

#68-F-217M

CLAREMONT HILL

MOUNTAIN ACCESS

ROAD

HAMILTON

BA2943  
site 36-224

PETO ASSOCIATES LIMITED

SOIL INVESTIGATION  
CLAREMONT HILL MOUNTAIN ACCESS ROAD  
HAMILTON, ONTARIO

68-F-217 M for

CORPORATION OF THE CITY OF HAMILTON  
c/o PROCTOR AND REDFERN

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JOB NO. 68-F7

DECEMBER, 1968



**PETO ASSOCIATES LTD.**  
CONSULTING SOIL ENGINEERS  
1287 Caledonia Rd Toronto 19 - Ontario - Phone (416) 789-1126

JOB NO. 68-F7

December 20, 1968.

The Corporation of the City of  
Hamilton,  
c/o Proctor and Redfern,  
Consulting Engineers,  
75 Eglinton Avenue East,  
Toronto 12, Ontario.

Attention: Mr. Peter A. Hertzberg, P. Eng.

Dear Sir:

Re: CHARM - Contract 2

We enclose, herewith, our comments on the soil conditions as they affect the proposed construction work scheduled for Contract 2 of the CHARM project.

The boreholes, on which these comments are based, were sunk both for our Report 62-116, and for the CHARM Project. Two boreholes #'s 4 and 5, sunk for the preliminary design of the CHARM Project, also lie in this area and information obtained from a test auger hole, and the slope indicator installation in borehole 157 has been used.

The area covered by Contract 2 of the Charm Project lies to the north of chainage 60+00 of the Claremont Hill Mountain Access Road, with the exception of the continuation of sewer construction to the south of this in the area of Contract 3. The road and sewer alignments are shown on the appended site plan. A bridge is to be constructed to carry the Claremont Hill Mountain Access Road across Stinson Street and retaining walls are required on the eastern and western sides of the road to the north and south of this bridge.



It should be appreciated that the boreholes for the Charm Project were sunk for the proposed road alignment and consequently, soil conditions on the sewer line are an interpretation. Our comments are thus made with respect to the interpretation made.

We do not have any boreholes in the area to the west of the Claremont Hill Mountain Access Road north of Stinson Street, and this area is excluded from our comments.

The detailed soil and ground water conditions are contained in the appended borehole logs. Table 1 lists the ground water observations and the concluded probable ground water conditions.

The details of the test auger hole are contained in a supplementary report now added to Part I of our Report 68F7. The borehole log for borehole 157 is not presented as soil sampling was not carried out during the drilling of the hole for the slope indicator installation. A simplified soil profile is appended showing the soil conditions at the boreholes closest to the proposed sewer alignment. These boreholes have been superimposed over the sewer profile. The soil conditions will be discussed relative to the various phases of the project.

Our comments on the various phases of the proposed construction are as follows:

1. SEWER LINE

- a) Manhole 30 to 31

The only boreholes completed near the sewer line are located near manhole 30, i.e. boreholes D1, E1 (Report No. 62116) and 157, and the test auger hole. Borehole 153 lies about halfway between manholes 30 and 31, but is displaced about 40 ft. to the north of the sewer line.

All of these holes found till materials, either silty clay or clayey silt with a large gravel, cobble and boulder content. Manhole 31 is near the base of the mountain and will probably also be in till materials, although we do not know at which point the overburden changes from till, to the sand with clayey silt layers, as in borehole 130. Borehole 157 slope indicator installation results to date, indicate possible slope instability in this area. The movements recorded to date are downhill and suggest possible movement up to 1 inch, from the surface to a depth of about 50 ft. below ground level, over a period of 7 months. We have previously recommended that it would be prudent to design the sewer line over this length such that movements of this order could be tolerated.

Assuming the overburden to comprise clayey silt or silty clay till, the excavations for the sewer should not pose any particular problem, unless ground water in large quantities is encountered. As the average depth of the sewer is less than 10 ft. 0 ins. below grade, this is unlikely. The soils encountered in the boreholes to this depth were stiff or very stiff and if similar conditions prevail along the sewer line, open sheeting should suffice.

At manhole 30, as the excavation will only be taken to about elevation 400, there should be no problem with large inflows of ground water. Seepage may be present, but normal sump pumping would be able to deal with this. Open sheeting may suffice for this excavation, but the safety regulations will govern the minimum support required.

In the case of manhole 31, the excavation will be to about elevation 326, which involves a total depth of excavation of the order of 32 ft. It is not possible to say that ground water will not be a problem. From the evidence of the test auger hole and the boreholes sunk in the till to the south of this manhole, definite drainage paths probably associated with boulder concentrations exist in the overburden till comprising the Hamilton Mountain slopes in this area. Large volumes of water, as in the case of the test auger hole, may be associated with such drainage paths.

The amounts of water, however, will vary throughout the year and should normally be a minimum during the summer months. It would be prudent to investigate the soil and ground water conditions at this manhole location prior to the commencement of construction.

Sheeting consistent with safety regulations, will be required for this excavation.

b) Manhole 31 - Manhole 35 (i.e. Manholes 31, 32, 34, 35)

The boreholes near this stretch of sewer, were sunk for the alignment of the Claremont Hill Mountain Access Road and the results can only be applied with caution to the sewer line. Ground water is not anticipated to be a problem during excavations, in that seepage seams only are anticipated and conventional pumping from the trench should deal with this. It would appear that from Manhole 35 to Manhole 32, that the sewer line will be founded in rock. From Manhole 35 to Manhole 32, similar materials to those found in boreholes 133, 132 and 131 will likely be found, although the depths to rock may be less than found at the borehole locations.

Close sheeting would be appropriate to those sections of the sewer between manholes 35 and 32, where damage to adjacent structures and services is possible through loss of ground. On site decisions will require to be made if such a danger exists, in determining if such sheeting should be left in place after laying the sewer line.

Provided both manholes are founded on rock, then bearing capacity is not a problem. Close sheeting will be required for the manhole excavations. Between Manholes 32 and 31 it seems likely that the trench will be located in compact or loose fill materials, or loose sand/silt.

If this is the case, this material will require to be overexcavated to bedrock or weathered shale and the sewer founded on compacted backfill. Over this section, open sheeting would probably suffice, as the line is out of the built up area. This will depend on the soil materials encountered, however.

It is possible that till deposits similar to these found in borehole 153 etc. will be encountered at some point near Manhole 31. Open sheeting could possibly be used depending on the depth of the excavation. It may be possible and preferable to drive the last section of the sewer excavation into Manhole 31 as tunnel. The feasibility of this would depend on the soil conditions encountered.

c) Manhole 35, Manhole 41 (i.e. Manholes 35, 36, 38, 39, 40, 41)

The boreholes completed for this section were also completed for the road alignment and are located on the opposite side of Victoria Avenue from the sewer line and hence some variations in the soil conditions at the sewer line are to be expected. However, from the borehole results, it would appear that the sewer will be founded in shale bedrock from Manhole 35 to a point near borehole 135A when the sewer will probably be founded in grey silty clay till. From this point to Manhole 41, the sewer will probably be founded in this till, although over an area opposite borehole 137, the sewer may be founded on sand with layers of silt. At such locations it may be necessary, if seepage seams are found at or near this founding depth, to overexcavate the trench down to the till and backfill in 6 inch layers with compacted granular material. No problems with respect to bearing capacity are expected for the anticipated conditions over this section.

Ground water is unlikely to be a problem over this section in that seepage seams only, are anticipated and conventional pumping from the trench should deal with this.

Accordingly, close sheeting will only be required in general near the ground surface, where loose fills and sands are encountered. Where loose materials persist to depth, however, close sheeting will be required. Otherwise, open sheeting will be required, unless heavy surcharge loads from deeper than normal foundations are within a distance equivalent to invert depth of the sewer line. It is recommended that where close sheeting is employed for the top section of the trench excavation, that these sections be overexcavated to allow drainage water to be collected at the step so formed at the base of the close sheeting.

d) Manhole 36 - 37

We do not know the founding elevation for manhole 37, but presume that this will be at or near bedrock. Assuming similar conditions to boreholes 134 and 135, then comments with respect to sheeting and ground water control are as previously given for the section of sewer between Manholes 35 and 36.

e) Manhole 32 - 33

We do not have boreholes near this section, however, it is probable that Manhole 33 will be founded in till with a change to the fill and sand/silt materials as in borehole 130 occurring at some point along the line of the sewer.

f) Manholes 42, 43, 44, 45, 46 and 47

These sewer sections are not shown on the appended site plan, as boreholes have not been completed in this area. Accordingly, we cannot make any comments regarding these sections.

2. STRUCTURES ASSOCIATED WITH THE CLAREMONT HILL MOUNTAIN ACCESS ROAD

a) Stinson Street Bridge

It is recommended that the foundations for the bridge abutments at Stinson Street be taken to rock, as loose sand deposits down to bedrock were found to depths of 14 ft. 0 ins. and 16 ft. 6 ins. in boreholes 134 and 135 respectively.

We recommend that steel H section piles be used for the bridge abutments and that these be driven through the weathered shale into the bedrock proper.

b) Embankment to the North and South of the Stinson Street Bridge

The embankments may be placed on the loose materials present, as immediate settlements only will occur as the embankments are placed, and will be safe from bearing capacity and future settlement once the embankments are placed. Approved granular material should be used as backfill behind the retaining walls and this should be compacted in 6 inch lifts to a minimum of 95% Standard Proctor Optimum Density.

c) Retaining Walls to the North of the Stinson Street Bridge

It is recommended that the retaining wall be founded on steel H section piles taken to the bedrock with raker piles used to resist the lateral forces on the foundation. Piled foundations will be required, until the dense material shown in probe 135A is encountered. Thereafter, strip footings set a depth of 9 ft. below existing ground level, may be used, designed to an allowable bearing capacity of 5 Kips/sq. ft. Differential settlements over this section of the wall founded on footings are not anticipated to exceed 3/4 ins.

A construction joint should be made at the junction of the piled section of the wall with the section founded on strip footings.

d) Retaining Walls to the South of the Stinson Street Bridge

As for the retaining walls immediately to the north of the bridge, a steel H section piled foundation to bedrock is recommended.

3. GENERAL

- a) Nine soil samples from boreholes 130, 131, 132, 134, 135A and 153 were tested for  $SO_4$  concentration. The highest value obtained was 503 ppm with the remainder below 300 ppm. Accordingly, we have no evidence to suggest that sulphate attack on concrete is likely.
- b) The excavated materials should in general be suitable for trench backfill, subject to weather conditions. The only materials unsuitable, would be the organic fills as found in boreholes 130, 131, 132 and 135. Where the sewer is founded in grey silty till, we would recommend that only the overlying granular materials be used as backfill. The till materials found on the mountain slopes may contain large amounts of boulders and on site decisions will require to be made in assessing the suitability of the material. The backfill should be compacted to 95% Standard Proctor Optimum.

Where the trench underlies new pavement, the top 2 ft. should be backfilled with granular B material compacted to 100% Standard Proctor Optimum.

We trust that the foregoing comments cover your requirements, but if you have any points you wish to raise, we will be pleased to discuss these with you.

Yours very truly,

PETO ASSOCIATES LTD.

*D J Belshaw*

DJB/jc

D. J. Belshaw, P. Eng.

TABLE I - GROUND WATER OBSERVATIONS

<u>Borehole #</u>	<u>Ground Water Observations</u>	<u>Conclusions</u>	<u>Estimated WL Below G.L. at Time of Drilling</u>
D1	Occasional wet seams in overburden, wash water lost at 58'6", ±64'0", 82'6"	Possible drainage paths in boulder concentrations	
E1	Occasional wet seams in overburden	Water levels recorded in plastic tube varied between 27'3" and 35'6" Nov.-Jan 1962	
Large Diameter test hole	On withdrawal of auger at 34'6", water entered hole, rose to 26'0" in 5 minutes, 22'0" in 12 minutes, 20'6" in 1 hour.	Possible drainage path in boulder layer intersected by test auger hole	
133	Drill water used almost continually in overburden, cave at 50'0", WL on completion 38'2" after 14 hrs. 45'2"		±45'0"
130	Water level 11'2", cave 11'3", drill water used in rock	Perched water table at surface of rock	±11'0"
4	No water table readings		± 9'0"
131	WL at 10'4", cave at 10'6" WL on completion 13'0", drill water used in rock	Perched W.T. on top of shale	±10'0"
132	WL 15'3", cave at 16'0", WL on completion 28'6"-drill water used in rock	Perched water table at surface of rock	±15'0"
133	Cave at 14'2", water level 14'0", W.L. 18'9" on completion, drill water used in rock	Perched water table at surface of shale	±14'0"
134	Water level at completion 12'7", drill water used in rock	Perched water table at surface of shale	±12'0"

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<u>Borehole #</u>	<u>Ground Water Observations</u>	<u>Conclusions</u>	<u>Estimated WL Below G.L. Time of Drilling</u>
135	Casing to 10'0", W.L. at 16'2", cave 16'9", W.L. on completion 12'6"-drill water used in rock	Perched water table at surface of shale	±16'0"
135A	Wash water used from 12'6", W.L. at completion 13'9", casing used, drill water used in rock	Seepage seams in sand/ silt	±15'0"
136	Wash water used from 17'0", W.L. on completion 13'7", drill water used in rock	No definite water table established	±17'0"
137	Cave at 17'0", water level on completion 9'5". Wash water used from 12'4", casing used	Perched water table on top of grey silty clay till	±17'0"
5	Cave at 15'10"	Perched water table on top of grey silty clay till	±16'0"

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## LIST OF ABBREVIATIONS

### PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

### DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS:-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		
W.T.P.L.	WETTER THAN PLASTIC LIMIT		D.T.P.L.	DRIER THAN PLASTIC LIMIT
	A.P.L.		ABOUT PLASTIC LIMIT	

### TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H.	SAMPLE ADVANCED HYDRAULICALLY	
	P.M.	SAMPLE ADVANCED MANUALLY	

### SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL		

## ABBREVIATIONS USED IN THIS REPORT

### SOIL PROPERTIES

$\gamma$	UNIT WEIGHT OF SOIL (BULK DENSITY)
$\gamma_s$	UNIT WEIGHT OF SOLID PARTICLES
$\gamma_w$	UNIT WEIGHT OF WATER
$\gamma_d$	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
$\gamma'$	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
$S_r$	DEGREE OF SATURATION
$w_L$	LIQUID LIMIT
$w_p$	PLASTIC LIMIT
$I_p$	PLASTICITY INDEX
s	SHRINKAGE LIMIT
$I_L$	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
$I_c$	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
$e_{max}$	VOID RATIO IN LOOSEST STATE
$e_{min}$	VOID RATIO IN DENSEST STATE
$I_D$	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY $D_r$ IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
$m_v$	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
$C_v$	COEFFICIENT OF CONSOLIDATION
$C_c$	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
$T_v$	TIME FACTOR = $\frac{C_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
$\tau_f$	SHEAR STRENGTH
$c'$	EFFECTIVE COHESION INTERCEPT
$\phi'$	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
$c_u$	APPARENT COHESION
$\phi_u$	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
$\mu$	COEFFICIENT OF FRICTION
$S_t$	SENSITIVITY

### GENERAL

$\pi$	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

### STRESS AND STRAIN

u	PORE PRESSURE
$\sigma$	NORMAL STRESS
$\bar{\sigma}$	NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED)
$\tau$	SHEAR STRESS
$\epsilon$	LINEAR STRAIN
$\gamma$	SHEAR STRAIN
$\nu$	POISSON'S RATIO ( $\mu$ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
$\eta$	COEFFICIENT OF VISCOSITY

### EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
$\delta$	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
$K_o$	COEFFICIENT OF EARTH PRESSURE AT REST

### FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
$k_s$	MODULUS OF SUBGRADE REACTION

### SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
$\beta$	ANGLE OF SLOPE TO HORIZONTAL



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## RECORD OF BOREHOLE NO.

JOB NO. 67-257 JOB NAME 101 BORING FOR WATER IN HILL CANYON, DEPT. 101 TECHNICIAN JL  
BORING DATE 10-15-66 CLIENT U.S. GEOLOGICAL SURVEY, WASHINGTON, D.C. ENGINEER DBJF  
GROUND ELEV. BOREHOLE TYPE 6" DIA. RIG TYPED BY HP

SOIL PROFILE		SAMPLES			DYNAMIC CONE PENETRATION BLOWS/FOOT STANDARD PENETRATION TEST BLOWS/FOOT		LIQUID LIMIT _____ W <sub>L</sub> PLASTIC LIMIT _____ W <sub>P</sub> WATER CONTENT _____ W		REMARKS
DEPTH ELEV.	DESCRIPTION	LEGEND	NUMBER	TYPE	BLOWS/FOOT	SHLAR STRENGTH C <sub>u</sub> LB/50 FT	W <sub>P</sub> _____ W _____ W <sub>L</sub> WATER CONTENT %		
0'0"	1.5' layer of fine sand, brown brown & tan, silty from 0.1" to 0.2" possible trace moist								
	Increased moisture content in 1.5' layer								
12'6"	fine sand, silty brown, brown & tan sand, gravelly, fine fine sand lodge								
15'9"	fine sand, silty brown, brown & tan sand, gravelly, fine fine sand lodge								
18'6"	coarse sand, brown, tan fine, gray silty sand fill with some fine co. coarse gravel								hole caved at 18'6"
	MOIST								hole caved at 18'6"
30'9"	Terminated at 30'9" on completion hole caved at 15'1"								

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## RECORD OF BOREHOLE NO. 20

JOB NO. 1080 JOB NAME 1080 TECHNICIAN  
BORING DATE MAR. 1960 CLIENT U.S. GEOLOGICAL SURVEY ENGINEER D. S. KING  
GROUND ELEV. 122.91 BOREHOLE TYPE 1080-1 TYPED BY J.C.

SOIL PROFILE		SAMPLES			DYNAMIC CONE PENETRATION BLOWS/FOOT	LIQUID LIMIT _____ W <sub>L</sub> PLASTIC LIMIT _____ W <sub>P</sub> WATER CONTENT _____ W <sub>p</sub>			REMARKS
DEPTH ELEV.	DESCRIPTION	LEGEND	NUMBER	TYPE	BLOWS/FOOT	SHEAR STRENGTH C <sub>u</sub> LB/SQ. FT.  W <sub>p</sub> W <sub>c</sub> W <sub>L</sub> WATER CONTENT %			
0.0'	SURFACE								
1.0'	FILL - SANDY SILT								
1.5'	(CUT)								
2.0'	MID Hard brown c.								
2.5'	silty clay, gravel &								
3.0'	clayey silt, very								
3.5'	moist, compact								
4.0'	SAND: CLAY OR. S.S.								
4.5'	F. to coarse sand								
5.0'	SAND/SILT mix, silty								
6.0'	med. to coarse sand								
7.0'	with layers of med.								
8.0'	Gish clayey silt, med.								
9.0'	loose								
10.0'	Shale, med. hard								
11.0'	red and green								
12.0'	FAIR CORE								
13.0'									
14.0'	"Recovery" 60%								
15.0'	Note terminated								
16.0'	Water level 10' "								
17.0'	hole caved at								
18.0'	11' 3"								

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# RECORD OF BOREHOLE NO.

JOB NO. 1017 JOB NAME CLAYTON DRIVE, CLAYTON, ONT. TECHNICIAN IT  
 BORING DATE 11-1-77 CLIENT CLAYTON DRIVE, CLAYTON, ONT. ENGINEER IND. INC.  
 GROUND ELEV. 122.3' BOREHOLE TYPE CLAYTON DRIVE, CLAYTON, ONT. TYPED BY JOE

DEPTH ELEV.	SOIL PROFILE DESCRIPTION	LEGEND	SAMPLES			DYNAMIC CONE PENETRATION BLOWS/FOOT STANDARD PENETRATION TEST BLOWS/FOOT SHEAR STRENGTH $C_u$ LB/50 FT	LIQUID LIMIT <u>      </u> $W_L$ PLASTIC LIMIT <u>      </u> $W_p$ WATER CONTENT <u>      </u> $W$ $W_p$ $W$ $W_L$ WATER CONTENT % 10 20 30	REMARKS
			NUMBER	TYPE	BOREHOLE			
1.3'	CLAYTON DRIVE, CLAYTON, ONT.							
2.0'	CLAYTON DRIVE, CLAYTON, ONT.							
3.0'	CLAYTON DRIVE, CLAYTON, ONT.							
4.0'	CLAYTON DRIVE, CLAYTON, ONT.							
5.0'	CLAYTON DRIVE, CLAYTON, ONT.							
6.0'	CLAYTON DRIVE, CLAYTON, ONT.							
7.0'	CLAYTON DRIVE, CLAYTON, ONT.							
8.0'	CLAYTON DRIVE, CLAYTON, ONT.							
9.0'	CLAYTON DRIVE, CLAYTON, ONT.							
10.0'	CLAYTON DRIVE, CLAYTON, ONT.							
11.0'	CLAYTON DRIVE, CLAYTON, ONT.							
12.0'	CLAYTON DRIVE, CLAYTON, ONT.							
13.0'	CLAYTON DRIVE, CLAYTON, ONT.							
14.0'	CLAYTON DRIVE, CLAYTON, ONT.							
15.0'	CLAYTON DRIVE, CLAYTON, ONT.							
16.0'	CLAYTON DRIVE, CLAYTON, ONT.							
17.0'	CLAYTON DRIVE, CLAYTON, ONT.							
18.0'	CLAYTON DRIVE, CLAYTON, ONT.							
19.0'	CLAYTON DRIVE, CLAYTON, ONT.							
20.0'	CLAYTON DRIVE, CLAYTON, ONT.							
21.0'	CLAYTON DRIVE, CLAYTON, ONT.							
22.0'	CLAYTON DRIVE, CLAYTON, ONT.							
23.0'	CLAYTON DRIVE, CLAYTON, ONT.							
24.0'	CLAYTON DRIVE, CLAYTON, ONT.							
25.0'	CLAYTON DRIVE, CLAYTON, ONT.							
26.0'	CLAYTON DRIVE, CLAYTON, ONT.							
27.0'	CLAYTON DRIVE, CLAYTON, ONT.							
28.0'	CLAYTON DRIVE, CLAYTON, ONT.							
29.0'	CLAYTON DRIVE, CLAYTON, ONT.							
30.0'	CLAYTON DRIVE, CLAYTON, ONT.							
31.0'	CLAYTON DRIVE, CLAYTON, ONT.							
32.0'	CLAYTON DRIVE, CLAYTON, ONT.							
33.0'	CLAYTON DRIVE, CLAYTON, ONT.							
34.0'	CLAYTON DRIVE, CLAYTON, ONT.							
35.0'	CLAYTON DRIVE, CLAYTON, ONT.							
36.0'	CLAYTON DRIVE, CLAYTON, ONT.							
37.0'	CLAYTON DRIVE, CLAYTON, ONT.							
38.0'	CLAYTON DRIVE, CLAYTON, ONT.							
39.0'	CLAYTON DRIVE, CLAYTON, ONT.							
40.0'	CLAYTON DRIVE, CLAYTON, ONT.							
41.0'	CLAYTON DRIVE, CLAYTON, ONT.							
42.0'	CLAYTON DRIVE, CLAYTON, ONT.							
43.0'	CLAYTON DRIVE, CLAYTON, ONT.							
44.0'	CLAYTON DRIVE, CLAYTON, ONT.							
45.0'	CLAYTON DRIVE, CLAYTON, ONT.							
46.0'	CLAYTON DRIVE, CLAYTON, ONT.							
47.0'	CLAYTON DRIVE, CLAYTON, ONT.							
48.0'	CLAYTON DRIVE, CLAYTON, ONT.							
49.0'	CLAYTON DRIVE, CLAYTON, ONT.							
50.0'	CLAYTON DRIVE, CLAYTON, ONT.							
51.0'	CLAYTON DRIVE, CLAYTON, ONT.							
52.0'	CLAYTON DRIVE, CLAYTON, ONT.							
53.0'	CLAYTON DRIVE, CLAYTON, ONT.							
54.0'	CLAYTON DRIVE, CLAYTON, ONT.							
55.0'	CLAYTON DRIVE, CLAYTON, ONT.							
56.0'	CLAYTON DRIVE, CLAYTON, ONT.							
57.0'	CLAYTON DRIVE, CLAYTON, ONT.							
58.0'	CLAYTON DRIVE, CLAYTON, ONT.							
59.0'	CLAYTON DRIVE, CLAYTON, ONT.							
60.0'	CLAYTON DRIVE, CLAYTON, ONT.							
61.0'	CLAYTON DRIVE, CLAYTON, ONT.							
62.0'	CLAYTON DRIVE, CLAYTON, ONT.							
63.0'	CLAYTON DRIVE, CLAYTON, ONT.							
64.0'	CLAYTON DRIVE, CLAYTON, ONT.							
65.0'	CLAYTON DRIVE, CLAYTON, ONT.							
66.0'	CLAYTON DRIVE, CLAYTON, ONT.							
67.0'	CLAYTON DRIVE, CLAYTON, ONT.							
68.0'	CLAYTON DRIVE, CLAYTON, ONT.							
69.0'	CLAYTON DRIVE, CLAYTON, ONT.							
70.0'	CLAYTON DRIVE, CLAYTON, ONT.							
71.0'	CLAYTON DRIVE, CLAYTON, ONT.							
72.0'	CLAYTON DRIVE, CLAYTON, ONT.							
73.0'	CLAYTON DRIVE, CLAYTON, ONT.							
74.0'	CLAYTON DRIVE, CLAYTON, ONT.							
75.0'	CLAYTON DRIVE, CLAYTON, ONT.							
76.0'	CLAYTON DRIVE, CLAYTON, ONT.							
77.0'	CLAYTON DRIVE, CLAYTON, ONT.							
78.0'	CLAYTON DRIVE, CLAYTON, ONT.							
79.0'	CLAYTON DRIVE, CLAYTON, ONT.							
80.0'	CLAYTON DRIVE, CLAYTON, ONT.							
81.0'	CLAYTON DRIVE, CLAYTON, ONT.							
82.0'	CLAYTON DRIVE, CLAYTON, ONT.							
83.0'	CLAYTON DRIVE, CLAYTON, ONT.							
84.0'	CLAYTON DRIVE, CLAYTON, ONT.							
85.0'	CLAYTON DRIVE, CLAYTON, ONT.							
86.0'	CLAYTON DRIVE, CLAYTON, ONT.							
87.0'	CLAYTON DRIVE, CLAYTON, ONT.							
88.0'	CLAYTON DRIVE, CLAYTON, ONT.							
89.0'	CLAYTON DRIVE, CLAYTON, ONT.							
90.0'	CLAYTON DRIVE, CLAYTON, ONT.							
91.0'	CLAYTON DRIVE, CLAYTON, ONT.							
92.0'	CLAYTON DRIVE, CLAYTON, ONT.							
93.0'	CLAYTON DRIVE, CLAYTON, ONT.							
94.0'	CLAYTON DRIVE, CLAYTON, ONT.							
95.0'	CLAYTON DRIVE, CLAYTON, ONT.							
96.0'	CLAYTON DRIVE, CLAYTON, ONT.							
97.0'	CLAYTON DRIVE, CLAYTON, ONT.							
98.0'	CLAYTON DRIVE, CLAYTON, ONT.							
99.0'	CLAYTON DRIVE, CLAYTON, ONT.							
100.0'	CLAYTON DRIVE, CLAYTON, ONT.							

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 CONDITION OF ORIGINAL DOCUMENT



e. m. peto associates ltd

### Consulting soil engineers

## RECORD OF BOREHOLE NO.

JOB NO.	JOB NAME	TECHNICIAN
BORING DATE	CLIENT	ENGINEER
GROUND ELEV	BOREHOLE TYPE	TYPED BY

GROUND ELEV. 100.00 BOREHOLE TYPE 100.00 TYPED BY

GROUND ELEV. 100.00 BOREHOLE TYPE 100.00 TYPED BY

GROUND ELEV. 100.00 BOREHOLE TYPE 100.00 TYPED BY

[illegible]

DEFECTS IN NEGATIVE DUE TO  
CONDITION OF ORIGINAL DOCUMENT

e m peto associates llc

### Consulting soil engineers

## RECORD OF BOREHOLE NO. 11

JOB NO. 6492

JOB NAME

TECHNICIAN

BORING DATE

## CLIENT

ENGINEER.

GROUND ELEV

BOREHOLE TYPE

TYPED BY

[illegible]

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CONDITION OF ORIGINAL DOCUMENT

e. m. petro associates ltd.

### Consulting soil engineers

## RECORD OF BOREHOLE NO.

JOB NO. 1007 JOB NAME TECHNICAL  
BORING DATE 10/11/07 CLIENT ENGINEER  
GROUND ELEV. 100.0 BOREHOLE TYPE TYPED BY

SOIL PROFILE		SAMPLES			DYNAMIC CONE PENETRATION BLOWS/FOOT STANDARD PENETRATION TEST BLOWS/FOOT		LIQUID LIMIT _____ W <sub>L</sub> PLASTIC LIMIT _____ W <sub>P</sub> WATER CONTENT _____ W		REMARKS	
DEPTH ELEV.	DESCRIPTION	NUMBER	TYPE	BLOWS/FOOT	CONFINING STRENGTH C <sub>u</sub> LB/SQ FT	W <sub>0</sub>	W <sub>1</sub>	W <sub>2</sub>		WATER CONTENT %
0'9"	TOP OF FILL FILL SAND AND GRAVEL OPEN TO FILL COR. SET									
4'9"	SAND GRAVEL MIXTURE SILTY FINE TO MEDIUM SAND WITH OCCASIONAL FINE GRAVEL  Loose									
16'0"										
17'6"	WEATHERED SHALE SHALE, redish-brown, hard sandstone interbedded with FINE GRAVEL  At 18'00" FAIR COR.									
23'9"	SHALE, red and grey medium sandstone at 23'9" water test 1.6 12.5"									

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e.m. peto associates ltd.

## RECORD OF BOREHOLE NO.

Consulting soil engineers

JOB NO. 6877

JOB NAME

TECHNICIAN

BORING DATE Mar. 9-7/85

CLIENT

ENGINEER

GROUND ELEV.

BOREHOLE TYPE

TYPED BY

SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION BLOWS/FOOT		LIQUID LIMIT $W_L$		REMARKS
DEPTH ELEV.	DESCRIPTION	LEGEND NUMBER	FIG.	STANDARD PENETRATION TEST BLOWS/FOOT	WATER CONTENT $W$	PLASTIC LIMIT $W_P$	WATER CONTENT %	
0' 0"	Surface							
0' 0"	STAY/SLIT TEST TOP to medium sand with layers of reddish silt.							
	moist,							
9' 0"	loose to compact,							
	HAND/SLIT TEST medium to coarse sand with clay & silt with layers of reddish silt.							
	Wet.							
20' 0"	Very dense							
21' 0"	fine grey silt till very silty sand Borehole terminated at 21' 0"							
	at 21' 0"							
	at 17' 0"							

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GROUND ELEV. \_\_\_\_\_ BOREHOLE TYPE \_\_\_\_\_ TYPED BY \_\_\_\_\_

DEFECTS IN NEGATIVE DUE TO  
CONDITION OF ORIGINAL DOCUMENT

## RECORD OF BOREHOLE NO.

JOB NO. \_\_\_\_\_ JOB NAME \_\_\_\_\_ TECHNICIAN \_\_\_\_\_  
 BORING DATE \_\_\_\_\_ CLIENT \_\_\_\_\_ ENGINEER \_\_\_\_\_  
 GROUND ELEV. \_\_\_\_\_ BOREHOLE TYPE \_\_\_\_\_ TYPED BY \_\_\_\_\_

DEPTH ELEV.	SOIL PROFILE DESCRIPTION	SAMPLES				DYNAMIC CONE PENETRATION FLAWS/100' STANDARD PENETRATION TEST BLOWS/100' SPREAD TENSILE $T_u$ LB/100'	LIQUID LIMIT _____ $W_L$ PLASTIC LIMIT _____ $W_P$ WATER CONTENT _____ $W$ WATER CONTENT _____ $W_L$ WATER CONTENT _____ $W_P$			REMARKS
		NO.	DATE	TIME	LOCATION					
0' 0"	Surface									
0' 1"	Topsoil									
0' 2"	Topsoil									
0' 3"	Topsoil									
0' 4"	Topsoil									
0' 5"	Topsoil									
0' 6"	Topsoil									
0' 7"	Topsoil									
0' 8"	Topsoil									
0' 9"	Topsoil									
0' 10"	Topsoil									
0' 11"	Topsoil									
0' 12"	Topsoil									
0' 13"	Topsoil									
0' 14"	Topsoil									
0' 15"	Topsoil									
0' 16"	Topsoil									
0' 17"	Topsoil									
0' 18"	Topsoil									
0' 19"	Topsoil									
0' 20"	Topsoil									
0' 21"	Topsoil									
0' 22"	Topsoil									
0' 23"	Topsoil									
0' 24"	Topsoil									
0' 25"	Topsoil									
0' 26"	Topsoil									
0' 27"	Topsoil									
0' 28"	Topsoil									
0' 29"	Topsoil									
0' 30"	Topsoil									
0' 31"	Topsoil									
0' 32"	Topsoil									
0' 33"	Topsoil									
0' 34"	Topsoil									
0' 35"	Topsoil									
0' 36"	Topsoil									
0' 37"	Topsoil									
0' 38"	Topsoil									
0' 39"	Topsoil									
0' 40"	Topsoil									
0' 41"	Topsoil									
0' 42"	Topsoil									
0' 43"	Topsoil									
0' 44"	Topsoil									
0' 45"	Topsoil									
0' 46"	Topsoil									
0' 47"	Topsoil									
0' 48"	Topsoil									
0' 49"	Topsoil									
0' 50"	Topsoil									
0' 51"	Topsoil									
0' 52"	Topsoil									
0' 53"	Topsoil									
0' 54"	Topsoil									
0' 55"	Topsoil									
0' 56"	Topsoil									
0' 57"	Topsoil									
0' 58"	Topsoil									
0' 59"	Topsoil									
0' 60"	Topsoil									

JOB NO. 68P7

JOB NAME 153

TECHNICIAN JF

BORING DATE May 2, 1968

CLIENT CHLORIDE CORPORATION, 10000 140th Ave., Richmond, B.C.

ENGINEER DB &amp; JPC

GROUND ELEV. 374.91

BOREHOLE TYPE STANDARD PENETRATION TEST


TYPED BY JC

DEPTH ELEV.	SOIL PROFILE DESCRIPTION	LEGEND	SAMPLES			DYNAMIC CONE PENETRATION BLOWS/FOOT STANDARD PENETRATION TEST BLOWS/FOOT SHEAR STRENGTH $c_u$ LB/CG FT.	LIQUID LIMIT _____ $W_L$ PLASTIC LIMIT _____ $W_P$ WATER CONTENT _____ $W$			REMARKS
			NUMBER	TYPE	BLWS/FOOT		$W_D$	$W$	$W_L$	
0'0"	10'0" - 15'0" silt till with fine to coarse sand, contact with gravel Till, brown, sticky silt till, no brown sandy till, dry.									
20'0"	compact, dense silt till PERSISTENT MATERIAL, dark brown and grey silty clay with stones, wet, very stiff									Reamed AS casing 17'0" - 20'0"
26'0"	26'0" - 28'0" Tuffstone, boulders boulders rounded piece 4"									Reamed AS casing 26'0" - 28'0"
31'0"	Recovery 46 Cobbles, stones, some clay binder (TILL)									Reamed casing 28'0" - 31'0"
33'0"	Recovery 51 TILL with boulders clay till 33'0" - 34'0" TILL with boulders stones and pebbles (medium, large)									Reamed casing 31'0" - 33'0" Reamed AS casing 33'0" - 34'0"
34'0"	34'0" - 35'0" Tuffstone stones (medium shale)									Reamed AS casing 34'0" - 35'0"
44'0"	Recovery 67 Red clayey shale sandstone cobbles									Reamed AS casing 35'0" - 44'0"
48'0"	Recovery 70 SANDY boulders (pre-cambrian)									Grilled AS casing 38'0" - 44'0"
50'0"	50'0" - 51'0" SANDY boulders (pre-cambrian)									Reamed AS casing 44'0" - 51'0"
53'0"	Recovery 74 SANDY boulders (pre-cambrian)									Reamed AS casing 51'0" - 53'0"
54'0"	54'0" - 55'0" SANDY boulders (pre-cambrian)									Reamed AS casing 53'0" - 54'0"
60'0"	Recovery 77 AS ABOVE, boulders piece 8" small of approx. 2" x 2" x 6000									Reamed AS casing 54'0" - 60'0"
65'0"	Recovery 100 Borehole terminated at 65'0" - 66'0"									Reamed AS casing 60'0" - 65'0"
66'0"	66'0" - 67'0" 2" on May 14 1968 on May 15 1968									

# e. m. peto associates ltd.

3101 - 15th Avenue S.W. - Calgary, Alberta T2C 1P5

TEL: 263-1200 FAX: 263-1206

Job Name	Bainfield Mountain Road 1		Client	City of Bainfield		Location	Section 11, T14, R10	
Elevation	+111.1		Scale	1:100		Notes		
<div><div> Sandstone</div><div> Limestone</div><div> Dolomite</div><div> Shale</div><div> Clay</div></div>								
Ground surface			Topsoil, stone fragments			Depth	1.0m	
Sandy silt and detrital clay			clay			Depth	1.0m	
Clayey silt till			clay			Depth	1.0m	
Sandy silt and rock fragments			clay			Depth	1.0m	
Silty clay till			clay			Depth	1.0m	
As above			clay			Depth	1.0m	
As above			clay			Depth	1.0m	
As above			clay			Depth	1.0m	
As above			clay			Depth	1.0m	
As above			clay			Depth	1.0m	
Dolomite boulder			clay			Depth	1.0m	
Dolomite boulder			clay			Depth	1.0m	
Clayey till			clay			Depth	1.0m	
Shale, fragments of sandstone in clayey till matrix			clay			Depth	1.0m	
Weathered shale boulder			clay			Depth	1.0m	
Silty clay till			clay			Depth	1.0m	
Dolomite boulder			clay			Depth	1.0m	
Dolomite boulder, pieces			clay			Depth	1.0m	
clayey till and highly weathered shale fragments			clay			Depth	1.0m	
Dolomite and shale boulder			clay			Depth	1.0m	
Very fossiliferous limestone boulder (from Cabot Head formation)			clay			Depth	1.0m	
Sandy clay till			clay			Depth	1.0m	
Sandy, silty till			clay			Depth	1.0m	
Silty, clayey till and highly weathered shale			clay			Depth	1.0m	
Silty till and rock fragments (fals)			clay			Depth	1.0m	
Dolomite and limestone (porous) boulder pieces			clay			Depth	1.0m	
Shale fragments			clay			Depth	1.0m	
Boulder (mostly dolomite pieces, layers of clayey till			clay			Depth	1.0m	
Sandstone, crossbedded some shale parts in it (probably boulder)			clay			Depth	1.0m	
Sandstone			clay			Depth	1.0m	
Limestone gravel, clay boulder pieces (G. limestone dolomite, red shale?			clay			Depth	1.0m	
Gravel, boulder pieces			clay			Depth	1.0m	
Queenslon shale			clay			Depth	1.0m	
little broken at top			clay			Depth	1.0m	
Red shale changes to green at 84" for 1' length			clay			Depth	1.0m	
Queenslon shale			clay			Depth	1.0m	
Thin green shale at 88"			clay			Depth	1.0m	
Queenslon shale			clay			Depth	1.0m	

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CONCORD OF ORIGINAL DOCUMENT

Date: 10/10/2010 at 10:10

Recovery: 97%

# e. m. pete associates ltd.

SOIL ENGINEERING SERVICES LTD. TORONTO, ONTARIO

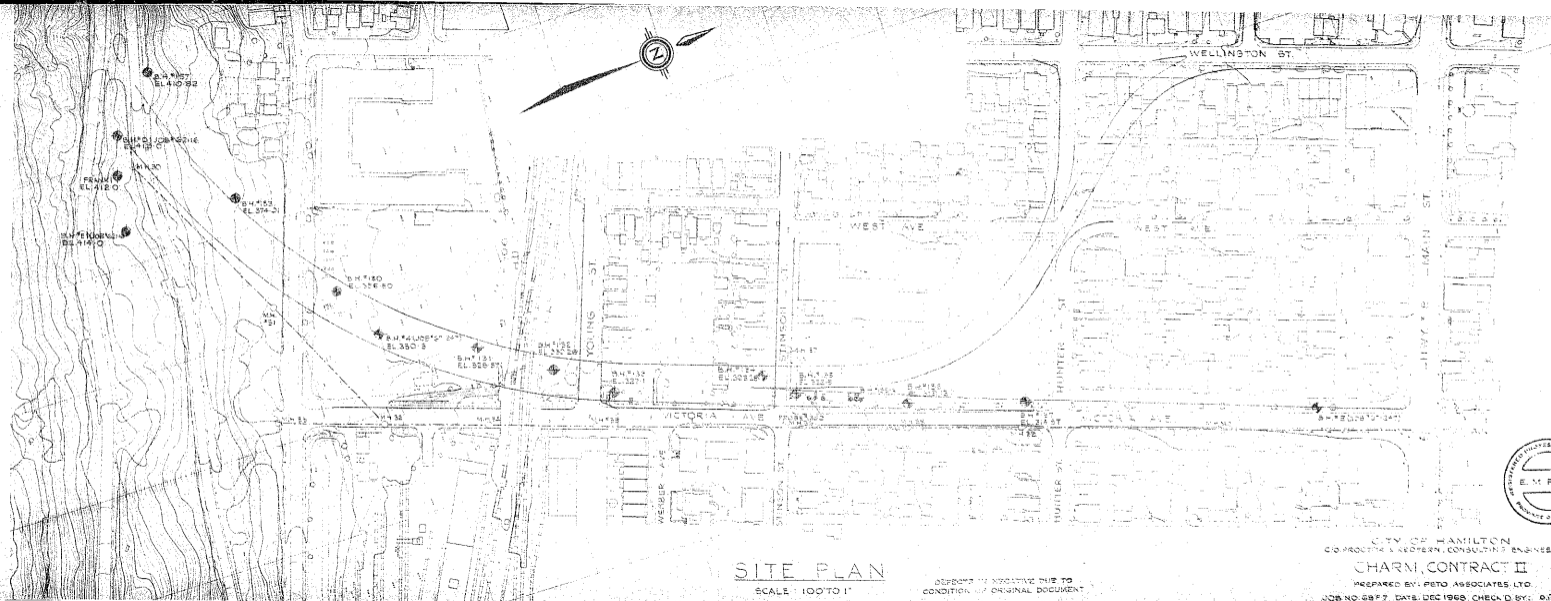
SCHEMATIC LOG

Job Name: Hamilton Mountain, Label No. 14  
 Client: City of Hamilton  
 Elevation: 414.0  
 Date: 11-23-1990  
 Project: W.D.

SAMPLE CONDITION	SAMPLE TYPE	ANALYSIS
UNDISTURBED	A.S. - SOIL SAMPLE	A.S. - SOIL SAMPLE
1AIP	C.S. - SOIL SAMPLE	A.S. - SOIL SAMPLE
UNDISTURBED	A.S. - SOIL SAMPLE	A.S. - SOIL SAMPLE
LOOSE	A.S. - SOIL SAMPLE	A.S. - SOIL SAMPLE

Ground surface  
 Organic topsoil and clayey till  
 Sandy, silty clay with some rock fragments  
 As above and talus  
 Sandy silt with talus  
 Silty, sandy clay and talus  
 Silty clay silt  
 As above, 1 rock fragments  
 Silty clay till  
 As above  
 Sandy, silty clay with  
 Dolomite boulder pieces  
 Rock fragments, calcareous and shale with till, clay  
 Silty, clayey till, some fragments  
 Sandy clayey till, rock fragments  
 As above, some and talus, some and blocks  
 Rock fragments with sandy clay  
 Limestone boulder pieces between 57' and 61'  
 Limestone and sandstone boulder pieces  
 Sandstone, limestone, some shale, probably in a (probably, bent bed)  
 Sandstone boulder  
 Limestone and sandstone and again limestone boulder pieces mixed  
 Shale, limestone boulder pieces  
 Greenish shale  
 As above  
 Brown limestone (77' to 79')  
 Greenish shale  
 Silty  
 Greenish shale  
 As above

Ground surface	1.25
Organic topsoil and clayey till	1.25
Sandy, silty clay with some rock fragments	1.25
As above and talus	1.25
Sandy silt with talus	1.25
Silty, sandy clay and talus	1.25
Silty clay silt	1.25
As above, 1 rock fragments	1.25
Silty clay till	1.25
As above	1.25
Sandy, silty clay with	1.25
Dolomite boulder pieces	1.25
Rock fragments, calcareous and shale with till, clay	1.25
Silty, clayey till, some fragments	1.25
Sandy clayey till, rock fragments	1.25
As above, some and talus, some and blocks	1.25
Rock fragments with sandy clay	1.25
Limestone boulder pieces between 57' and 61'	1.25
Limestone and sandstone boulder pieces	1.25
Sandstone, limestone, some shale, probably in a (probably, bent bed)	1.25
Sandstone boulder	1.25
Limestone and sandstone and again limestone boulder pieces mixed	1.25
Shale, limestone boulder pieces	1.25
Greenish shale	1.25
As above	1.25
Brown limestone (77' to 79')	1.25
Greenish shale	1.25
Silty	1.25
Greenish shale	1.25
As above	1.25



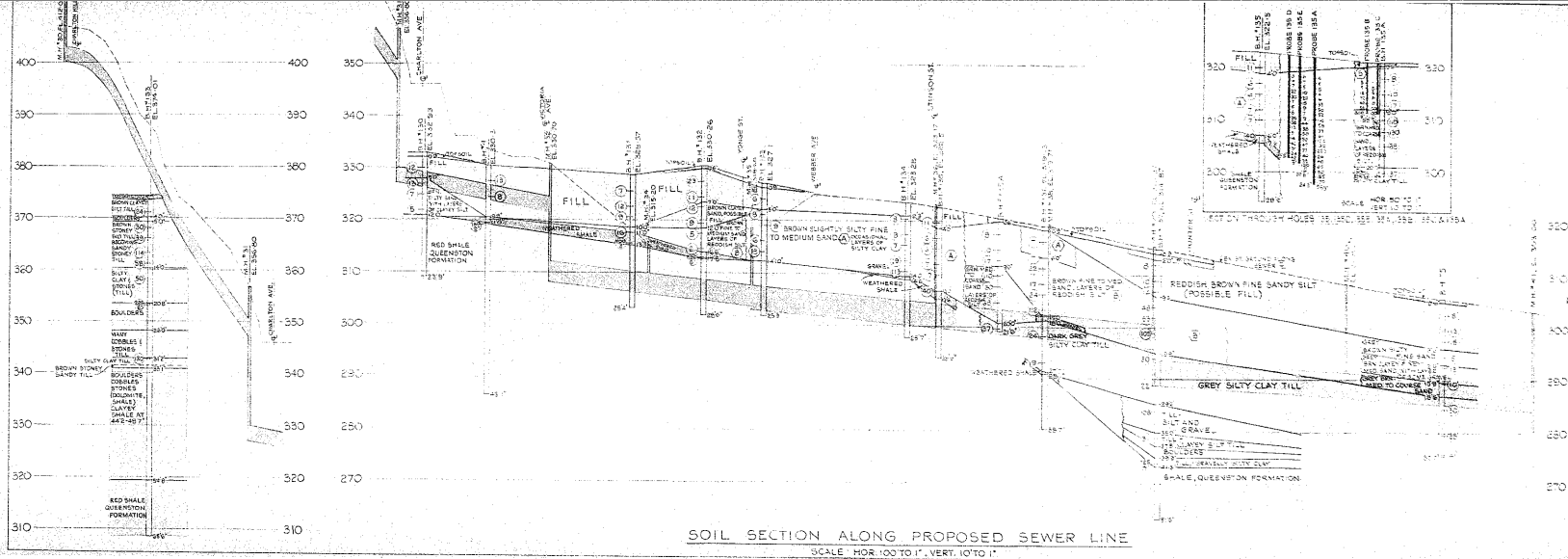
**SITE PLAN**

SCALE - 100' TO 1"

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CONDITION OF ORIGINAL DOCUMENT



CITY OF HAMILTON  
CO-OPERATING & REFORM, CONSULTING ENGINEERS  
**CHARN, CONTRACT II**  
PREPARED BY: PETO ASSOCIATES LTD.  
JOB NO. 6877 DATE: DEC 1968 CHECKED BY: P.S.



# LEGEND

- (2) BLOWS/FT. STANDARD PENETRATION
- (1) BLOWS/FT. CONE

## NOTES

- (1) FOR GROUND WATER CONDITIONS SEE TABLE I
- (2) SEE BOREHOLE LOGS FOR COMPLETE SOIL DETAILS

NOTE: The section was verified by a geologist and the soil conditions may vary from those shown between points.



CITY OF HAMILTON			
PROCTOR & REDFERN, CONSULTING ENGINEERS			
CHARM			
CONTRACT NO. II			
PREPARED BY:			
PETO ASSOCIATES LTD.			
JOB NO.	DATE	DRAWN BY	CHECKED BY:
68 F 7	DEC 1968	PC	D.B.