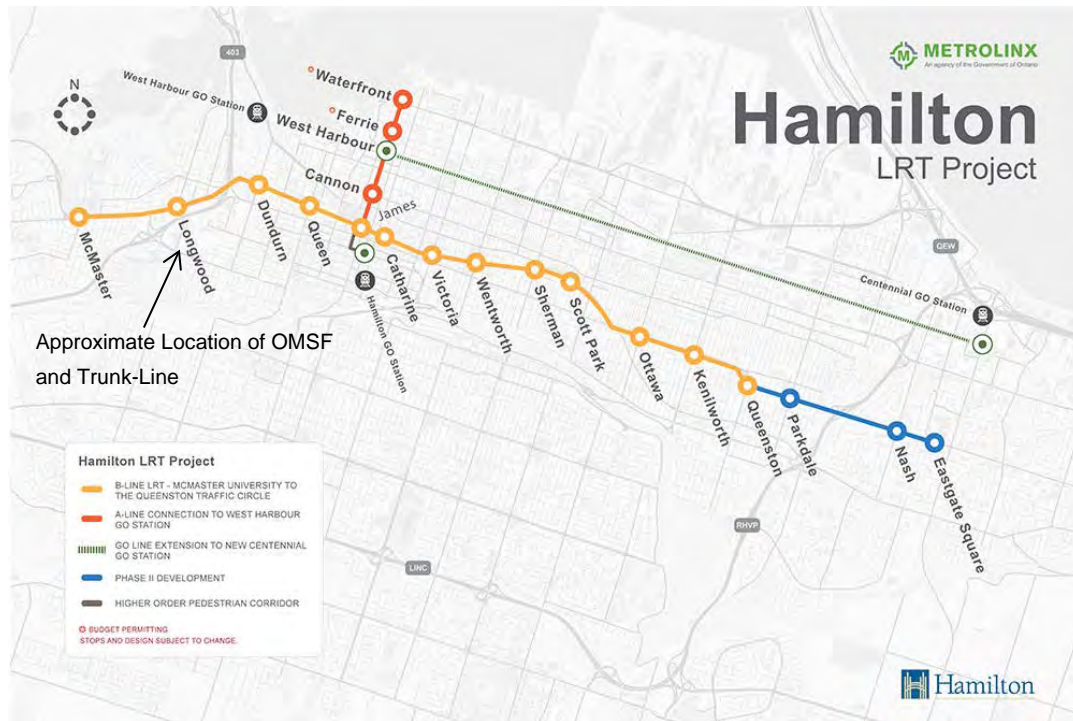


Figure 3.1. Updated LRT Plan.

(<https://www.hamilton.ca/city-initiatives/priority-projects/light-rail-transit-lrt>)

4. Review of EA Geotechnical Evaluation and Preliminary Recommendations

A preliminary geotechnical evaluation and various recommendations were provided in Section 5.0 of the geotechnical EA report. AECOM has provided comments on this section and additional recommendations are provided below.

4.1 Track Design

The provided LRT track design is similar to the typical LRT track design presented in the Transportation Research Board (TRB) Transit Cooperative Research Program (TCRP) Report 155 "Track Design Handbook for Light Rail Transit". Typical 3% cross fall on the subgrade level, 300 mm thick Granular 'A', sub-drain, an approximately thick 250 mm first pour and 200 mm thick second pour were presented on the typical cross section. Actual track structural design should be carried out with consideration of site-specific subsurface and groundwater conditions as well as traffic loading conditions.

Provided subgrade modulus values should be verified during the detailed design stage, and typical values for a preliminary design purposes can be found in the Chapter 7 of the latest Canadian Foundation Engineering Manual (CFEM, 4th Edition).

Table 4.1.1. Typical Ranges in Vertical Modulus of Subgrade Reaction, From CFEM, Chapter 7.

Soil Type	k_{v1} (MPa/m) ^(*)
Granular Soils (Moist to Dry)^(*)	
Loose	5 – 20
Compact Sand	20 – 60
Dense	60 – 160
Very Dense	160 – 300 ^(*)
Cohesive Soils	
Soft	< 5
Firm	5 – 10
Stiff	10 – 30
Very Stiff	30 – 80
Hard	80 – 200 ^(*)

*Detail notes, please refer to CFEM Chapter 7

Depending on the site-specific subsurface conditions and subgrade inspection findings during construction, proper frost mitigation measures should be implemented to minimize any frost related maintenance issues. For a preliminary design purposes, most commonly used MTO frost susceptibility criteria is provided in the table below.

Table 4.1.2. Frost Susceptibility of Soils (MTO).

Grain Size (5 to 75 μ m)	Susceptibility to Frost Heave
0 to 40%	Low
40 to 55%	Moderate
55 to 100%	High

If a detailed frost study is required, the following factors should be considered:

- Seasonal ground temperatures and thermal gradients;
- Mobility of water;
- Seasonal depth of the groundwater table; and
- Soil type and condition (e.g. segregation potential).

Consideration can also be given to the use of geo-synthetics depending on subgrade condition.

4.2 LRT Stop Foundations

Although the geotechnical EA report noted that foundations should be placed below the frost depth (1.2 m), the typical stop platform detail presented in the geotechnical EA report has about 1.8 m of earth cover, reprinted in Figure 4.2.1. This may be due to site-specific subsurface and groundwater conditions. It is suggested to present a minimum frost cover requirement (1.2 m) on the typical drawing instead of site-specific foundation depth.

In case of using short caisson foundations in a frost susceptible soil with a high groundwater table, adfreezing/frost heave uplift mitigation should also be considered.

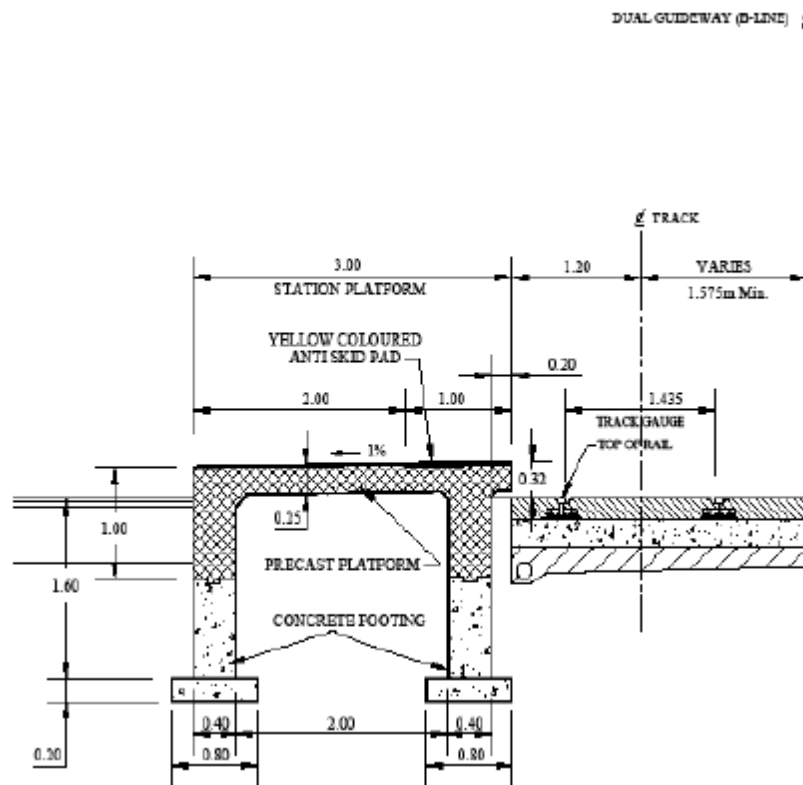


Figure 4.2.1. Typical Stop Platform Detail
 (SDG B-Line EA Report, Appendix B.7, Figure 5.2).

4.3 OCS Pole Foundations

Based on the available borehole data, it is anticipated that conventional concrete cast-in-place piles (caissons) could be used for supporting the LRT OCS and light poles. Locally deeper caissons may be required due to the observed poor quality fill and loose native soils near the existing grade. It should be pointed out that the Contractor shall be aware of the possible obstructions (such as demolition rubble in the fill and cobbles/boulders in the native sand/gravel and clay till) during the caisson installation.

Caissons under lateral loading conditions should be analyzed and designed using the method described by Broms, as detailed in the following papers:

- Broms, B.B.: *Lateral Resistance of Piles in Cohesive Soils*, Journal of the Soil Mechanics and Foundations Division, ASCE, Vol. 90, SM2, March 1964.
- Broms, B.B.: *Lateral Resistance of Piles in Cohesionless Soils*, Journal of the Soil Mechanics and Foundations Division, ASCE, Vol. 90, SM3, March 1964.
- Broms, B.B.: *Design of Laterally Loaded Piles*, Journal of the Soil Mechanics and Foundations Division, ASCE, Vol. 91, SM3, May 1965.

Alternatively, consideration can be given to the use of p-y curve approach (as per CFEM Chapter 18).

In any case, a passive resistance of soil within the frost depth should be ignored for the OCS pole design.

4.4 Highway 403 Structure Foundations

AECOM has prepared General Arrangement drawings (see Appendix A) for a 10-span highway bridge which will carry two LRT tracks over Highway 403 between Main Street West and King Street West. This structure can be supported on deep foundations such as driven steel H-piles or cast-in-place concrete caissons.

It should be noted that a buried CSO storage tank and outfall channel are located between King Street West and Main Street West on the east side of the Highway 403 and the exact location and depth of these structures should be considered for the detailed bridge foundation design.

The provided driven H-pile capacities (a factored geotechnical axial resistance of 1600 kN/pile at ULS and geotechnical axial reaction of 1200 kN/pile at SLS, for HP 310x110) may be based on the previous MTO pile load test results (in early 1960's, GEOCRE 30M05-65) in the vicinity and the old MTO driven pile capacity guidelines. MTO driven H-pile capacity limits have been changed as outlined in Table 4.4.1:

Table 4.4.1. H-Pile Capacity as Specified by the MTO.

Year	Pile Types	Pile Capacity Limit	
		Factored axial geotechnical resistance at ULS (kN)	Axial geotechnical reaction at SLS (kN)
Before 1998	HP 310x110	1600	1150
	HP 310 X 79	1150	825
1998-2011	HP 310x110	2000	Upon pile settlement < ULS
	HP 310 X 79	1450	Upon pile settlement < ULS
After 2011	regardless	Based on the geotechnical resistance of piles	Upon pile settlement

It is suggested that dynamic pile load tests be performed (e.g. PDA, CAPWAP etc.) to confirm the design pile capacity for a cost-effective foundation design.

Typical rock-shale adhesion of 400 to 800 kPa (factored) can be used for cast-in-place concrete pile designs (socketed into bedrock) depending on the bedrock quality. Rock socketed caisson capacity can be verified by field tests (e.g. Osterberg cell). Typically rock socketed caissons use either shaft resistance or end bearing only depending on construction details due to the anticipated strain related pile resistance development.

The use of wing walls or RSS walls at the abutment locations is not clearly identified. Approach fill details are not known. Embankment and retaining structure stability and serviceability (settlement) should be assessed in the detailed design stage.

4.5 CP Crossing at King Street and Highway 403 Foundations

Based on the latest LRT plan drawing, no widening of existing CP overhead will be required. MTO GEOCRE 30M05-034 (King Street Overhead & Church Access Overhead for Chedoke Express way, 1960) and contract drawings (see Appendix A) are available for the nearby CP overhead structure on Hunt Street. The Hunt Street CP overhead structure is supported by spread footings placed at approximately El. 85 m and a bearing capacity of 6000 pounds/square foot, or 3 t.s.f. (equivalent to an allowable bearing capacity of 285 kPa) was used. Another nearby existing CP overhead structure between King Street and Hunt Street is also supported by spread footings based on the available structural drawings.

No as-built drawing and subsurface information of the existing King Street CP overhead structures are available at the time of preparing this memorandum. In addition, site-specific subsurface and groundwater conditions should also be verified during the detailed investigation stage.

4.6 Existing Pedestrian Bridge and MacNab Truck Tunnel

No geotechnical issues are anticipated at the existing pedestrian bridge and MacNab truck tunnel locations.

It is our understanding that the existing pedestrian bridge can be removed to maintain minimum LRT vertical clearance.

4.7 Proposed CP Spur Line Crossing Near East Bend Avenue

The existing CP at-grade crossing near East Bend Avenue South on King Street East is planned for a grade separation. The two LRT tracks will pass underneath the CP tracks.

Based on the AECOM prepared GA drawing for this grade separation (included in Appendix A), approximately 6.5 m of vertical clearance will be provided for the LRT, and retaining walls (most likely in-situ walls, such as contiguous caisson wall or soldier pile and concrete lagging) will be constructed on both sides of the crossing.

For a temporary braced support of excavation (SOE) system, the earth pressure distribution (apparent) can be estimated as described in Section 26.10 of the CFEM (2006) or Chapter 28 of Metrolinx Design Criteria Manual (DCM). A typical triangular earth pressure distribution can be used for a temporary SOE without internal bracing, or permanent earth retention system design. Surcharge and water pressure should be taken into consideration, as appropriate, for all temporary excavation support systems and permanent earth retention systems.

A detailed construction staging plan and temporary excavation support design should be prepared in the detailed design phase.

4.8 Relocation of Underground Utilities

All utilities within the LRT footprint should be relocated/installed in accordance with the provided Metrolinx utility zoning scheme (Figure 4.8.1). Due to space limitations, consideration may be given to the use of a trench box or an internally braced temporary shoring system. The internally braced retaining structure should be designed in accordance with the relevant provincial standards and design codes (OPSS, CFEM and Metrolinx DCM). Surcharge and water pressure should be taken into consideration, as appropriate, for all temporary excavation support systems.

All other excavations should be carried out as per OHSA requirements.

Pipe bedding and backfill should be placed in accordance with relevant City of Hamilton Standards (watermain and sewer standard drawings, and relevant specifications)

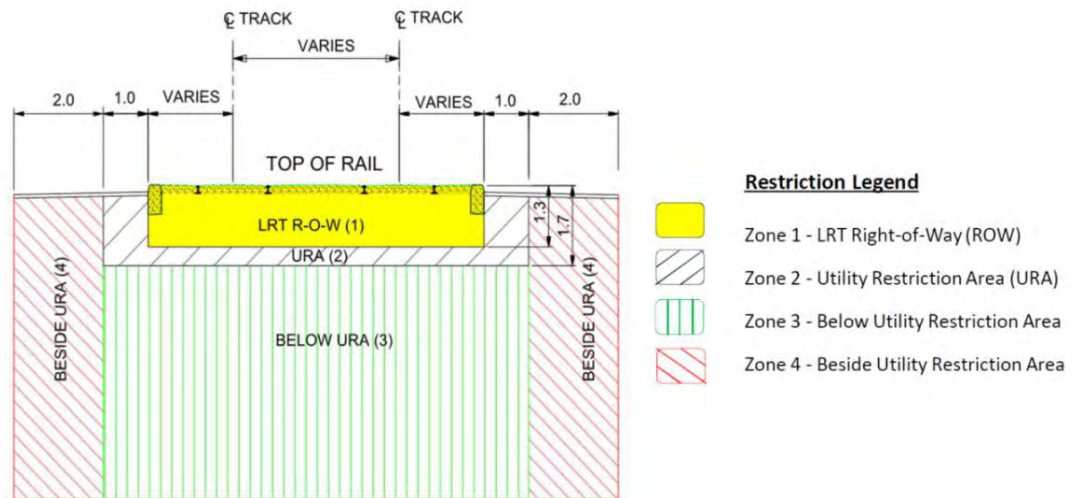


Figure 4.8.1. Transit Expansion Department's Utility Scheme for LRT Projects (Metrolinx LRT DCM, Chapter 10).

All utility excavations/trenches should be backfilled and restored as per City of Hamilton requirements (both materials and construction quality requirements). The existing pavement structure should be matched as much as possible to maintain the drainage and provide uniform support to the traffic.

4.9 New Pavement or Pavement Rehabilitation Design

The current standard for pavement design in the City of Hamilton (2016) is specified based on the Superpave Design Method. For arterial roads, the minimum design standard for flexible pavements is as follows:

Superpave 12.5 FC2 (PG 64-28)	40 mm
Superpave SP 19.0 (PG 64-28) in two lifts	120 mm
OPSS Granular A Base	150 mm
OPSS Granular B Type II Subbase	450 mm

Although the City of Hamilton does not have a minimum requirement/standard for a composite pavement structural design, composite pavements with variable thickness were encountered throughout the existing King Street and Main Street.

Adequate pavement design (flexible or composite) should be carried out during the detailed design phase with consideration given to subsurface and traffic conditions.

5. Hydrogeology Overview and Construction Groundwater Control

A preliminary hydrogeological assessment of the B-Line alignment was completed for the EA Geotechnical Report (Appendix B.2 Hydrogeology and Contaminated Soil) and summarized in the Geotechnical Report (Appendix B.7 Geotechnical: Section 4.0 Summary of Geotechnical Conditions). A summary of this information includes the following:

- The study area (B-Line alignment) consists of heavily urbanized areas (residential, commercial and industrial development) with the presence of underground utilities;
- The alignment crosses 3 entrenched rivers (Coldwater Creek and Chedoke Creek in the west end, and Red Hill Creek in the east end);

- The topography is typically flat, sloping gently northward toward Cootes Paradise, Hamilton Harbour and Lake Ontario, which reflects the fact that the City of Hamilton is situated on a nearly level terrace of the Iroquois Plain (Chapman and Putnam, 1966);
- The only regional aquifer identified in the study area is the overburden sand and gravel aquifer located at the west end of the B-Line. There are no other regional aquifer identified in the rest of the study area;
- The water table is relatively deep to the west of Highway 403, ranging from approximately 2 m bgs to 16 m bgs, whereas the water table is relatively shallower east of Highway 403, ranging from approximately 2 m bgs to 9 m bgs; a perched water table at approximately 1 m bgs may be present at various locations along the central portion of the study area;
- The general direction of groundwater flow is from the southern highlands (and the Niagara Escarpment) toward Cootes Paradise and Hamilton Harbour to the north, but the presence of deep infrastructure and other shallow linear infrastructure will affect groundwater flow within the study area;
- The majority of the study area is considered to be a discharge area where groundwater flow is upwards toward the ground surface, except in the Red Hill Valley, which is considered to be a recharge area;
- There are no municipal wells within the study area, and as a result, there are no Source Water Protection Areas along the alignment. The closest Wellhead Protection Area is for the Greensville wellfield, which is located 5 km northeast of the western portion of the alignment;
- The closest Permit to Take Water is located approximately 1 km north of the alignment in the vicinity of the intersection of King and Queen Streets;
- A number of contaminated sites have been identified along the alignment, and an assessment of the potential for more contaminated sites is being completed concurrently.

The B-Line is planned to be at-grade construction and from a groundwater construction control perspective, the following observations are relevant:

- Shallow groundwater levels may occur along the proposed route and, as a result, dewatering parts of the proposed route during construction may be required;
- A Permit to Take Water may be required to address groundwater extraction for construction dewatering;
- During construction, contaminated groundwater may be encountered at some locations along the alignment and, as a result, any groundwater that is pumped from construction dewatering should be assessed for water quality parameters prior to disposal.

6. Recommendations for IO AFP Due Diligence Investigation

The available subsurface and groundwater information was reviewed and the investigation requirements for the next stage are identified with consideration of Infrastructure Ontario (IO) AFP-Geotechnical, Hydrogeology, Environmental Due Diligence Technical Requirements-Civil Infrastructure Projects (final draft dated on January, 2016). The minimum due diligence geotechnical investigation requirements are summarized in Table 6.1.

Table 6.1. Minimum Geotechnical Investigation Requirements (Infrastructure Ontario).

#	Type of Structure	Conditions	Recommended Borehole			Remark
			Location/Detail	Spacing (m)	Minimum Depth (m)	
1	Road (surface)	Urban-Existing Road, No widening	Each direction	50 to 100	4.5 m BSGE or ARBR	<i>Road boreholes will be combined with Track boreholes</i> No widening is planned for the LRT construction
2	Track (surface)	Rural/Urban-New Track	Each direction	35 to 70	5 m BSGE or ARBR	<i>For LRT mainline track</i> 60 m BH spacing to 6 m depth will be used for a preliminary work plan, with consideration of the proposed centreline LRT set-up and relatively narrow corridor, boreholes will be advanced as close as possible to the road centreline (not on each direction)
3	Surface Station/ Associated building structures	Formerly developed (With subsurface structure)	Building Area	15 to 30	6 m BFBE/BPTE or ARBR, 3 m rock coring in case of shallow bedrock, in case of poor subsurface condition extend boreholes deeper to encounter 3 m competent soil	<i>For LRT Stops and TPSSs (locations are not decided)</i> 30 m spacing to 8 m depth will be typically used for a preliminary work plan (shallow foundation below frost depth 1.2 m + 6 m = 7.2 m). TPSS boreholes are proposed to advance to a depth of 8 m below the existing grade
		Formerly developed (No subsurface structure)		20 to 40		
4	Surface Parking	Formerly Developed (With subsurface structure)	Parking Area	30 to 60	4.5 m BSGE or ARBR	<i>For 2 Intermodal Termini (McMaster, and Queenston)</i> 20 BHs to 6 m depth will be used for the preliminary work plan
		Formerly Developed (No subsurface structure)		35 to 70		

#	Type of Structure	Conditions	Recommended Borehole			Remark
			Location/Detail	Spacing (m)	Minimum Depth (m)	
5	Utilities Alignment	Formerly developed	Alignment	30 to 60	6 m BIL or 2 TDOE-WEG (this seems extensive, typical utility borehole extended to 2 times of the pipe diameter below the proposed invert level)	Utilities boreholes are combined with LRT track boreholes. Depending on the actual utility depth, borehole depth should be adjusted
6	Bridge	Abutments	Two way single lane	2 BHs	Deep foundations- minimum 10 m BPTE or auger refusal at Bedrock, At least one BH to minimum 30 m BPTE. If bedrock in encountered, minimum 5 m rock coring into competent bedrock (IO AFP guidelines may be extensive and these should be discussed with Metrolinx) Shallow foundations- Increase BH to five for each foundation element. If bedrock is encountered, minimum 3 m rock coring should be done in 50% of BHs. Artesian condition (if encountered) should be recorded and sealed properly.	<i>Highway 403 flyover, CP overpass extension at King Street near Highway 403</i> The proposed Highway 403 overpass will carry two tracks and 2 BHs per each abutment to 30 m depth below the existing grade (including 3 m rock coring) are proposed for a preliminary work plan. Same investigation scheme was used for the CP overpass extension.
			Two way multilane	3BHs		
		Piers	Per pier	1 BH	Same as abutments	<i>Highway 403 flyover</i> For Highway structures, MTO minimum requirement for a detail design is 2 BHs per pier. 2 BHs will be included in a preliminary work plan.
		MSE or retaining walls	Each side	25 m c/c with minimum 3 BHs	10 m BFBE or ARBR	<i>Locations and details are not available</i> No BH for this element is included in a preliminary work plan.

#	Type of Structure	Conditions	Recommended Borehole			Remark
			Location/Detail	Spacing (m)	Minimum Depth (m)	
		Wing walls	Each side	25 m c/c with minimum 1 BH	6 m BFBE or ARBR	<i>No information available</i> No BH for this element is included in a preliminary work plan.
		Approach fills	Each side	25 m c/c with minimum 1 BH	Extend 6 m BSGE or 100% of embankment height (fill) or 50% of cut depth below the base of embankment. If bedrock is encountered, presence of bedrock should be confirmed with multiple boreholes	<i>Extent of approach embankment is not available</i>
7	Culvert	-	BHs at Inlet and outlet location	25 m interval along culvert alignment	Same as bridge abutment (IO AFP guidelines may be extensive and these should be discussed with Metrolinx)	<i>No culvert work is identified</i> No BH for this element is included in a preliminary work plan.
8	Slope stability	V:H=1:3 or steeper	Each side	50 m c/c at toe minimum 3 50 m c/c at top of slope	3 m below toe elevation or ARBR	<i>No detail information available</i> No BH for this element is included in a preliminary work plan.
9	Tunnel	Cut and Cover (soil, formerly developed)	Adverse medium	20 to 40	9 m BFBE/BPTE, outer rows of BHs should be as close as possible to perimeter of excavation	<i>CP Spur line crossing near East Bend Avenue.</i> 6 BHs to 20 m depth are included in a preliminary work plan.
			Favorable medium	25 to 50		

Notes: BSGE: below subgrade elevation
ARBR: auger refusal at bedrock
BFBE: below foundation base elevation
BPTE: below pile tip elevation
BIL: below invert level
TDOE: times depth of excavation
WEG: whichever is greater
BPTE: below pile tip elevation
c/c: centre to centre

As part of the hydrogeology investigation, we proposed to include the following hydrogeological testing of the geotechnical boreholes:

- Monitoring wells for one (1) of every three (3) boreholes;
- Well development prior to testing;
- Water quality sampling of every monitoring well;
- Slug testing of every second monitoring well; and
- A short-term pumping test for each of the excavations for deep structures.

Due to the extensive minimum investigation requirements stipulated in the current IO AFP Document (2016), consideration can be given to the use of Infrastructure Ontario (IO) AFP-Geotechnical, Hydrogeology, Environmental Due Diligence Technical Requirements (may, 2012), which has been successfully used for a number of large scale transit projects in the GTA.

7. Closure

We trust that the information provided in this memorandum is sufficient for the EA amendment. Should you have any questions, please do not hesitate to contact the undersigned.



Eric Tiedje, E.I.T., Ph.D.
Geotechnical Engineer-in-Training



Miln Harvey, Ph.D., P.Eng., FEC
Senior Hydrogeologist

Memorandum Reviewed By



Gwangha Roh, P.Eng., Ph.D.
Senior Geotechnical Engineer

References

1. SDG-SNC Lavalin: Hamilton Rapid Transit Preliminary Design and Feasibility Study, Appendix B7 Geotechnical Design Brief, September 2011
2. Canadian Geotechnical Society (2006), "Canadian Foundation Engineering Manual, 4th Edition"
3. Canadian Standards Association, Canadian Highway Bridge Design Code S6-14
4. Metrolinx. "Design Criteria Manual Light Rail Transit", Program Engineering Group, Transit Expansion Department Commission, 2012.
5. Broms, B.B.: *Lateral Resistance of Piles in Cohesive Soils*, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 90, SM2, March 1964
6. Broms, B.B.: *Lateral Resistance of Piles in Cohesionless Soils*, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 90, SM3, March 1964.
7. Broms, B.B.: *Design of Laterally Loaded Piles*, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 91, SM3, May 1965.
8. City of Hamilton, Comprehensive Development Guidelines and Financial Policies Manual, 2016.
9. Infrastructure Ontario (IO) AFP-Geotechnical, Hydrogeology, Environmental Due Diligence Technical Requirements-Civil Infrastructure Projects (final draft dated on January, 2016).
10. Infrastructure Ontario (IO) AFP-Geotechnical, Hydrogeology, Environmental Due Diligence Technical Requirements (final draft dated on May, 2012).
11. Ontario Department of Mines, Map 2034, Bedrock Topography of the Hamilton Area

Appendix A

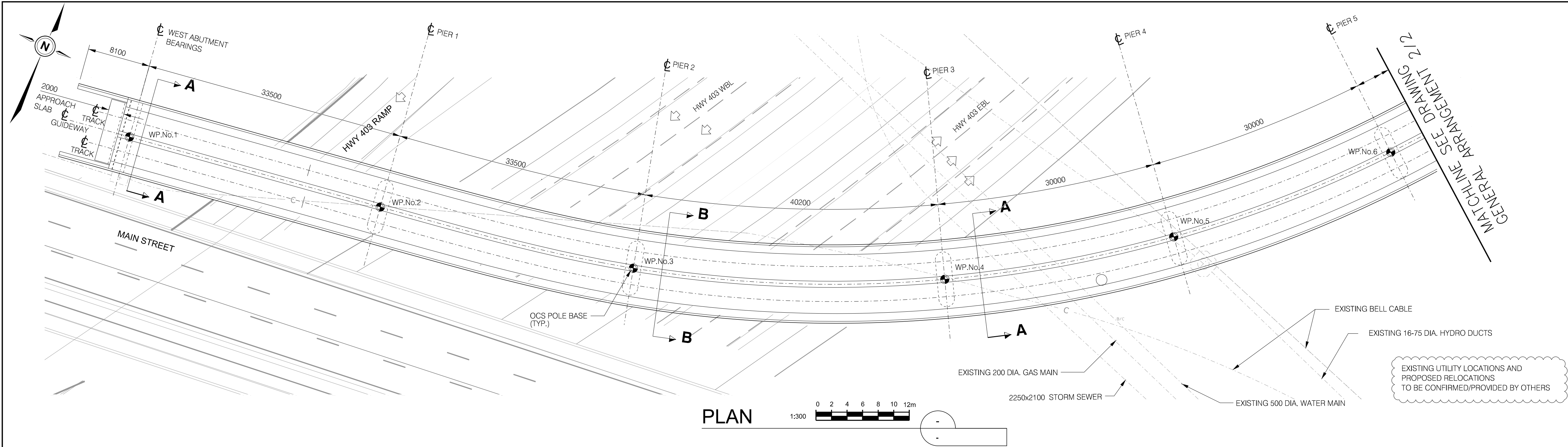
- Highway 403 Overpass GA Drawings
- CP Underpass (Eastbend Ave.) GA Drawings
- CP King St. Overpass – M58.92 Hamilton Subdivision
- CP Overpass Hunt St. Contract Drawings

Appendix **A**

- Highway 403 Overpass GA Drawings
- CP Underpass (Eastbend Ave.) GA Drawings
- CP King St. Overpass – M58.92 Hamilton Subdivision
- CP Overpass Hunt St. Contract Drawings

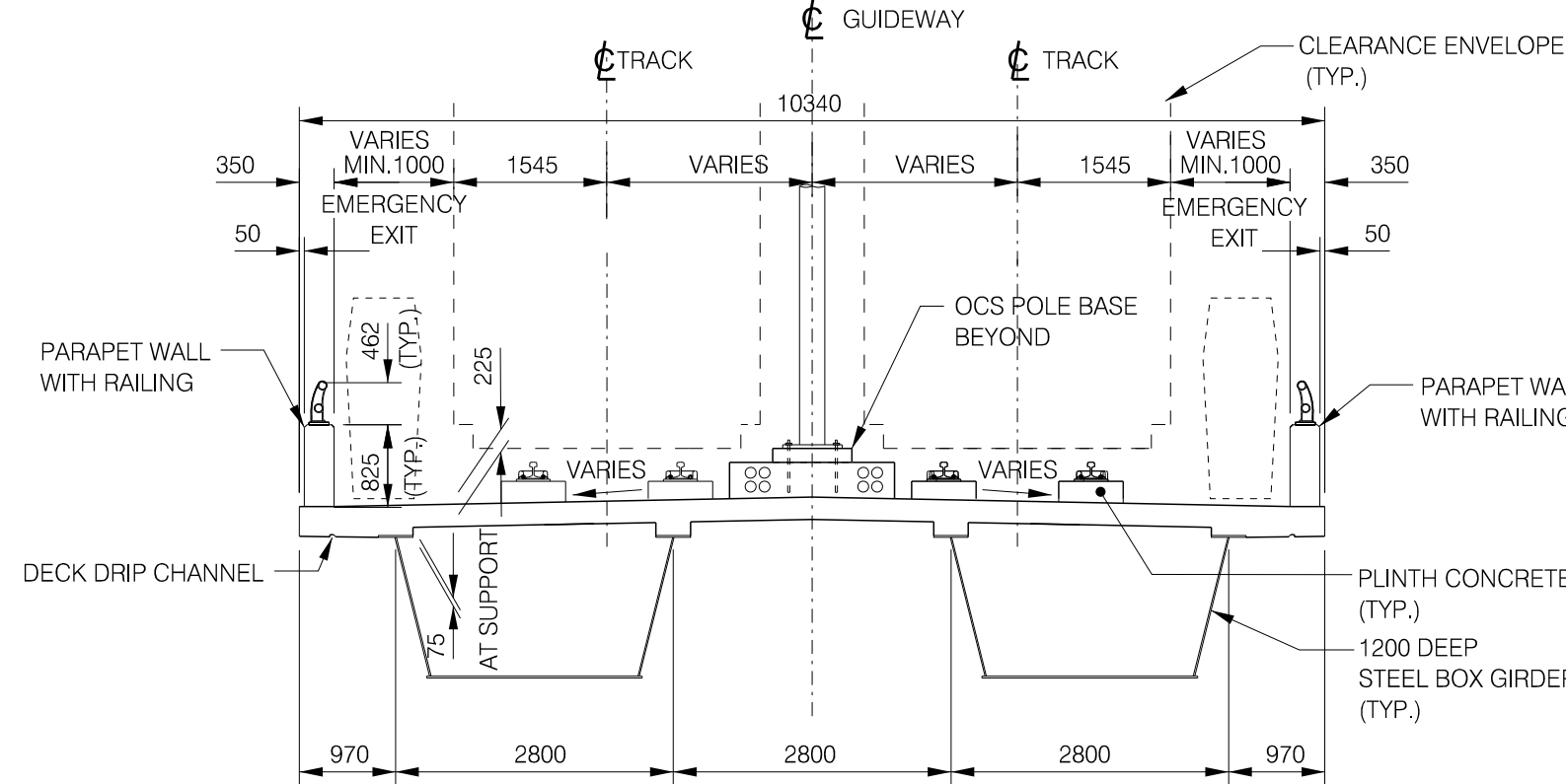
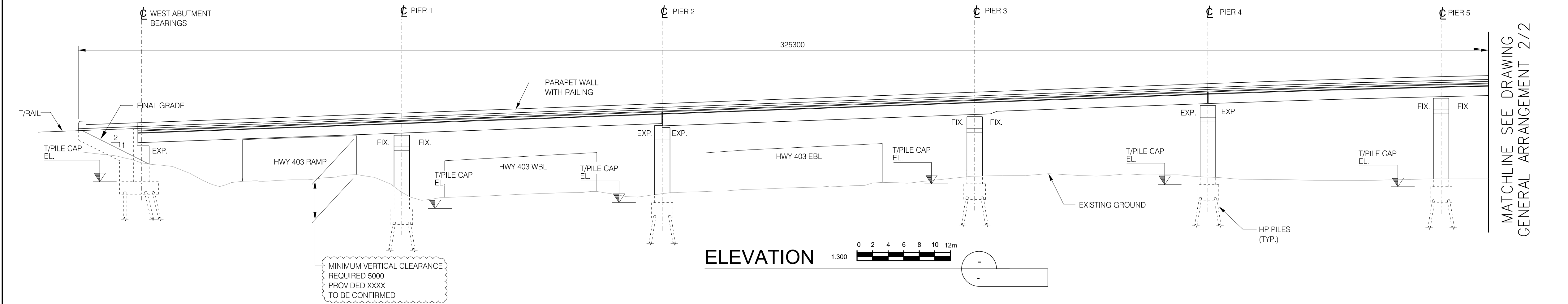


Highway 403 Overpass GA Drawings

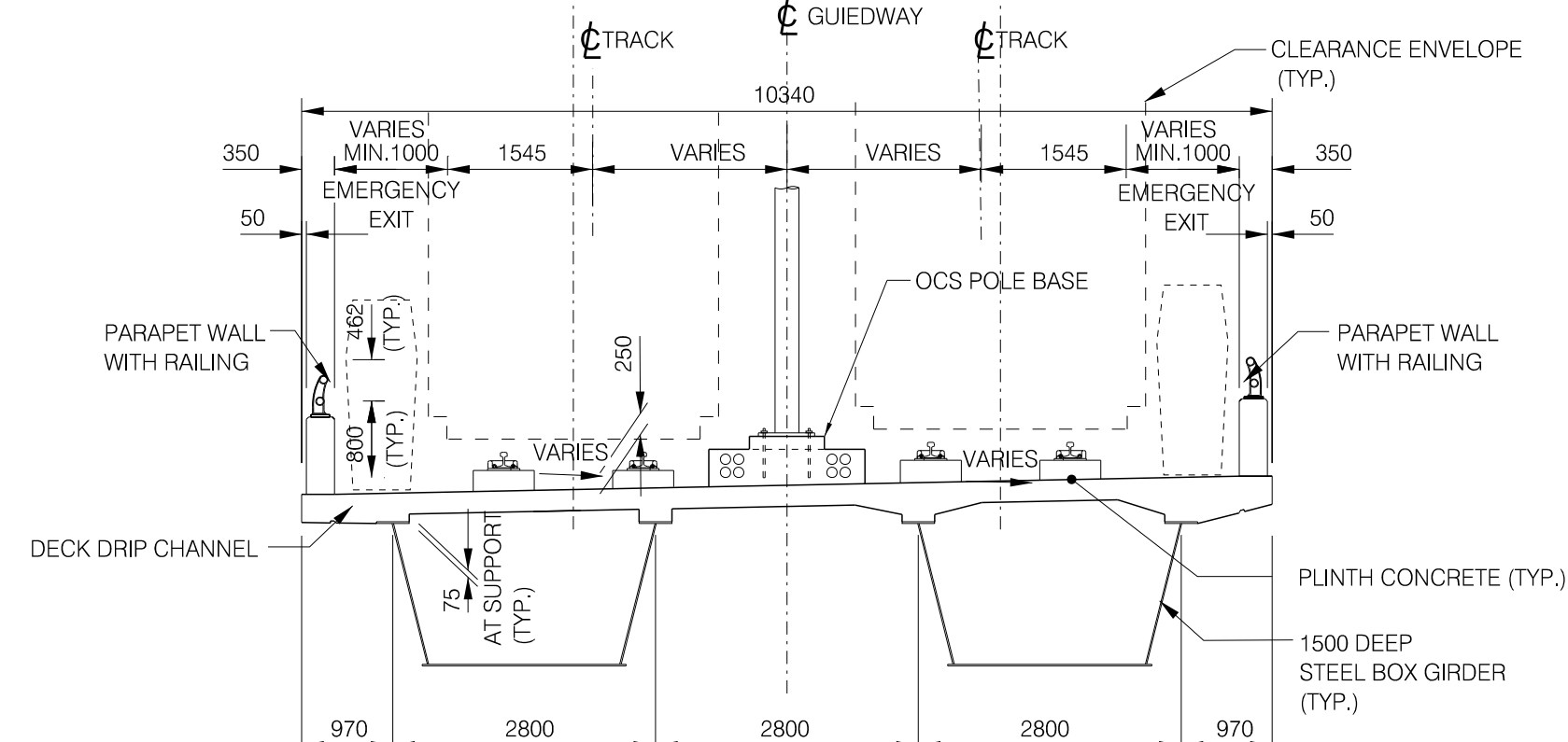


FILE No.	CONTRACT No. C11-12-10	SHEET No.
DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED		

- LIST OF ABBREVIATIONS:
- | | |
|------------|-------------------------|
| EL. | DENOTES ELEVATION |
| EXP. | DENOTES EXPANSION |
| FIX. | DENOTES FIXED |
| R.O.W. | DENOTES RIGHT OF WAY |
| T/PILE CAP | DENOTES TOP OF PILE CAP |
| T/RAIL | DENOTES TOP OF RAIL |
| TYP. | DENOTES TYPICAL |
| W.P. | DENOTES WORKING POINTS |



SECTION 1:75
A



SECTION 1:75
B

No.	REVISIONS	INITIAL	DATE	REFERENCE MATERIAL:
0	EA AMENDMENT	PR	16/10/31	Survey Plan: COMPILED PBS AND SURVEY LRT.dgn (MAY 19, 2011) 0937HAM10002 ALL v8.dgn (OCTOBER 7, 2010) basemap2.dwg (MAY 19, 2011)
				Sewer Plan: Water Plan:
				Geodetic Bench Mark Index Borehole Report -

Project Manager	NAME
Manager of Design	NAME
NAME	NAME

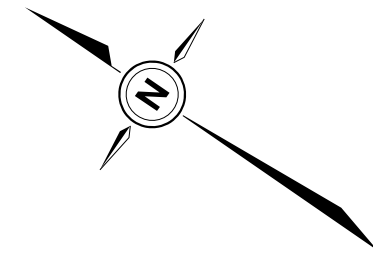
steer davis gleave	DRAWN: VESNA KRUMARIC
AECOM	CHECKED: JUSTIN CHEN
DIALOG	APPROVED: PEDRO RABSLIN
	DATE: 2016/10/31

Hamilton Public Works	RAPIDTransit moving HAMILTON forward	METROLINX An agency of the Government of Ontario
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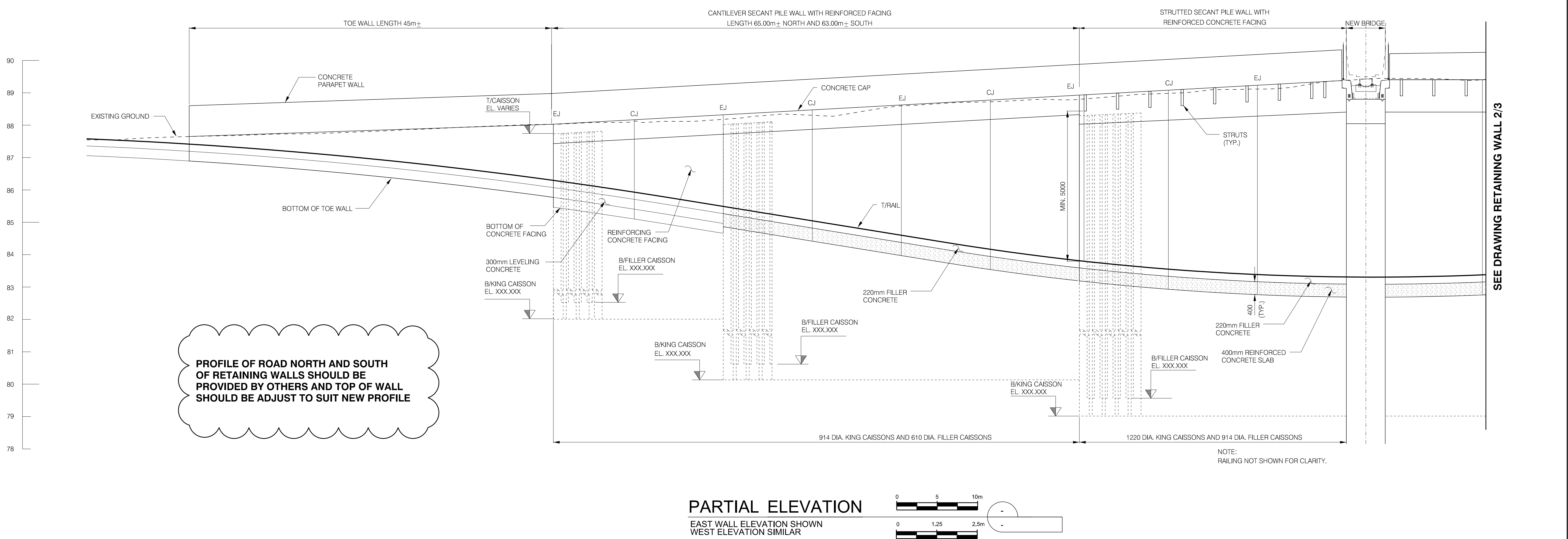
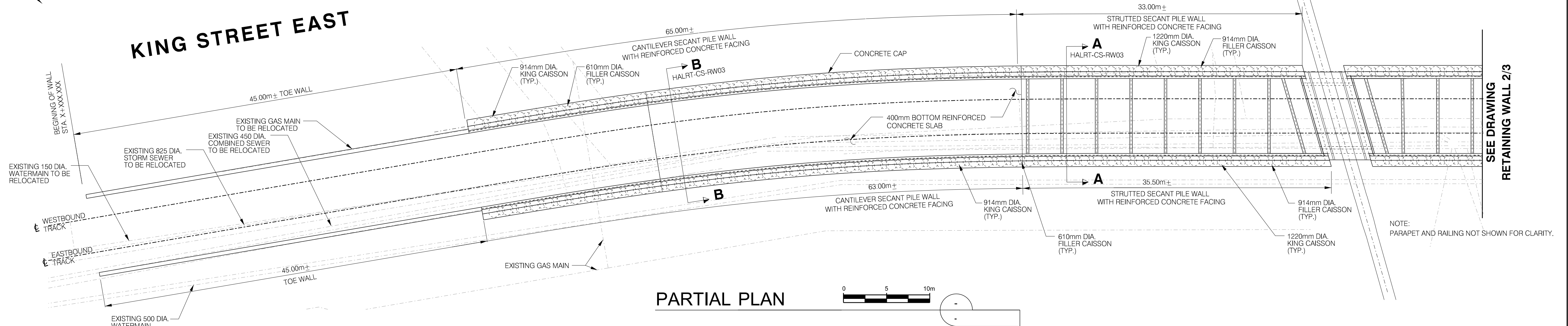
HAMILTON LRT 'B' LINE
PRELIMINARY DESIGN
GUIDEWAY OVER HWY 403
GENERAL ARRANGEMENT 1/2



**CP Underpass (Eastbend Ave.) GA
Drawings**



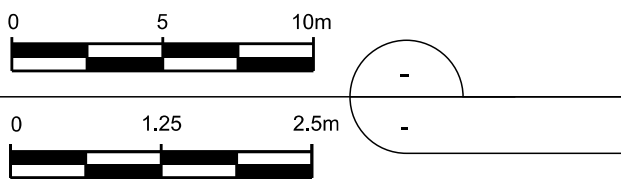
KING STREET EAST



PROFILE OF ROAD NORTH AND SOUTH
OF RETAINING WALLS SHOULD BE
PROVIDED BY OTHERS AND TOP OF WALL
SHOULD BE ADJUST TO SUIT NEW PROFILE

PARTIAL ELEVATION

EAST WALL ELEVATION SHOWN
WEST ELEVATION SIMILAR



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No.	REVISIONS	INITIAL	DATE	REFERENCE MATERIAL:	SCALES	Project Manager							
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				Sewer Plan: Water Plan:		Manager of Design							
				Geodetic Bench Mark Index Borehole Report -		NAME							

steer davis gleave

AECOM

DIALOG

DRAWN: YESNA KRMARIC

CHECKED: JUSTIN CHEN

APPROVED: PEDRO RABSLIN

DATE: 2016 /10 /31

Hamilton

Public Works

RAPIDTransit

moving HAMILTON forward

METROLINX

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HAMILTON LRT 'B' LINE

PRELIMINARY DESIGN

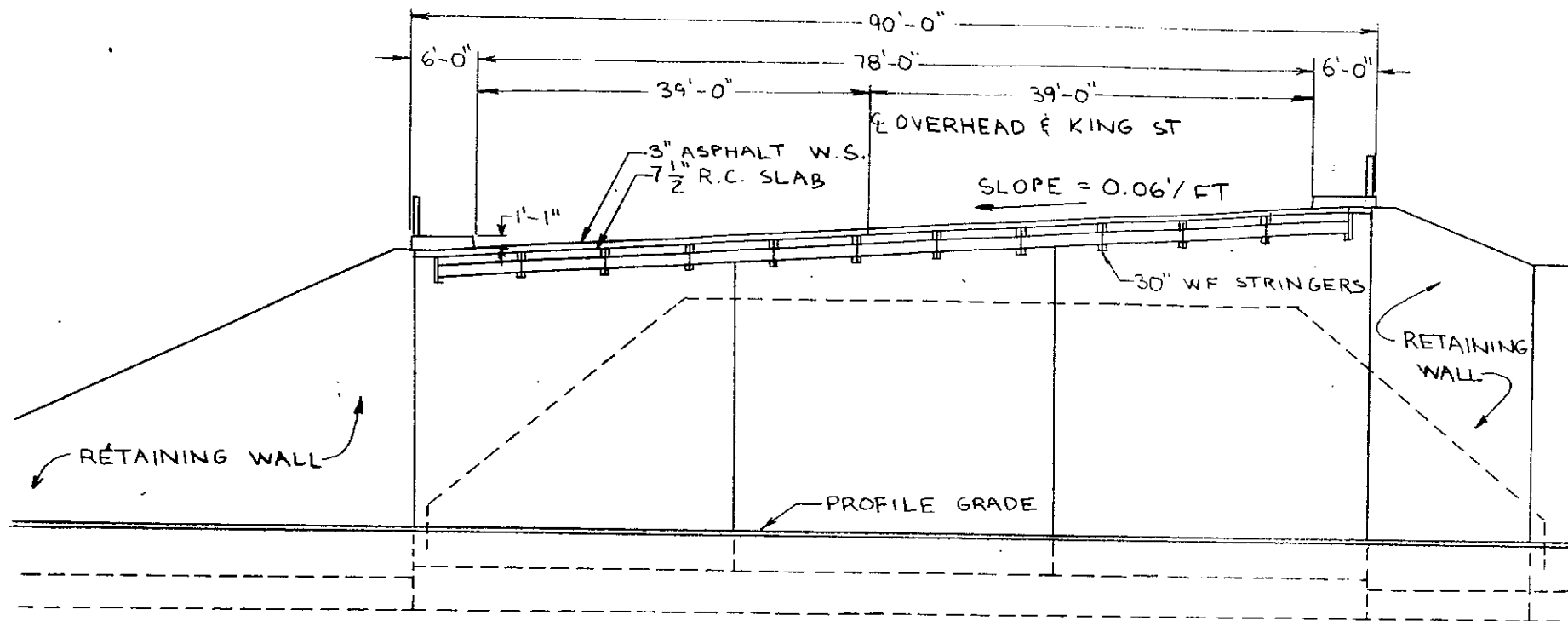
KING STREET EAST GRADE SEPARATION

RETAINING WALL 1/3

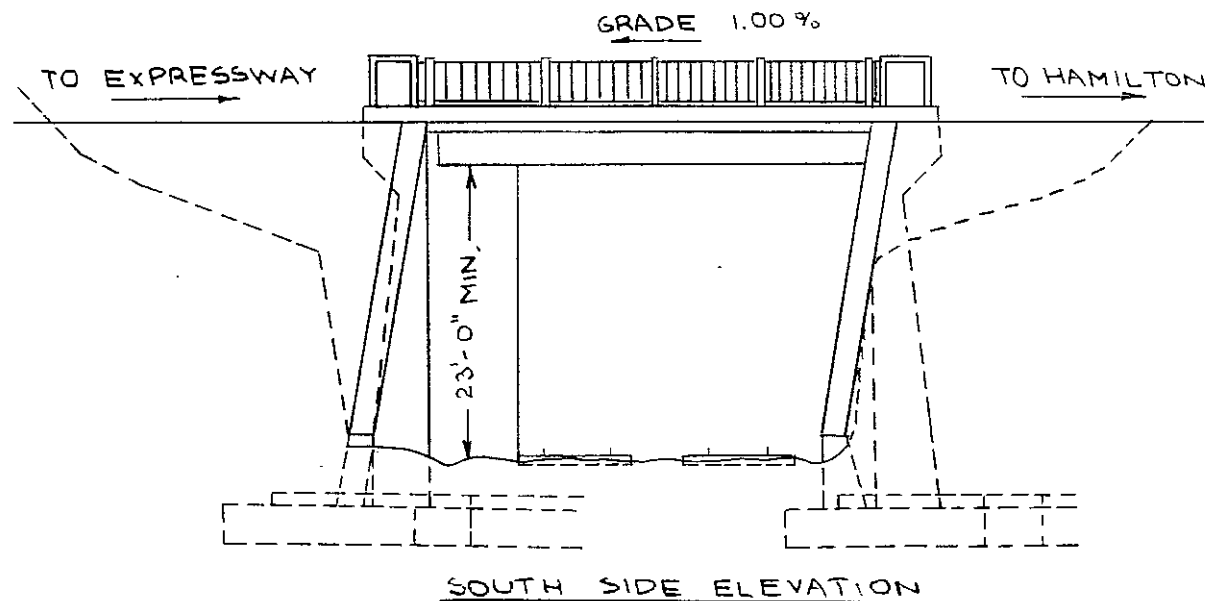
PLAN AND ELEVATION



CP King St. Overpass - M58.92 Hamilton Subdivision



TYPICAL CROSS-SECTION AT RIGHT ANGLES TO C OF OVERHEAD



KING ST. OVERPASS - M 58.92

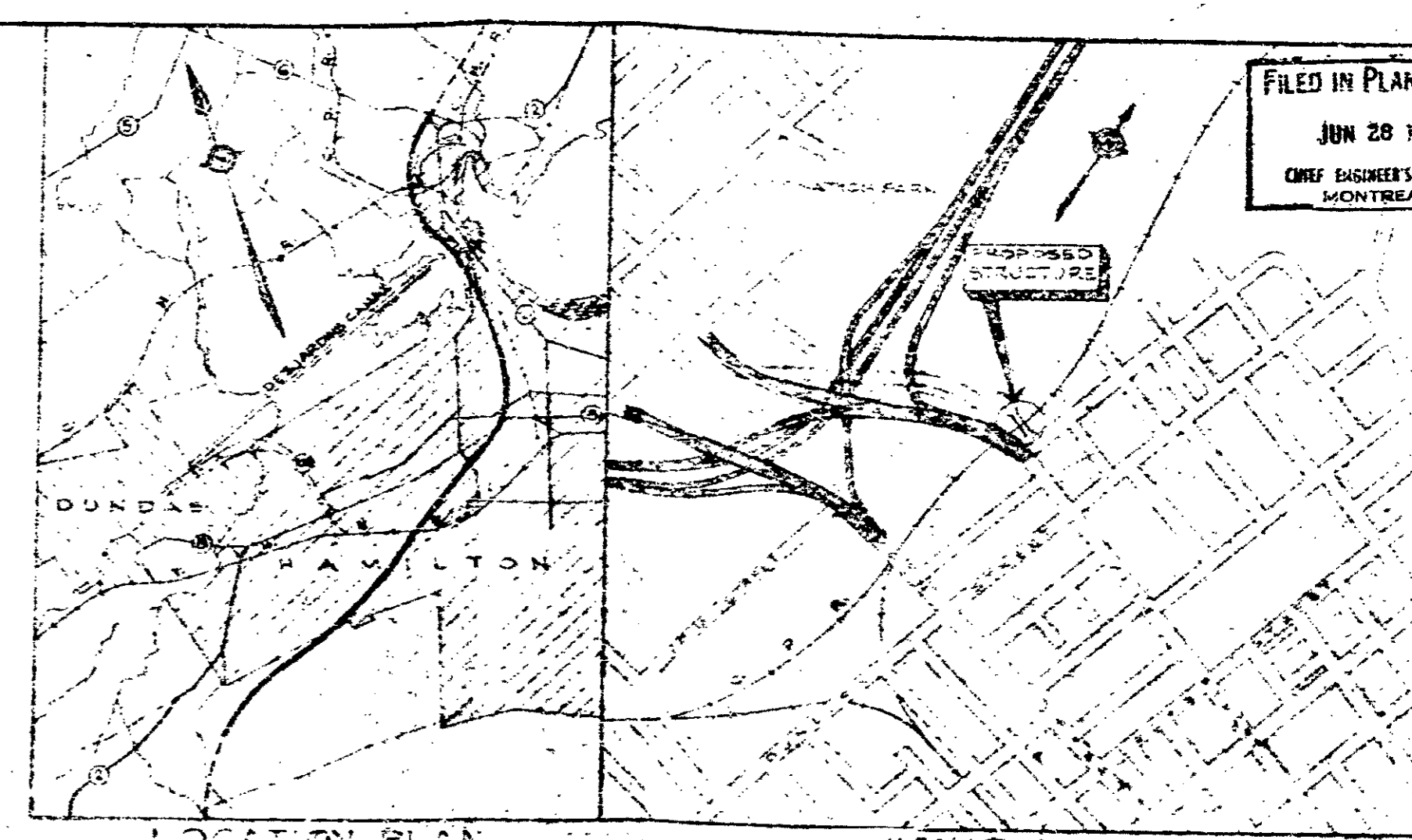
HAMILTON SUBDIVISION

N.T.S.



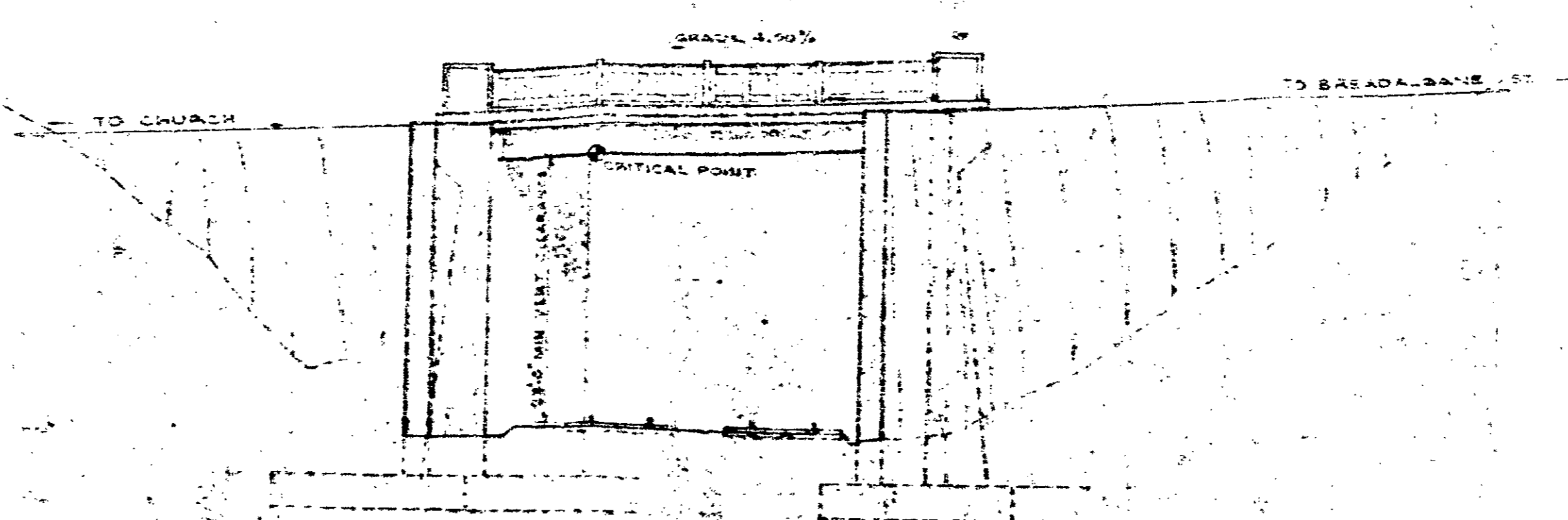
CP Overpass Hunt St. Contract Drawings

FILED IN PLAN ROOM
JUN 28 1922
CHIEF ENGINEER'S OFFICE
MONTREAL

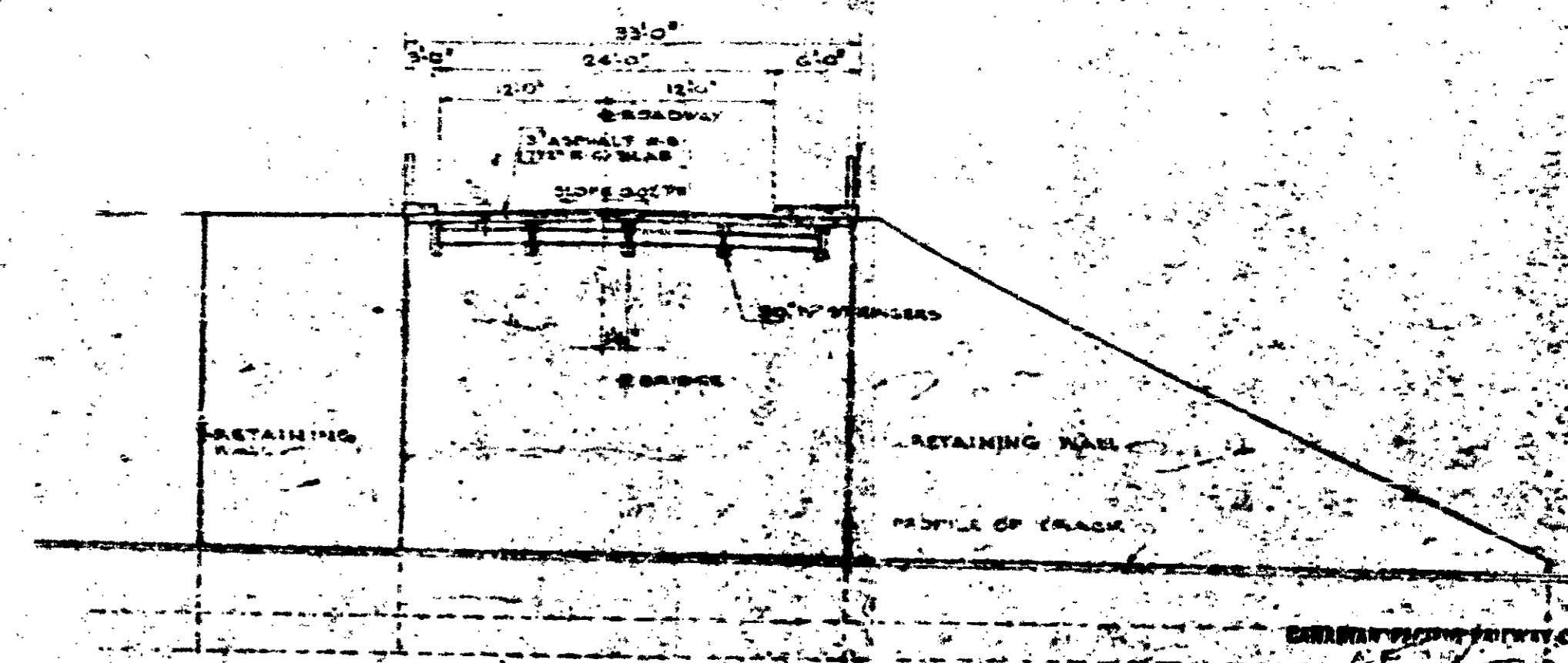


LOCATION PLAN
SCALE = 1" = 1 MILE

KEY PLAN
SCALE = 1" = 500'

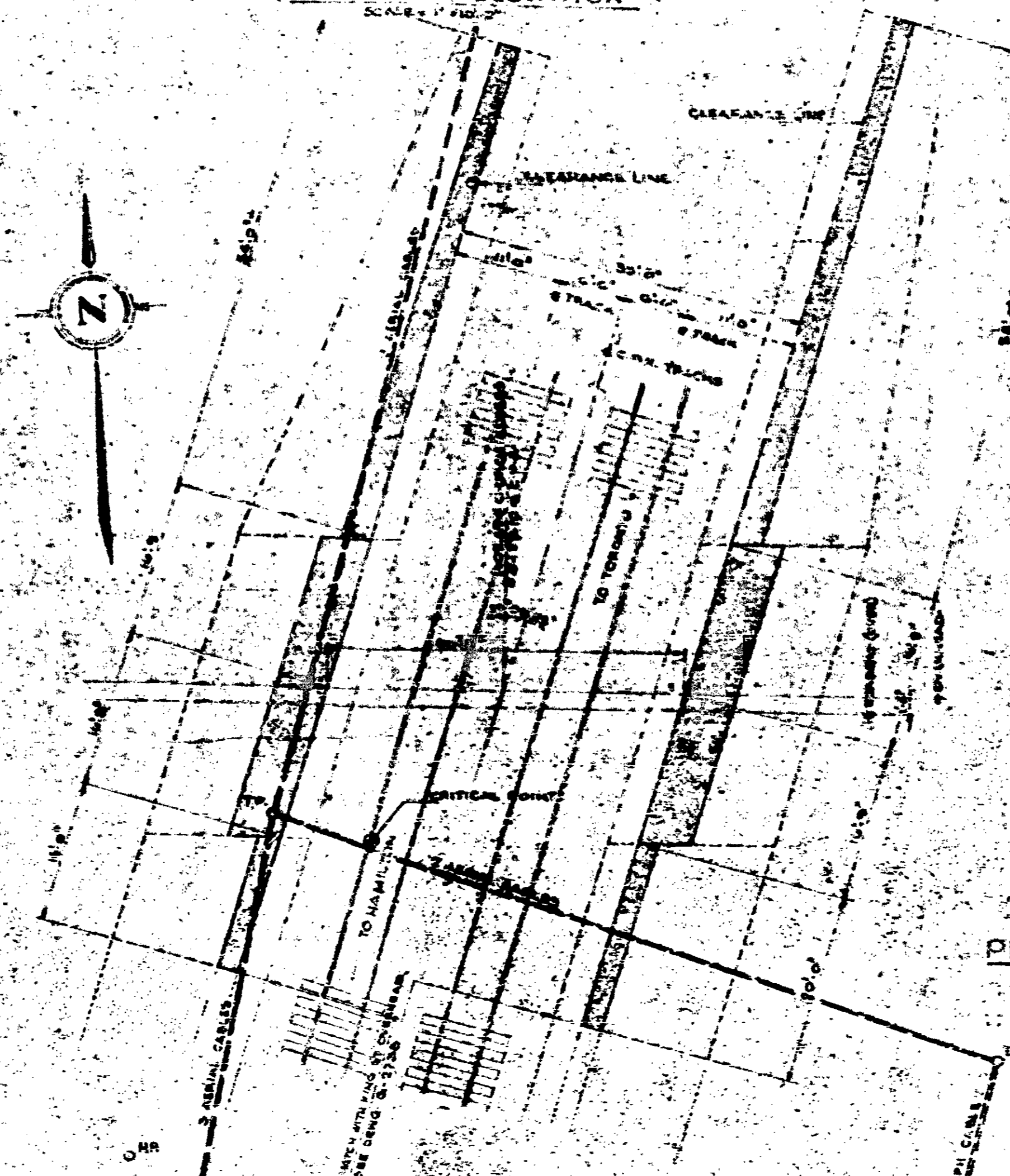


SOUTH SIDE ELEVATION
SCALE = 1" = 10'



TYPICAL CROSS SECTION AT RIGHT ANGLES TO A BRIDGE
SCALE = 1" = 10'

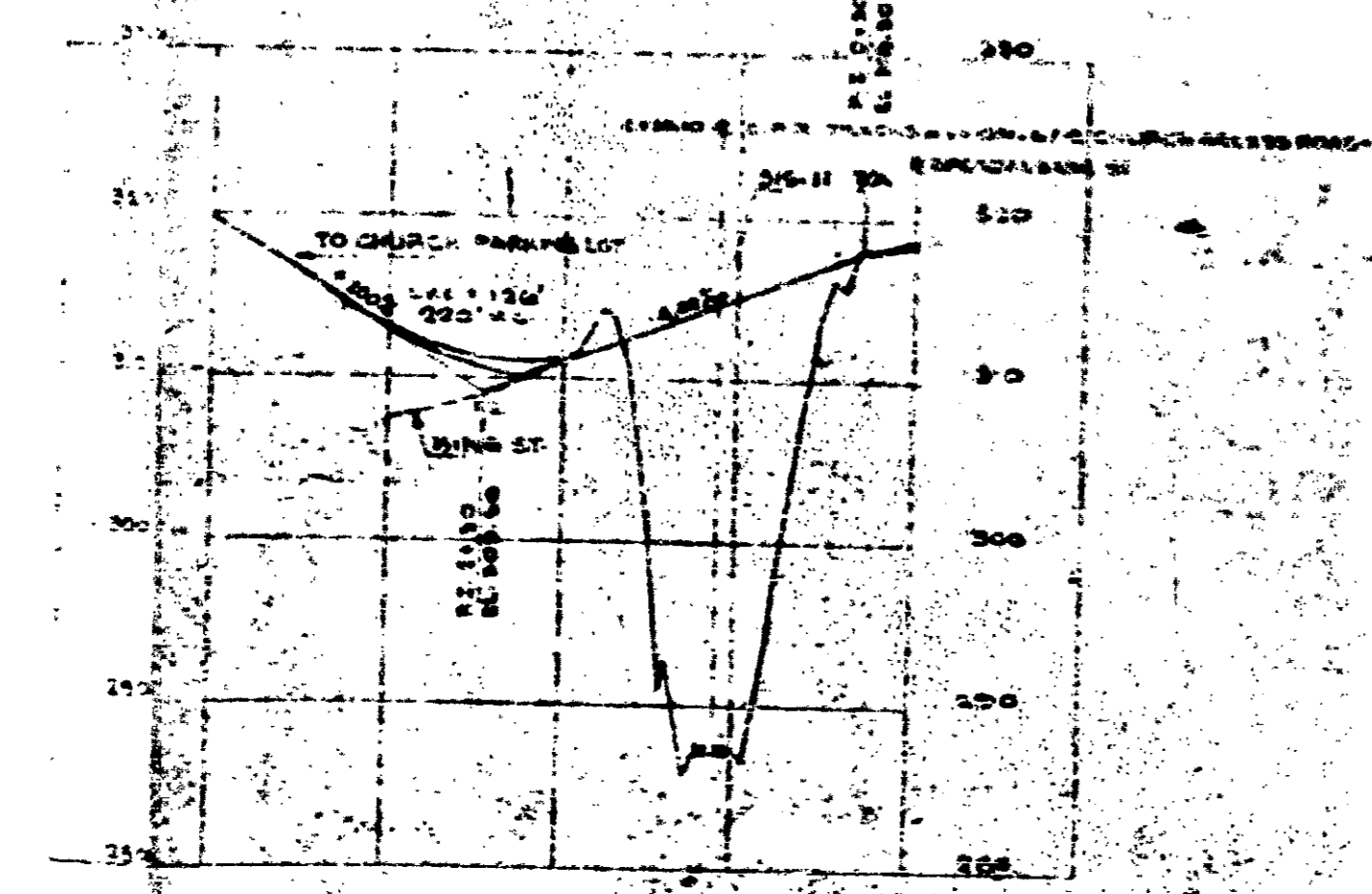
THIS APPROVAL GIVEN BY THE ENGINEER OF BRIDGES
FOR THE CANADIAN PACIFIC RAILWAY COMPANY
ON THE 27th day of May 1922
By *W. H. H. H.*
CHIEF ENGINEER OF BRIDGES



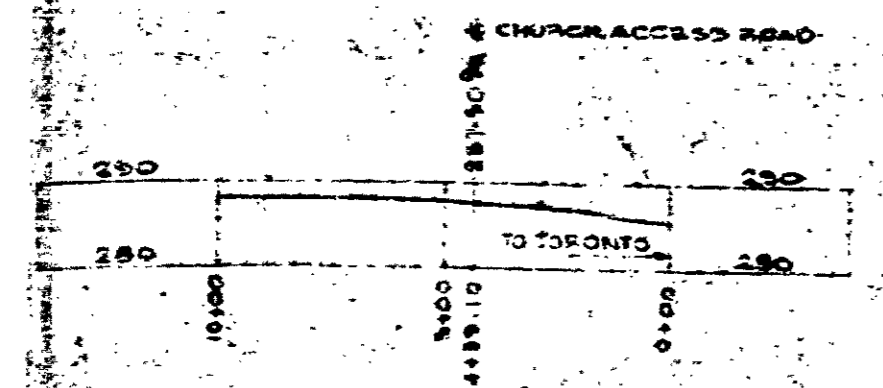
PLAN OF SUBSTRUCTURE
SCALE = 1" = 10'

PROPERTIES OF 15° OG 25° SKEW ANGLE

SINE .259822
COSINE .965941
TANGENT .259822



PROFILE OF CHURCH PARKING LOT APPROACH
1" = 10' HORIZ.
1" = 10' VERT.



PROFILE OF CANADIAN PACIFIC RAILWAY (BASE OF RAIL)
1" = 400' HORIZ.
1" = 20' VERT.

CC PARKER & PARSONS, BRINCKERHOFF LIMITED
HAMILTON CONSULTING ENGINEERS - ONTARIO
DEPARTMENT OF HIGHWAYS - ONTARIO
BRIDGE OFFICE - TORONTO

CHEDOKE EXPRESSWAY
CHURCH ACCESS OVERHEAD
OVER 2 R. TRACKS - MILEAGE 30.24 HAMILTON DIVISION
THE KING'S HIGHWAY NO. 203
CO. OF WENTWORTH
TWP. CITY OF HAMILTON LOT 15 CON. II

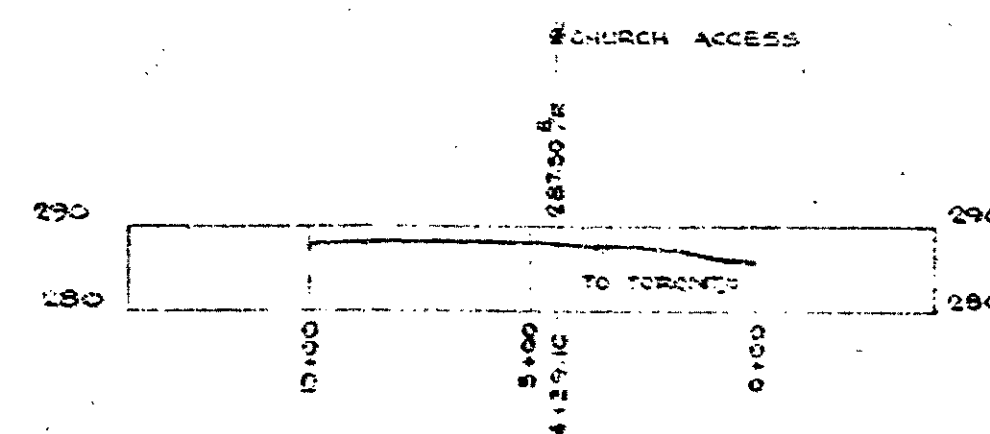
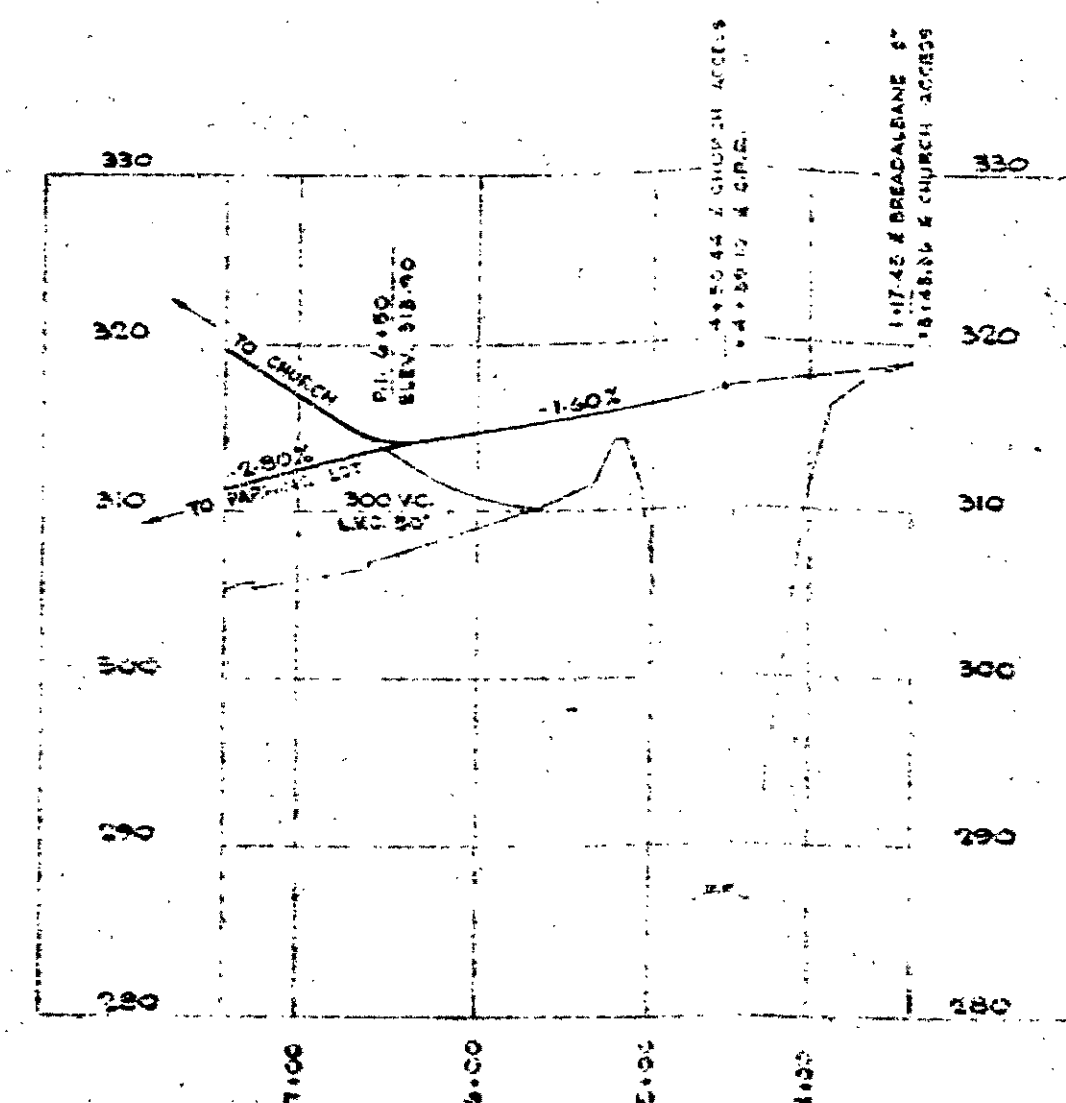
GENERAL PLAN

APPROVED
BRIDGE ENGINEER
DESIGN ENGINEER

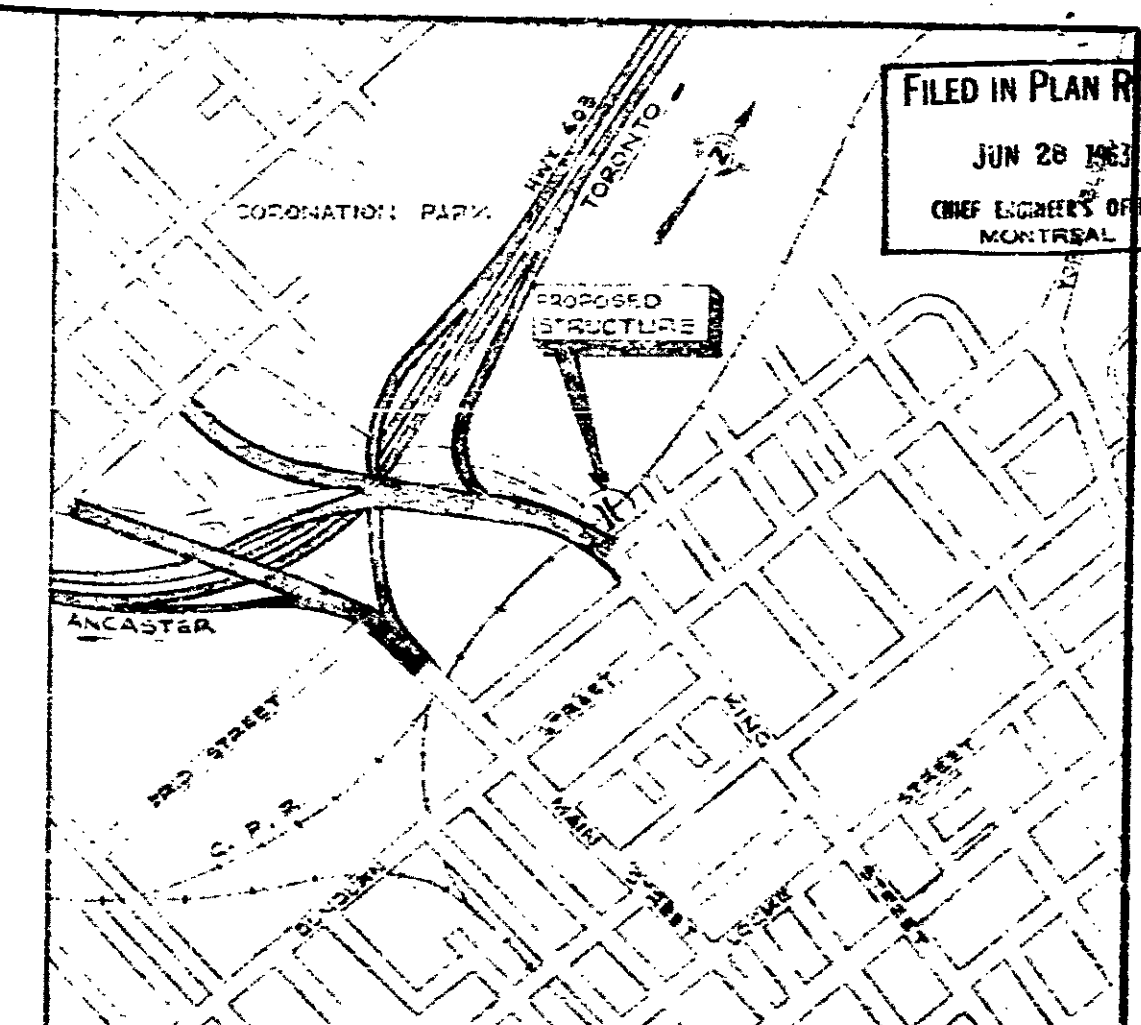
REVISIONS	DATE	DESCRIPTION
1	1922	GENERAL REVISION
2	1922	CHANGES ADDED & ROADWAY ELEVATIONS CHANGED
3	1922	GENERAL REVISION & DRAWING CHANGED FROM SP. 1708
4	1922	RAILWAY BRIDGE SCALE CHANGED

NO.	DATE	BY	CHECKED	CONTRACT NUMBER
1	1922	W. H. H. H.	D. C. C.	1922-510
2	1922	W. H. H. H.	D. C. C.	1922-510
3	1922	W. H. H. H.	D. C. C.	1922-510

61012-1



PROFILE OF CANADIAN PACIFIC RAILWAY (BASE OF RAIL)



KEY PLAN

GENERAL NOTES

NOTE TO DISTRICT ENGINEER. CONCRETE WORK ON THIS STRUCTURE
SHOULD NOT BE COMMENCED UNTIL MEASUREMENTS TO FIX CONTROL
POINTS HAVE BEEN DIRECTED BY THE DISTRICT ENGINEER.
NOTE TO STRUCTURAL STEEL CONTRACTOR. FOR NOTES CONCERNING
STRUCTURAL STEEL SEE DRAWING D-567-3.
NOTE TO GENERAL CONTRACTOR. STRUCTURE IS TO BE BUILT IN
ACCORDANCE WITH FORM NO. 9 (LATEST REVISION) AND THE SPECIAL
PROVISIONS EXTRA COPIES OF WHICH MAY BE OBTAINED FROM THE
DISTRICT ENGINEER.
CONCRETE MIX.

MINIMUM TENSILE STRENGTH
AT 48 DAYS

COMPLETE STRUCTURE 3000 P.S.I.

APPROVED ADJUSTMENTS SUPPLIED BY CONTRACTOR. WILL BE ADDED TO ALL CONCRETE AS SPECIFIED BY THE MATERIALS INSPECT. SECTION D-10

BAR COVER ON REINFORCING STEEL.

FOOTINGS 3"

ABUTMENTS 1.5" 3" O.F. 2"

WING WALLS 1.5" 3" O.F. 2"

TO MAIN STEEL DECK TOP OF BOTTOM "

CONSTRUCTION NOTES - ALL EXPOSED CONCRETE EDGES TO HAVE 1" MIN. CHAMFER EXCEPT WHERE NOTED.

CONSTRUCTION JOINTS SHALL BE MADE ONLY WHERE LOCATED ON THE DRAWINGS UNLESS APPROVED BY THE ENGINEER.

NO CONCRETE TO BE PLACED BEFORE MATERIALS HAVE BEEN APPROVED AND A MIX ESTABLISHED TO THE SATISFACTION OF THE ENGINEER.

FOR NOTES CONCERNING FOUNDATION CONSTRUCTION SEE DRAWING D-10.2

NO CONCRETE TO BE PLACED BEFORE FORMWORK, FALSBWORK AND REINFORCING STEEL HAVE BEEN CHECKED AND APPROVED BY THE ENGINEER.

THE PLACING OF THE STRUCTURAL STEEL SHALL BE IN ACCORDANCE WITH SPECIFICATIONS FOR STRUCTURES D-10. FORM NO. 9.

THE GENERAL CONTRACTOR SHALL BE RESPONSIBLE FOR FINISHING THE BRIDGE TO BE LEVEL TO THE PROPER ELEVATIONS FOR THE STRUCTURAL STEEL.

BRIDGE SEATING SHALL BE FINISHED TO THE SPECIFIED ELEVATIONS TO A TOLERANCE OF PLUS OR MINUS 1/8" INCH. IF THEY ARE CAST TOO HIGH THEY SHALL BE BUSH HAMMERED DOWN BY THE GENERAL CONTRACTOR. IF THEY ARE CAST TOO LOW THE GENERAL CONTRACTOR SHALL PROVIDE FULL BEARING STEEL. SHALL BE RESPONSIBLE TO BRING THEM UP TO THE CORRECT ELEVATIONS. THE USE OF GROUT IS PROHIBITED.

THE GENERAL CONTRACTOR IS RESPONSIBLE FOR ENSURING THAT THE FINAL BRIDGE ELEVATIONS CONFORM WITH THE ELEVATIONS SHOWN.

D.F. JOINTS INSIDE FACE, O.F. OUTSIDE FACE, S.F. FACE, ALL REINFORCING BAR SPACES TO BE LAPPED 35 DIAMETERS OF BAR UNLESS OTHERWISE NOTED.

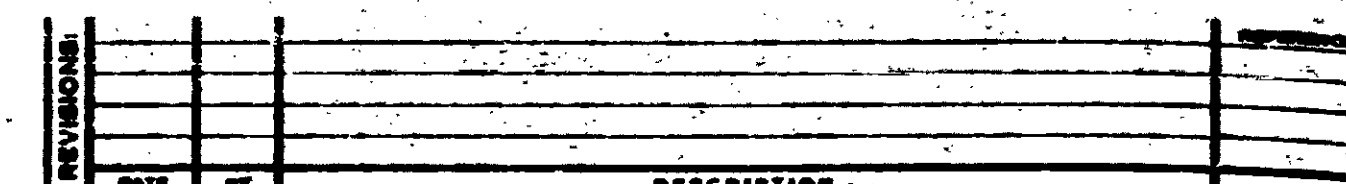
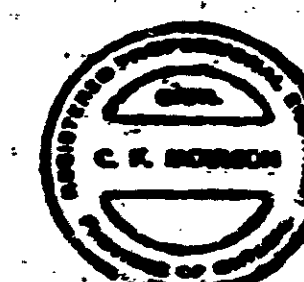
BOARD OF TRANSPORT COMMISSIONERS
FOR CANADA
Certified as a copy of the original duly sanctioned
by order of the Board under Section _____
of the Railway Act.
on this _____ day of April 1962
Order No. 107750
John D. ...
Member of Board of Transport
Commissioners for Canada
Witness: Mr. ...

LIST OF DRAWINGS

- D4567-1 GENERAL ARRANGEMENT.
- 2 FOOTINGS, SLAB REINF, DECK SLEV 4 HANDRAIL LAYOUT
 - 3 WEST ABUTMENT AND RETAINING WALL REINFORCING
 - 4 EAST ABUTMENT AND RETAINING WALL REINFORCING
 - 5 STRUCTURAL STEEL, WING WALLS & END POSTS
 - 6 HANDRAIL DETAILS
 - 7 APPROACH SLAB DETAILS
 - 8 CONSTRUCTION DETAILS FOR DETOUR
 - 9 10-11-12 REINFORCING STEEL SCHEDULE

PROPERTIES OF 15° 06' 25" SKEW ANGLE

SINE	.260622
COSINE	.965441
TANGENT	.269951





C.C. PARKER & PARSONS, BRINCKERHOFF, LIMITED.
 WILMINGTON CONSULTING ENGINEERS ONTARIO
DEPARTMENT OF HIGHWAYS-ONTARIO-
 BRIDGE OFFICE-TORONTO

CHURCH ACCESS OVERHEAD

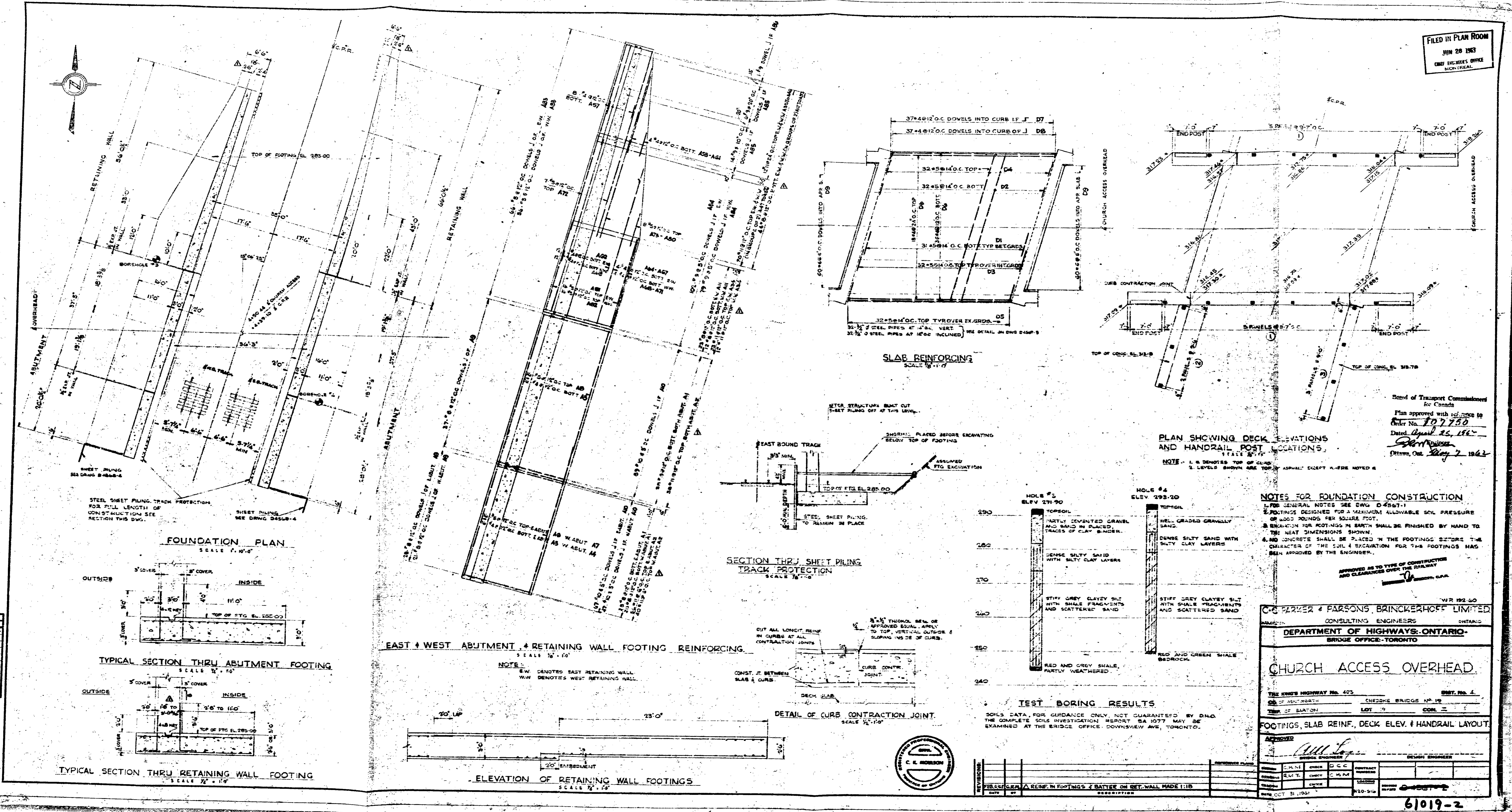
THE KING'S HIGHWAY No. 403 DIST. No. 4
CO. OF WENTWORTH CHEDoke BRIDGE No 19
TWP. OF BARTON LOT 19 CON. II

GENERAL ARRANGEMENT

APPROVED  BRIDGE ENGINEER		APPROVED AS TO TYPE OF CONSTRUCTION AND CLEARANCES OVER THE RAILWAY  BRIDGE ENGINEER	
DESIGNED BY	IC	CHECKED BY	D. C. C.
DRAWN BY	R. M. T.	CHECKED BY	C. K. M.
TRACED BY		CHECKED BY	
DATE SET MAY 1964		LOCATION #20-10	
		NUMBER D-15-1	

61019-

FILED IN PLAN ROOM
JUN 28 1967
CHIEF ENGINEER'S OFFICE
MONTREAL



Board of Transport Commissioners
for Canada
Plan approved with reference to
Order No. 107750
Dated April 25, 1967
G. H. Jones
District Eng. July 7, 1967

PLAN SHOWING DECK ELEVATIONS
AND HANDRAIL POST LOCATIONS.

NOTE: 1. & 2. DENOTES TOP OF SLAB
& LEVELS SHOWN ARE TOP OF ASPHALT EXCEPT WHERE NOTED

NOTES FOR FOUNDATION CONSTRUCTION
1. FOR GENERAL NOTES SEE DWG. D-4567-1
2. FOOTINGS DESIGNED FOR A MAXIMUM ALLOWABLE SOIL PRESSURE
OF 4000 POUNDS PER SQUARE FOOT.
3. EXCAVATION FOR FOOTINGS IN EARTH SHALL BE FINISHED BY HAND TO
THE NEAT DIMENSIONS SHOWN.
4. NO CONCRETE SHALL BE PLACED IN THE FOOTINGS BEFORE THE
CHARACTER OF THE SOIL & EXCAVATION FOR THE FOOTINGS HAS
BEEN APPROVED BY THE ENGINEER.

APPROVED AS TO TYPE OF CONSTRUCTION
AND CLEARANCES OVER THE RAILWAY
J. H. Jones, C.E.

W.R. 192-60
C.C. PARKER & PARSONS, BRINCKERHOFF LIMITED
CONSULTING ENGINEERS
DEPARTMENT OF HIGHWAYS-ONTARIO
BRIDGE OFFICE-TORONTO

CHURCH ACCESS OVERHEAD

THE KING'S HIGHWAY No. 403
CHURCH BRIDGE No. 19
DATE OF PLAN NORTH
DATE OF BATHON
LOT 19
CON. 2

FOOTINGS, SLAB REIN., DECK ELEV. & HANDRAIL LAYOUT

APPROVED
J. H. Jones
ENGINEER

DESIGN ENGINEER

NO.	CHKD.	APPROVED	DATE
1	CHKD.	APPROVED	DATE
2	CHKD.	APPROVED	DATE
3	CHKD.	APPROVED	DATE
4	CHKD.	APPROVED	DATE
5	CHKD.	APPROVED	DATE
6	CHKD.	APPROVED	DATE
7	CHKD.	APPROVED	DATE
8	CHKD.	APPROVED	DATE
9	CHKD.	APPROVED	DATE
10	CHKD.	APPROVED	DATE

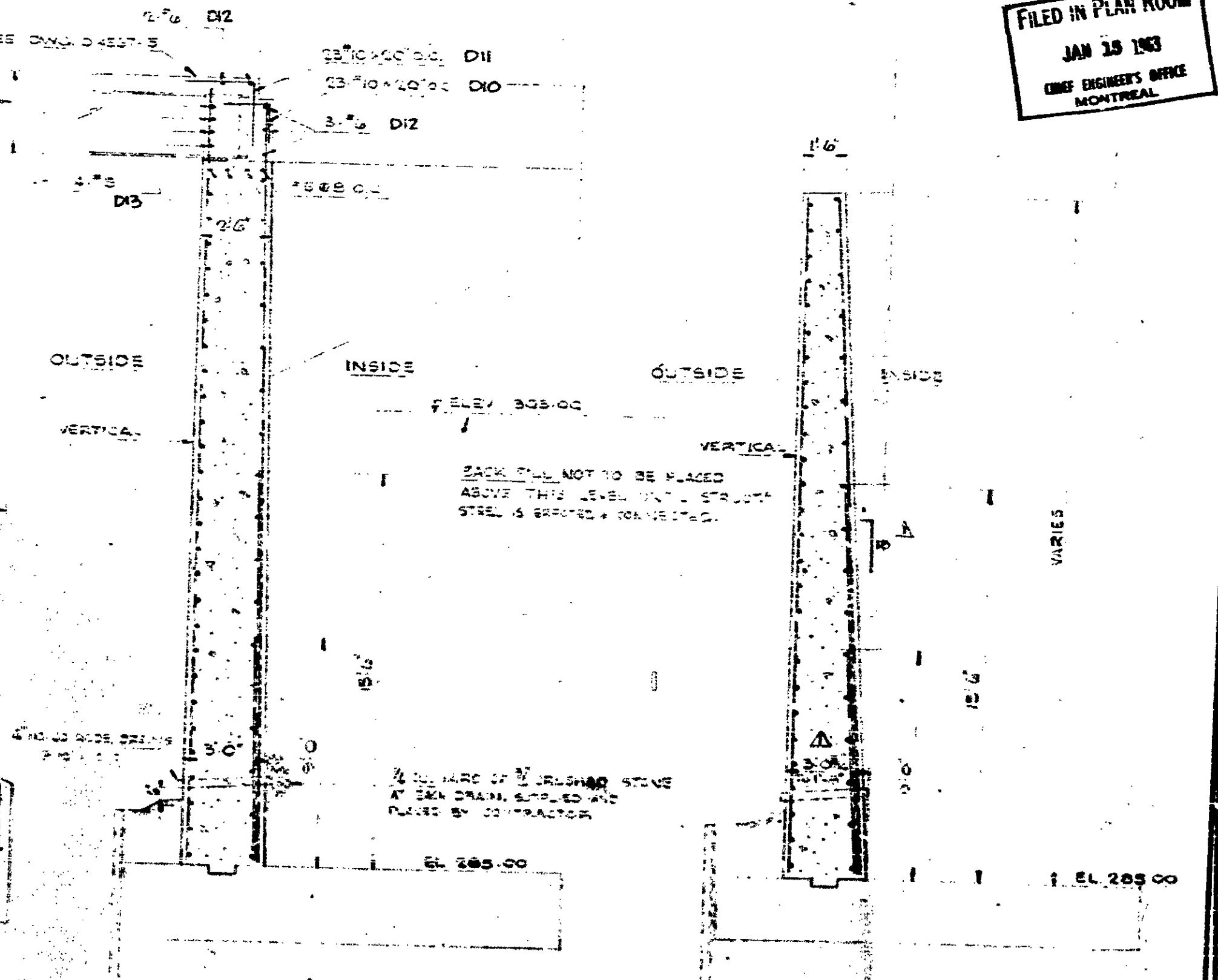
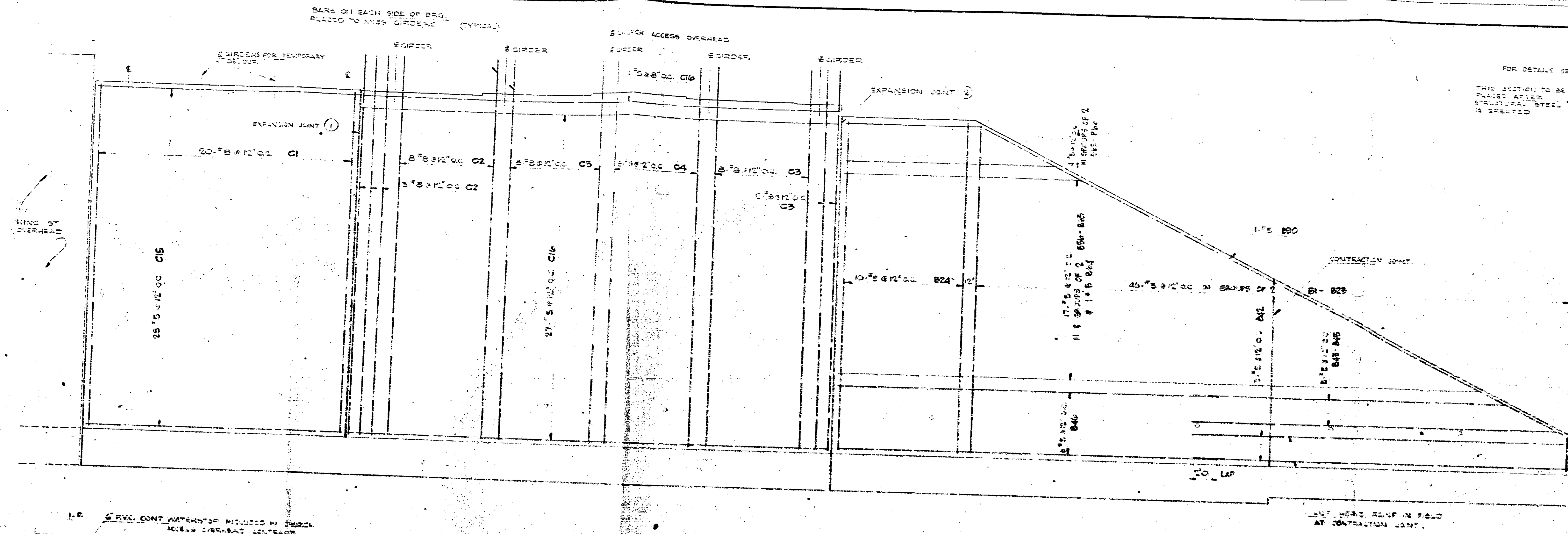
DATE OCT 31, 1967

TEST BORING RESULTS
SOILS DATA FOR GUIDANCE ONLY, NOT GUARANTEED BY D.M.O.
THE COMPLETE SOILS INVESTIGATION REPORT, BA 1077 MAY BE
EXAMINED AT THE BRIDGE OFFICE, DOWNVIEW AVE., TORONTO.

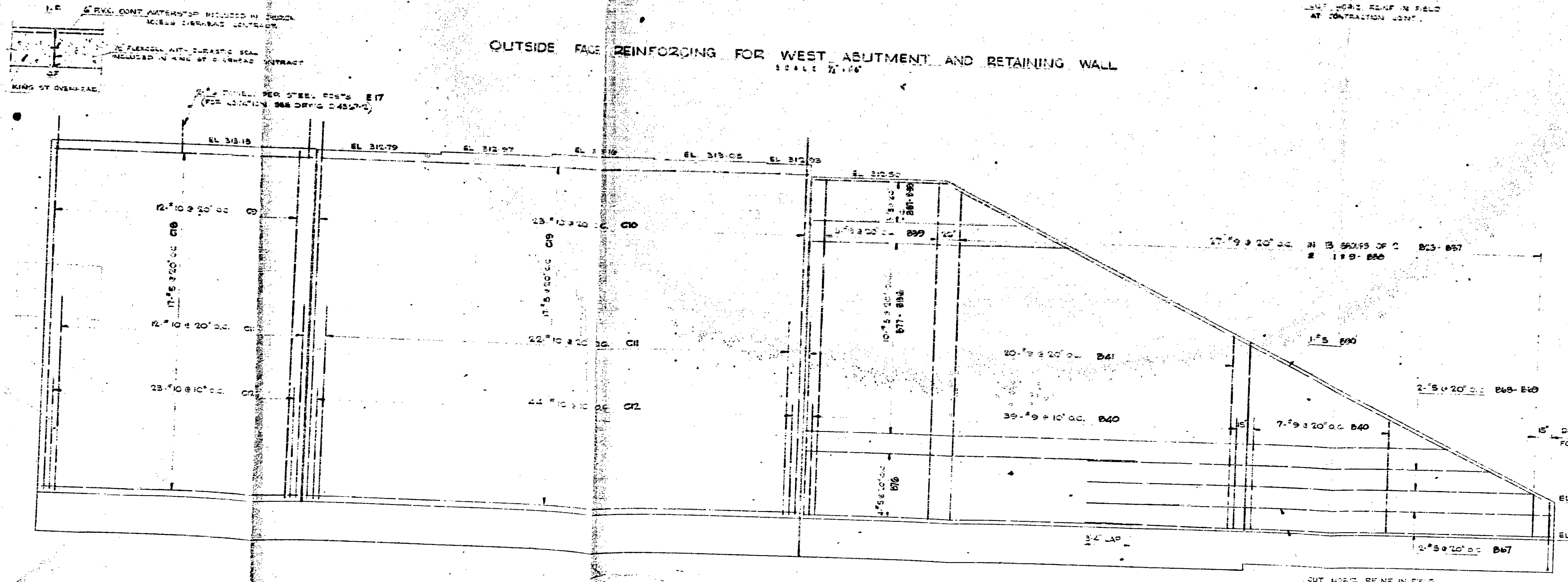


61019-2

FILED IN PLAN ROOM
JAN 29 1963
ENGINEERING OFFICE
MONTREAL



OUTSIDE FACE REINFORCING FOR WEST ABUTMENT AND RETAINING WALL
SCALE 1/4" = 1'-0"



TYPICAL SECTION THRU
ABUTMENT
SCALE 1/4" = 1'-0"

TYPICAL SECTION THRU
RETAINING WALL
SCALE 1/4" = 1'-0"

INSIDE FACE REINFORCING FOR WEST ABUTMENT AND RETAINING WALL
SCALE 1/4" = 1'-0"

NOTES:
1. FOR GENERAL NOTES SEE DRAWING 1045-1
2. FOR EXP. JOINT DETAILS SEE DRAW. 1045-2

Record of Transport Commission
for Canada
Plan approved with reference to
Order No. 107750
Dated Apr 25 1962
MAR 20 1962
Ottawa, Ont. John R. 1962

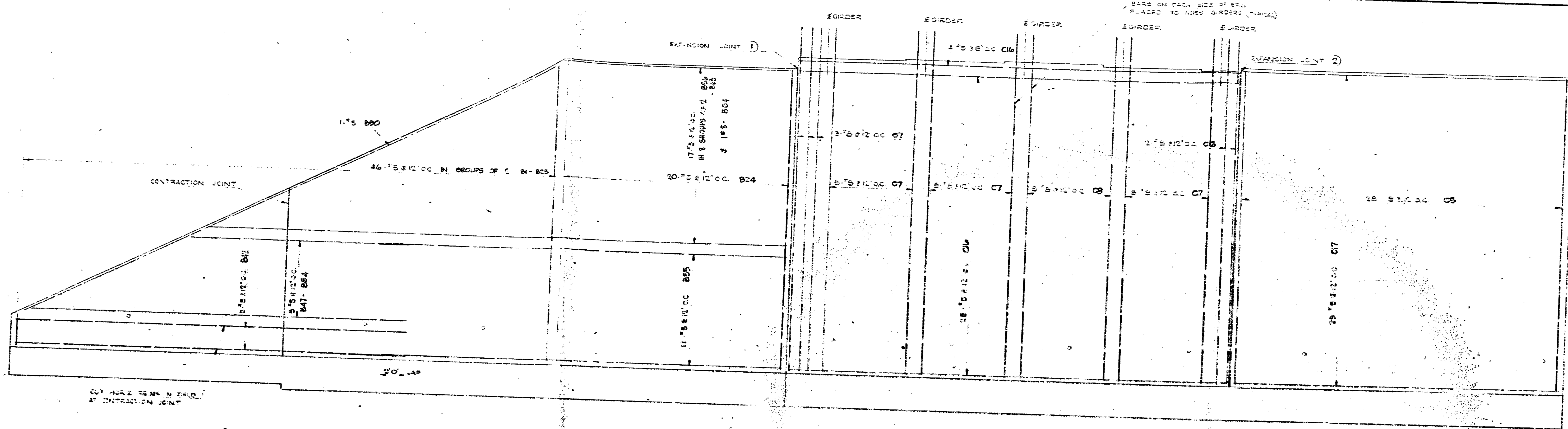
C.C. PARKER & PARSONS, PENCKERHOFF LIMITED			
CONSULTING ENGINEERS			
DEPARTMENT OF HIGHWAYS, ONTARIO			
BRIDGE OFFICE - TORONTO			
CHURCH ACCESS OVERHEAD			
THE KING'S HIGHWAY No. 403		DIST. No. 4	
CO. OF WENTWORTH		CHURCH BRIDGE No. 19	
TWP. OF EASTON		LOT 3 CON. 1	
WEST ABUTMENT AND RETAINING WALL REINFORCING			
APPROVED			
DESIGN ENGINEER			
DATE OCT 31, 1962			



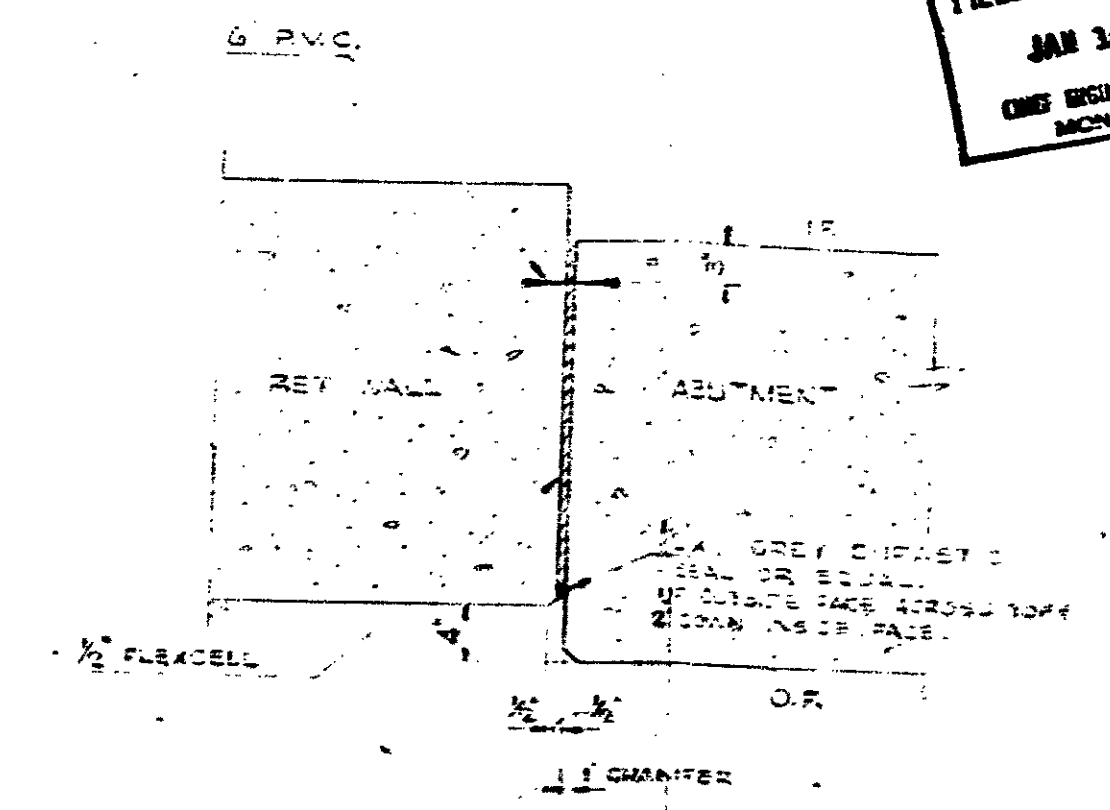
REVISION	DATE	BY	DESCRIPTION
1			FOR BATTER ON RETAINING WALL FACE (1/4" DIA. WATERED TO SUIT)

61019-3

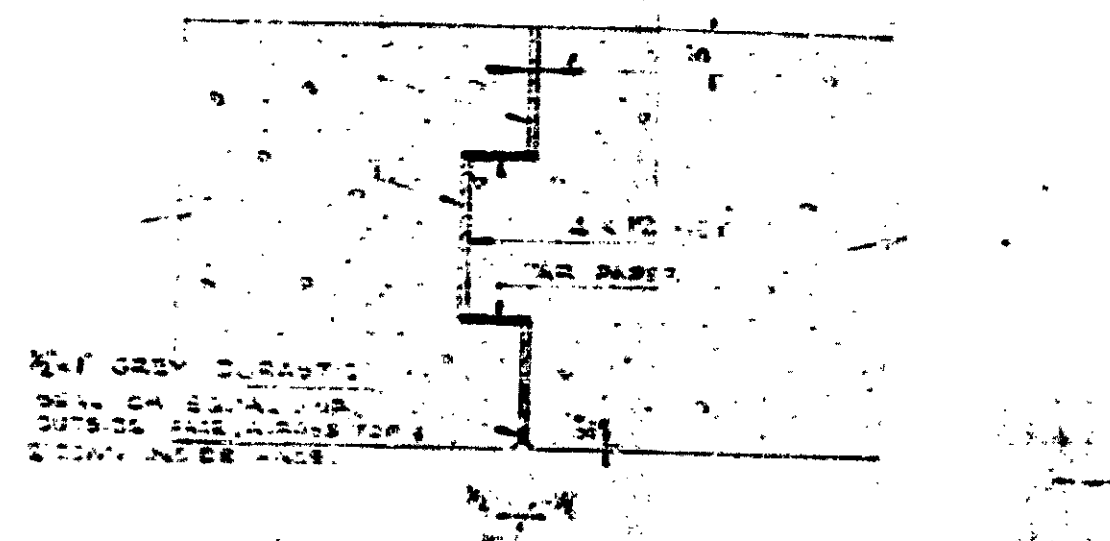
FILED IN PLAN ROOM
JAN 35 1963
CHIEF ENGINEER'S OFFICE
MONTREAL



OUTSIDE FACE REINFORCING FOR EAST ABUTMENT AND RETAINING WALL
SCALE 1/4" = 1'-0"



EXPANSION JT. BETWEEN ABUTMENT AND RETAINING WALL D
SCALE 1/4" = 1'-0"



EXPANSION JOINT IN ABUTMENT 2
SCALE 1/4" = 1'-0"

NOTES:
1. FOR GENERAL NOTES SEE DRAWING D4507-1
2. FOR ABUTMENT AND WALL SECTIONS SEE DRAWING D4507-2

Board of Transport Commissioners
for Canada
Plan approved with reference to
Order No. 102250
Dated 25/1/62
Ottawa, Ont. 2/1/63

C.C. PARKER & PARSONS, BRINCKERHOFF LIMITED.
CONSULTING ENGINEERS
DEPARTMENT OF HIGHWAYS-ONTARIO
BRIDGE OFFICE-TORONTO

CHURCH ACCESS OVERHEAD.

THE KING'S HIGHWAY No. 403 DIST. No. 1
CO. ST. MARY'S H. BRIDGE No. 19
TWP. OF BRANTON LOT 19 CON. 1

EAST ABUTMENT AND RETAINING WALL REINFORCING.
APPROVED
DESIGN ENGINEER
DATE 2/1/63



REVISIONS	DATE	BY	DESCRIPTION
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

DESIGN	CHECK	DATE	BY	DESCRIPTION
DESIGN	C.E.M.	2/1/63		
CHECK	C.E.M.	2/1/63		
DATE	2/1/63			

61019-4