Golder Associates Ltd.
CONSULTING ENGINEERS

REPORT TO

McNEELY ENGINEERING LIMITED

PIEZOMETER INSTALLATIONS

VILLAGE OF CHESTERVILLE, ONTARIO

Distribution:

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Golder Associates Ltd.
CONSULTING ENGINEERS

April 18, 1990 Our ref: 901-2077

McNeely Engineering Limited
880 Taylor Creek Drive
Orleans, Ontario
K1C 1T1

ATTENTION: Mr. D. Munro

RE: PIEZOMETER INSTALLATIONS, VILLAGE OF CHESTERVILLE, ONTARIO

Dear Sirs:

This letter reports on the installation of piezometer monitoring stations on various streets in the Village of Chesterville, Ontario. The piezometers were installed in order to monitor groundwater level fluctuations as they relate to the existing sanitary sewer system within the village. The locations for each installation were agreed upon by McNeely Engineering Limited personnel and the local Ministry of the Environment Plant Supervisor (Mr. D. Black) in Chesterville.

Although it was initially proposed that five piezometers be installed, an existing (MOE) piezometer monitor station was utilized as one of the monitoring points. It is located at the west end of Queen Street West. To prevent damage to grassed areas, the remaining four peizometers were installed in roadway areas. The approximate location of these installations are shown on the attached Piezometer Location Plan, Figure 1.

PROCEDURE

The installation of the piezometers was carried out on April 6, 1990. The piezometers were installed in holes augered through the subsoil using a track mounted hollow stem auger machine, owned and operated by the Marathon Drilling Company Ltd. of Gloucester, Ontario. Each hole was advanced to a depth of about 4.5 to 5.2 metres. Samples of the subsoils encountered were retrieved at 1.5 metre intervals using 50 millimetre drive sampling equipment.

Upon completion of the drilling piezometers were installed at the bottom of each hole and sealed within the underlying glacial till strata. A 150 millimetre diameter valve stem cover was used to provide a flush mounted protective pipe and cap to facilitate ease of access for monitoring purposes. Details of these installations are shown on the Record of Borehole Sheets following the text of this report.

The field work was supervised throughout by a member of our geotechnical staff who, cleared the boreholes, directed the drilling, logged the boreholes and supervised the installation of the piezometers.

SUBSURFACE CONDITIONS

A detailed description of the subsurface conditions at each of the piezometer installation locations are shown on the Record of Borehole sheets. The following provides a brief description of the subsurface conditions.

The roadways are surfaced with some 50 to 90 millimetres of asphalt. The asphalt is underlain by either sand and gravel or crushed limestone fill materials. The sand and gravel fill was encountered at boreholes 90-2 and 90-3. It is about 300 and 100 millimetres thick respectively. The crushed limestone fill was

At borehole 90-3 the roadway fills are underlain by brown sand fill to a depth of about 4.2 metres. Standard penetration test N values of 7 and 1 blow per 0.3 metres indicates that the sand fill is in a loose to very loose state of packing. The sand fill is probably trench backfill material.

At borehole 90-2 the roadway pavement structure is underlain by a thin layer of clayey silt topsoil about 100 millimetres thick. The roadway structure at boreholes 90-1 and 90-4 and the topsoil at borehole 90-2 are underlain by a relatively thin deposit of silty clay and/or clayey silt material. The silty clay and clayey silt have been weathered to a grey brown colour. A standard penetration test N value of 6 blows per 0.3 metres indicates a very stiff consistency. The thickness of this deposit ranges from about 0.1 to 1.1 metres.

The sand fill at borehole 90-3 and the silw clay and clayey silt at boreholes 90-1, 90-2 and 90-4 are underlain by a glacial till consisting predominantly of sandy silt material but also containing some gravel, cobbles, a trace of clay and occasional boulder size material. Standard penetration test N values ranging from 4 to 41 blows per 0.3 metres indicate a very wide range in the state of packing from loose to dense. All boreholes were terminated within the glacial till.

Groundwater Conditions

The first set of groundwater levels were obtained on April 10, 1990. At this time the stabilized groundwater level ranged from about 1.7 to 2.6 metres below the ground surface. A summary of the readings are shown on Table 1 which has been provided for comparison to subsequent groundwater level measurements.

We trust that this report contains sufficient information for your present purposes. Should you have any questions regarding this report, or if we can be of future service to you, please call us.

Yours truly,

GOLDER ASSOCIATES LTD.

for T.J. Nicholas, P. Eng.

LICENSED PROFESSIONAL ENGINEER
T. J. NICHOLAS
PROVINCE OF ONTARIO

R. A. Montgomery, P. Eng.

REGISTERED PROFESSIONAL ENGINEER
R. A. J. MONTGOMERY
PROVINCE OF ONTARIO

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Att: Table 1
Abbreviations and Symbols
Record of Borehole Sheets
Figure 1

TABLE 1

PIEZOMETER WATER LEVEL DEPTHS (METRES)

VILLAGE OF CHESTERVILLE, ONTARIO

DATE OF READINGS

BOREHOLE NO.	DETAILS	April 10/90								
90-1	Tip in glacial till @ 5.18 metres depth	1.74								
90-2	Tip in glacial till @ 5.18 metres depth	1.80								
90-3	Tip in glacial till @ 4.45 metres depth	2.62								
90-4	Tip in glacial till @ 4.57 metres depth	2.41								

Note: See Figure 1, Piezometer Location Plan for approximate piezometer installation locations. Depths shown are in metres below existing ground surface.

The abbreviation commonly employed on each "Record of Borehole," on the figures and in the text of the report, are as follows:

I. SAMPLE TYPES

AS auger sample
CS chunk sample
DO drive open
DS Denison type sample
FS foil sample
RC rock core
ST slotted tube
TO thin-walled, open
TP thin-walled, piston
WS wash sample

II. PENETRATION RESISTANCES

Dynamic Penetration Resistance:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 0.3 m (12 in.).

Standard Penetration Resistance, *N*:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 0.3 m (12 in.).

WH sampler advanced by static weight—weight, hammer

PH sampler advanced by pressure—pressure, hydraulic

PM sampler advanced by pressure—pressure, manual

III. SOIL DESCRIPTION

(a) *Cohesionless Soils*

Relative Density	*'N'* Blows/0.30m or Blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) *Cohesive Soils*

Consistency	*'Cu'* kPa	*'Cu'* psf.
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1000
Stiff	50 to 100	1000 to 2000
Very stiff	100 to 200	2000 to 4000
Hard	over 200	over 4000

IV. SOIL TESTS

C consolidation test
H hydrometer analysis
M sieve analysis
MH combined analysis, sieve and hydrometer[1]
Q undrained triaxial[2]
R consolidated undrained triaxial[2]
S drained triaxial
U unconfined compression
V field vane test

NOTES:

[1]Combined analyses when 5 to 95 per cent of the material passes the No. 200 sieve.

[2]Undrained triaxial tests in which pore pressures are measured are shown as $\bar{Q}$ or $\bar{R}$.

LIST OF SYMBOLS

I. 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

II. STRESS AND STRAIN

u	pore pressure
σ	normal stress
σ'	normal effective stress ($\bar{\sigma}$ is also used)
τ	shear stress
ϵ	linear strain
ϵ_{xy}	shear strain
ν	Poisson's ratio (μ is also used)
E	modulus of linear deformation (Young's modulus)
G	modulus of shear deformation
K	modulus of compressibility
η	coefficient of viscosity

III. SOIL PROPERTIES

(a) *Unit weight*

γ	unit weight of soil (bulk density)
γ_s	unit weight of solid particles
γ_w	unit weight of water
γ_d	unit dry weight of soil (dry density)
γ'	unit weight of submerged soil
G_s	specific gravity of solid particles $G_s = \gamma_s/\gamma_w$
e	void ratio
n	porosity
w	water content
S_r	degree of saturation

(b) *Consistency*

w_L	liquid limit
w_P	plastic limit
I_P	plasticity index
w_S	shrinkage limit
I_L	liquidity index $= (w - w_P)/I_P$
I_C	consistency index $= (w_L - w)/I_P$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
D_r	relative density $= (e_{max} - e)/(e_{max} - e_{min})$

(c) *Permeability*

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

(d) *Consolidation (one-dimensional)*

m_v	coefficient of volume change $= -\Delta e/(1+e)\Delta\sigma'$
C_c	compression index $= -\Delta e/\Delta \log_{10} \sigma'$
c_v	coefficient of consolidation
T_v	time factor $= c_v t/d^2$ (d, drainage path)
U	degree of consolidation

(e) *Shear strength*

τ_f	shear strength	
c'	effective cohesion intercept	in terms of effective stress $\tau_f = c' + \sigma' \tan \phi'$
ϕ'	effective angle of shearing resistance, or friction	
c_u	apparent cohesion*	in terms of total stress $\tau_f = c_u + \sigma \tan \phi_u$
ϕ_u	apparent angle of shearing resistance, or friction	
μ	coefficient of friction	
S_t	sensitivity	

*For the case of a saturated cohesive soil, $\phi_u = 0$ and the undrained shear strength $\tau_f = c_u$ is taken as half the undrained compressive strength.

RECORD OF BOREHOLE 90-1

SHEET 1 OF 1

LOCATION See Figure 2 | BORING DATE April 6, 1990 | DATUM --

SAMPLER HAMMER, 63.5kg, DROP, 760mm | PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (M)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3M	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH Cu, kPa (nat.V.- + Q.- ● rem.V.- ⊕ U.- O)	HYDRAULIC CONDUCTIVITY, k, CM/SEC; WATER CONTENT, PERCENT (Wp W Wl; 20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface									FLUSH MOUNTED PIPE & CAP
		ASPHALT		0.00							
				0.09							Bentonite Seal
		Brown sand and gravel, trace silt (FILL)			1	AS	--				
1											
		Grey brown SILTY CLAY and CLAYEY SILT		1.10							
					2	50 DO	6				Backfill
2	Power Auger 200mm Diam. (Hollow Stem)			1.89							
		Compact grey brown sandy silt, some gravel, occasional cobble (GLACIAL TILL)									
3					3	50 DO	12				
4											Granular Filter
				4.27							
		Loose grey sandy silt, some gravel (GLACIAL TILL)			4	50 DO	4				Caved
5											
		End of Hole		5.18							W.L. in Piezometer at 1.74m depth April 10, 1990
6											

0 15 10 6 PERCENT AXIAL STRAIN AT FAILURE

DEPTH SCALE 1 : 30

Golder Associates

LOGGED J.COBISA

CHECKED

RECORD OF BOREHOLE 90-2

SHEET 1 OF 1

LOCATION See Figure 2 | BORING DATE April 6, 1990 | DATUM --

SAMPLER HAMMER, 63.5kg, DROP, 760mm | PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm

PROJECT 901-2077

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (M)	SAMPLES: NUMBER	TYPE	BLOWS/0.3M	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH Cu, kPa (nat.V.- + Q.- ●, rem.V.- ⊕ U.- O)	HYDRAULIC CONDUCTIVITY, k, CM/SEC; WATER CONTENT, PERCENT (Wp, W, Wl; 20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface									FLUSH MOUNTED PIPE & CAP
		ASPHALT		0.00							
		Brown sand, trace to some gravel (FILL)		0.09	1	AS	--				Bentonite Seal
		Clayey silt TOPSOIL		0.46							
1		Very stiff grey brown SILTY CLAY (Weathered Crust)		0.55							
	Power Auger 200mm Diam. (Hollow Stem)			1.68	2	50 DO	6				Backfill
2											
3		Dense grey brown and brown sandy silt, some gravel, occasional cobble (GLACIAL TILL)			3	50 DO	41				
4				4.27							Granular Filter
		Compact grey sandy silt, some gravel (GLACIAL TILL)			4	50 DO	12				
5											
		End of Hole		5.18							W.L. in Piezometer at 1.80m depth April 10, 1990
6											

0 16 10 6 PERCENT AXIAL STRAIN AT FAILURE

DEPTH SCALE 1 : 30

Golder Associates

LOGGED J.COBISA

CHECKED

RECORD OF BOREHOLE 90-3

SHEET 1 OF 1

LOCATION See Figure 2 | BORING DATE April 6, 1990 | DATUM --

SAMPLER HAMMER, 63.5kg, DROP, 760mm | PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm

PROJECT 901-2077

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (M)	SAMPLES: NUMBER	TYPE	BLOWS/0.3M	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH Cu, kPa (nat.V.- + Q.- ●, rem.V.- ⊕ U.- ○)	HYDRAULIC CONDUCTIVITY, k, CM/SEC / WATER CONTENT, PERCENT (Wp, W, Wl; 20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface									FLUSH MOUNTED PIPE & CAP
		ASPHALT		0.00							Bentonite Seal
		Sand and gravel (FILL)		0.09							
				0.21							
1	Power Auger 200mm Diam. (Hollow Stem)				1	50 DO	7				Backfill
2		Loose to very loose brown sand (FILL)									
3					2	50 DO	WR				
4											
		Grey GLACIAL TILL		4.21							
		End of Hole		4.45							W.L. in Piezometer at 2.62m depth April 10, 1990
5											
6											

0 15 10 6 PERCENT AXIAL STRAIN AT FAILURE

DEPTH SCALE 1 : 30

Golder Associates

LOGGED J.COBISA

CHECKED

RECORD OF BOREHOLE 90-4

SHEET 1 OF 1

LOCATION See Figure 2

BORING DATE April 6, 1990

DATUM --

SAMPLER HAMMER, 63.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm

PROJECT 901-2077

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (M)	SAMPLES: NUMBER	TYPE	BLOWS/0.3M
0		Ground Surface					
		ASPHALT		0.00			
		Grey crushed stone (FILL)		0.10			
		Brown CLAYEY SILT		0.52			
1	Power Auger 200mm Diam. (Hollow Stem)	Dense brown sandy silt, some gravel, occasional cobble (GLACIAL TILL)		0.79	1	50 DO	51
2				2.44	2	50 DO	4
3		Loose to compact grey sandy silt, some gravel (GLACIAL TILL)					
4							
		End of Hole		4.57			
5							
6							

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa nat.V.- + Q.- ● rem.V.- ⊕ U.- O

HYDRAULIC CONDUCTIVITY, k, CM/SEC

WATER CONTENT, PERCENT Wp W Wl 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

FLUSH MOUNTED PIPE & CAP

Bentonite Seal

Backfill

Granular Filter

W.L. in Piezometer at 2.41m depth April 10, 1990

16 0 10 6 PERCENT AXIAL STRAIN AT FAILURE

DEPTH SCALE 1 : 30

Golder Associates

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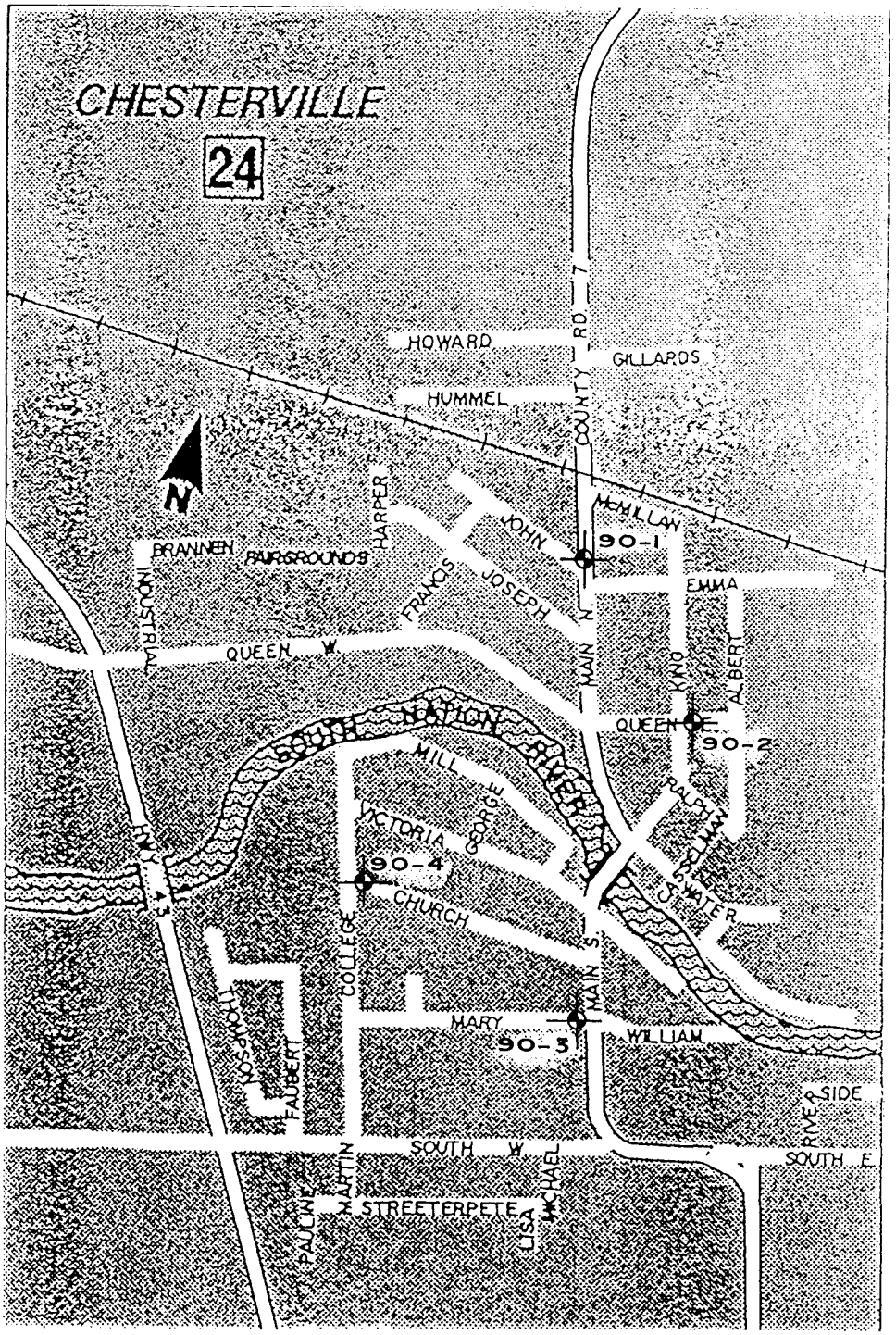
PIEZOMETER LOCATION PLAN

FIGURE 1



PIEZOMETER LOCATION IN PLAN

SCALE
1 : 10,000
(APPROX.)

SPECIAL NOTE
THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT

Date APRIL 18, 1990

Project 901-2077

Golder Associates

Drawn JC

Chkd.

Form GA-D-4 (Imperial)