

CARTER DRAIN
Haldimand County



**SPRIET
ASSOCIATES**
ENGINEERS & ARCHITECTS

155 York Street
London, Ontario N6A 1A8
Tel. (519) 672-4100
Fax (519) 433-9351
E-mail MAIL@SPRIET.ON.CA

CARTER DRAIN

Haldimand County

To the Mayor and Council of
Haldimand County

Mayor and Council:

We are pleased to present our report on the reconstruction of the Carter Municipal Drain serving parts of Lots 15 to 21, Concessions 2 and 3 in Haldimand County (formerly Moulton) and parts of Lots 50 to 54, Concession 7 in the Township of Wainfleet. The total watershed area contains approximately 456 hectares.

AUTHORIZATION

This report was prepared pursuant to Section 78 of the Drainage Act. Instructions were received from your Municipality with respect to a motion of Council. The work was initiated by a request from Haldimand County.

HISTORY

The Carter Drain was last reconstructed pursuant to a report submitted by A.M. Jackson, O.L.S. dated August 17, 1915 and consisted of approximately 4,744 meters of open ditch construction.

A new Maintenance Schedule was prepared in 1982 and some maintenance work has been completed in the past but none recently.

EXISTING DRAINAGE CONDITIONS

A site meeting was held with respect to the project and through later discussions, the owners reported the following:

- that the drain has not been maintained for quite some time and the Maintenance Schedule is out of date, the Drainage Superintendent of Haldimand County indicated
- the owner, Green Leaf Financial Capital (Roll No. 5-173), indicated that they recently installed an additional road entrance into their property west of the drain therefore eliminating the need for a lane crossing on their lands.
- the owner, M. & N. Mans (Roll No. 5-158), indicated that work was required in their lands and they preferred that the work be conducted from the west side
- the owner, T. Petter (Roll No.1-205), indicated that the drain needed to be deepened to provide a sufficient outlet for their lands
- the owner, R. & E. Dale (Roll No.5-020-50), indicated that their lands drained east to the drain via the railway ditch but the railway ditch no longer functions as it once did

EXISTING DRAINAGE CONDITIONS (cont'd)

- the owners, Heeg Dale Company Ltd. (Roll No. 5-117) and Tiersdale Holsteins Ltd. (Roll No. 5-116-50), indicated the lands were sub-surfaced drained to the east towards Black Creek

A field investigation and survey was completed and, upon reviewing our findings, we note the following:

- that maintenance work on the drain has not been completed for many years
- the bottom end of the drain, located in the Township of Wainfleet, lacks adequate depth and capacity with many locations overflowing into the adjacent farmland
- in multiple locations surface erosion is present causing increased sedimentation into the drain
- there are several existing laneway, road, and railway culverts need to be lowered or replaced as they are undersized or located too high to adequately provide an outlet to drain the upstream lands

Preliminary design, cost estimates and assessments were prepared and two informal public meetings were held, the first meeting on December 14, 2017 and the second on March 6, 2018, to review the findings and preliminary proposals. Further input and requests were provided by the affected owners at that time and at later dates. Based on the proposed design it was decided to proceed to this report.

DESIGN CONSIDERATIONS

All of the proposed work has been generally designed and shall be constructed in accordance with the DESIGN AND CONSTRUCTION GUIDELINES FOR WORK UNDER THE DRAINAGE ACT. All new farm crossings have been designed to convey for a 2 Year Storm

RECOMMENDATIONS

We are therefore recommending the following:

- that the existing Carter Drain be reconstructed, commencing 150 metres upstream of Black Creek to its head at the upstream end of Hutchinson Road, with 1:5:1 side slopes to provide a proper sub-service drainage outlet
- that all newly exposed ditch slopes be seeded upon completion of construction
- that the excavated material be levelled adjacent to the drain
- that a new farm culvert be installed on the J. & S. Mans property (Roll No.5-174) and two new farm culverts be installed on the M. & N. Mans property (Roll No. 5-158) and the existing culverts be removed and disposed of
- that the two existing farm culverts, one located in the H. Van Soelen lands (Roll No. 13-132) and the other in the Green Leaf Financial Capital lands (Roll No.5-173), be removed. Both of these properties will continue to access the properties on either side of the ditch from their respective roads

RECOMMENDATIONS (cont'd)

- that the existing culverts on the unmaintained road (Wainfleet) and Hutchinson Road (Haldimand County) be removed and replaced
- that the recently installed culvert on Young Road be removed, extended, and reinstalled, to the intended proper design grade
- that the existing culvert under the Canadian Pacific Railway remain and a new 914 mm diameter smooth wall steel pipe be installed adjacent to the existing culvert at the design grade and act as a low flow culvert. The pipe should be installed by Jack and Bore under the C.P.R. railway in accordance with the recommendations of the soils report prepared by Golder Associates, see Appendix A
- that the existing culvert under the former Canadian National Railway property, now F. & E. Vitoria (Roll No. 5-018-75) be removed and replaced with a new lane culvert
- that three sediment traps be installed at the locations identified on the plans and be maintained as part of this drain in an effort to reduce sedimentation

ENVIRONMENTAL CONSIDERATIONS AND MITIGATION MEASURES

There are wetlands and sensitive areas within the affected watershed area and along the route of the drains. These areas are located in the wooded areas in the properties of Roll No.'s 5-175, 5-116-50, and 5-117. There are also wetlands and sensitive areas along the route of the proposed drain in the properties of Roll No.'s 5-158 and 5-157. The proposed construction of the Carter Drain includes rock chutes and bank seeding which help reduce any subsequent erosion.

This project has been reviewed by the Fisheries Protection Program of Fisheries and Oceans Canada, File number 16-HCAA-01696. It should be noted that the downstream 500m of the drain is currently not rated under D.F.O classification and the remaining parts of the drain are considered a Class "F". The following was recommended by the DFO and should be incorporated into the project:

Timing

- During periods of low flow to further reduce the risk to fish and their habitat no in-stream work or construction activity should occur from March 15th to June 30th
- During dry periods work can proceed at any time of the year

Erosion and Sediment Control

- Effective erosion and sediment control measures must be installed before starting work to prevent sediment from entering the water body
- Regular inspections of erosion control and sediment control must be conducted; maintain as required
- Remove non-biodegradable erosion and sediment control materials upon completion and stabilization

Shoreline Re-vegetation and Stabilization

- Clearing of riparian vegetation should be kept to a minimum.

ENVIRONMENTAL CONSIDERATIONS AND MITIGATION MEASURES (cont'd)

- Immediately stabilize shoreline or banks disturbed by any activity associated with the project to prevent erosion and/or sedimentation, preferably through re-vegetation with native species suitable for the site
- If replacement rock reinforcement/armouring is required to stabilize eroding or exposed areas, ensure that appropriately-sized, clean rock is used; and that rock is installed at a similar slope to maintain a uniform bank/shoreline and natural stream/shoreline alignment
- Remove all construction materials from site upon project completion

Operation of Machinery

- Operate machinery in a manner that minimizes disturbance to the banks of the watercourse.

We are also recommending that the following erosion and sediment control measures be included as part of our reconstruction proposal to help mitigate any potential adverse impacts of the proposed drainage works on water quality and fishery habitat:

- various sediment basins are to be constructed along the course of the drain at the locations specified on the plan and these basins are to be maintained by Haldimand County
- a temporary flow check of silt fencing is to be installed for the duration of the construction at the bottom end of the ditch reconstruction
- a 3 meter wide grassed buffer strip of existing vegetation between the top of the bank and any cultivated lands on the working side is to be incorporated as part of the drain
- some existing washouts along the course of the drain are to be backfilled and protected with quarry stone rip-rap
- quarry stone rock chutes are to be constructed at surface inlet points to reduce erosion from direct surface water access into the ditch
- some existing tile outlets along the course of the drain are to be repaired using an outlet pipe (if required) and quarry stone rip-rap protection

It is to be noted that both the existing and newly vegetated banks as well as the existing natural and newly created buffer strips along the ditch are permanent parts of the Carter Drain and shall not be disturbed or destroyed.

SUMMARY OF PROPOSED WORK

The proposed work consists of approximately 4,287 lineal meters of open ditch reconstruction including quarry stone rip-rap bank protection, rock chutes, bank seeding, construction of farm and road culverts, and sediment basins.

SCHEDULES

Four schedules are attached hereto and form part of this report, being Schedule 'A' - Allowances, Schedule 'B' - Cost Estimate, Schedule 'C' - Assessment for Construction, and Schedule 'D' - Assessment for Maintenance.

Schedule 'A' - Allowances. In accordance with Sections 29 and 30 of the Drainage Act, allowances are provided for right-of-way and damages to lands and crops along the route of the drain as defined below.

Schedule 'B' - Cost Estimate. This schedule provides for a detailed cost estimate of the proposed work which is in the amount of \$ 323,000.00. This estimate includes engineering and administrative costs associated with this project. The assessed cost in Haldimand County is \$ 274,700.00 and the assessed cost in the Township of Wainfleet is \$ 48,300.00.

Schedule 'C' - Assessment for Construction. This schedule outlines the distribution of the total estimated cost of construction over the roads and lands which are involved.

Schedule 'D' - Assessment for Maintenance. In accordance with Section 38 of the Drainage Act, this schedule outlines the distribution of future repair and/or maintenance costs for portions of, or the entire drainage works.

Drawing No.'s 1 and 2, Job No. 205140 and specifications form part of this report. They show and describe in detail the location and extent of the work to be done and the lands which are affected.

ALLOWANCES

DAMAGES: Section 30 of the Drainage Act provides for the compensation to landowners along the drain for damages to lands and crops caused by the construction of the drain. The amount granted is based on \$4,647.00/ha. for open ditch work with excavated material levelled adjacent to drain. This base rate is multiplied by the hectares derived from the working widths shown on the plans and the applicable lengths.

RIGHT-OF-WAY Section 29 of the Drainage Act provides for an allowance to the owners whose land must be used for the construction, repair, or future maintenance of a drainage works.

For open ditches, the allowance provides for the loss of land due to the construction provided for in the report. The amounts granted are based on the value of the land, and the rate used was \$33,360.00/ha. When any buffer strip is incorporated and/or created, the allowance granted is for any land beyond a 1.8 meter width deemed to have always been part of the drain. For existing open ditches, the right-of-way to provide for the right to enter and restrictions imposed on those lands, is deemed to have already been granted.

ASSESSMENT DEFINITIONS

In accordance with the Drainage Act, lands that make use of a drainage works are liable for assessment for part of the cost of constructing and maintaining the system. These liabilities are known as benefit, outlet liability and special benefit liability as set out under Sections 22, 23, 24 and 26 of the Act.

ASSESSMENT DEFINITIONS (cont'd)

BENEFIT as defined in the Drainage Act means the advantages to any lands, roads, buildings or other structures from the construction, improvement, repair or maintenance of a drainage works such as will result in a higher market value or increased crop production or improved appearance or better control of surface or sub-surface water, or any other advantages relating to the betterment of lands, roads, buildings or other structures.

OUTLET liability is assessed to lands or roads that may make use of a drainage works as an outlet either directly or indirectly through the medium of any other drainage works or of a swale, ravine, creek or watercourse.

In addition, a Public Utility or Road Authority shall be assessed for and pay all the increased cost to a drainage works due to the construction and operation of the Public Utility or Road Authority. This may be shown as either benefit or special assessment.

ASSESSMENT

A modified "Todgham Method" was used to calculate the assessments shown on Schedule 'C'- Assessment for Construction. This entailed breaking down the costs of the drain into sections along its route. Special Assessments and Special Benefits were then extracted from each section.

The remainder is then separated into Benefit and Outlet costs. The Benefit cost is distributed to those properties receiving benefit as defined under "Assessment Definitions", with such properties usually being located along or close to the route of the drain. The Outlet Costs are distributed to all properties within the watershed area of that section on an adjusted basis. The areas are adjusted for location along that section, and relative run-off rates. Due to their different relative run-off rates, forested lands have been assessed for outlet at lower rates than cleared lands. Also, roads and residential properties have been assessed for outlet at higher rates than cleared farm lands.

The actual cost of the work involving this report, with the exception of Special Assessments, is to be assessed on a pro-rata basis against the lands and roads liable for assessment for benefit and outlet and for special assessments as shown in detail below and on Schedule 'C' - Assessment for Construction. The Special Assessments shall be levied as noted in the Section "Special Assessment".

SPECIAL ASSESSMENT

In accordance with Section 26 of the Drainage Act, a Special Assessment has been made against the Township of Wainfleet being the increased cost to the drainage work for installing a corrugated steel pipe across their road allowance on the Main Drain, due to the presence of the unmaintained road allowance. The Special Assessment shall be made up of the actual cost of this work and both the final and estimated values of the Special Assessment are to be calculated as follows:

Size of Crossing	Cost of Work	Plus Administration Cost	Plus Interest & Net H.S.T.	Special Assessment
1800mm	\$12,700.00	\$2,000.00	\$370.00	\$15,070.00

SPECIAL ASSESSMENT (cont'd)

In accordance with Section 26 of the Drainage Act, a Special Assessment has been made against Haldimand County being the increased cost to the drainage work for lowering and extending the existing CSP across their road allowance on the Main Drain, due to the construction and operation of Young Road. The Special Assessment shall be made up of the actual cost of this work and both the final and estimated values of the Special Assessment are to be calculated as follows:

Size of Crossing	Cost of Work	Plus Administration Cost	Plus Interest & Net H.S.T.	Special Assessment
1500mm	\$15,900.00	\$3,000.00	\$470.00	\$19,370.00

In accordance with Section 26 of the Drainage Act, a Special Assessment has been made against the Canadian Pacific Railway being the increased cost to the drainage work for boring a 914mm smooth wall steel pipe across their right-of-way on the Main Drain, due to the construction and operation of their railway. The Special Assessment shall be made up of the actual cost of this work and both the final and estimated values of the Special Assessment are to be calculated as follows:

Size of Crossing	Cost of Work	Plus Administration Cost	Plus Interest & Net H.S.T.	Special Assessment
914mm	\$37,610.00	\$7,500.00	\$1,130.00	\$46,240.00

In accordance with Section 26 of the Drainage Act, a Special Assessment has been made against Haldimand County being the increased cost to the drainage work for installing a corrugated steel pipe across their road allowance on the Main Drain, due to the construction and operation of Hutchinson Road. The Special Assessment shall be made up of the actual cost of this work and both the final and estimated values of the Special Assessment are to be calculated as follows:

Size of Crossing	Cost of Work	Plus Administration Cost	Plus Interest & Net H.S.T.	Special Assessment
1200mm	\$17,000.00	\$3,200.00	\$510.00	\$20,710.00

The above special assessments shall not apply for future maintenance purposes.

If any additional work is required to the drainage works due to the existence of buried utilities such as gas pipe lines, communications cables, etc. or if any of the utilities require relocation or repair, then, the extra costs incurred shall be borne by the utility involved in accordance with the provisions of Section 26 of the Drainage Act.

GRANTS

In accordance with the provisions of Section 85 of the Drainage Act, a grant **may** be available for assessments against privately owned parcels of land which are used for agricultural purposes and eligible for the Farm Property Class Tax rate. Section 88 of the Drainage Act directs the Municipality to make application for this grant upon certification of completion of this drain. The Municipality will then deduct the grant from the assessments prior to collecting the final assessments.

MAINTENANCE

Upon completion of construction, all owners are hereby made aware of Sections 80 and 82 of the Drainage Act which forbid the obstruction of or damage or injury to a municipal drain.

After completion, the portion of the Carter Drain located within Haldimand County shall be maintained by Haldimand County and the portion of the Carter Drain located within the Township of Wainfleet shall be maintained by the Township of Wainfleet at the expense of all upstream lands and roads assessed in Schedule 'D' - Assessment for Maintenance and in the same relative proportions until such time as the assessment is changed under the Drainage Act.

Special Assessments shall **not** be pro-rated for future maintenance purposes.


After completion, the new farm culverts constructed under this Carter Drain report in properties with Roll No.'s 5-174, 5-158 and 5-018-75 shall be maintained by the Haldimand County. Future maintenance costs shall be levied 50% to the affected owner and the remainder shall be pro-rated over the upstream outlet assessments.

Repairs or improvements to any road and railway culvert or bridge or sub-surface road crossing required by the performance of this work and for future repair and/or replacement, shall be the responsibility of the applicable Road and Railway Authority, entirely at their cost.



Respectfully submitted,

SPRIET ASSOCIATES LONDON LIMITED


J.R. Spriet, P. Eng.

JRS:bv

SCHEDULE 'A' - ALLOWANCES

CARTER DRAIN

Haldimand County

In accordance with Sections 29 and 30 of the Drainage Act, we determine the allowances payable to owners entitled thereto as follows:

CONCESSION	LOT	ROLL NUMBER (Owner)	Section 29 Right-of-Way	Section 30 Damages	TOTALS
MAIN DRAIN					
Hadlimand County					
<i>Geographic Township of Moulton</i>					
2	Pt. 14 & 15	1-205 (T. Petter)	\$ 20.00	\$ 40.00	\$ 60.00
2	Pt. 19,20, 21	5-173 (Green Leaf Financial Capital)	3,320.00	5,780.00	9,100.00
2	Pt. 19,20, 21	5-174 (J. & S. Mans)	1,770.00	3,090.00	4,860.00
2	Pt.16 & A	5-157 (E. Mazur)	1,640.00	2,850.00	4,490.00
2	Pt. 18,19, A	5-158 (M. & N. Mans)	3,850.00	6,710.00	10,560.00
2	Pt. 16,17,A B	5-018-75 (F. & E. Vitoria)	100.00	170.00	270.00
2	Pt. A & B	5-161 (J. Lomoro & 2027479 Ontario Inc.)	260.00	450.00	710.00
Total Allowances			\$ 10,960.00	\$ 19,090.00	\$ 30,050.00
Total Allowances in the Hadlimand County			\$ 30,050.00		
Township of Wainfleet					
7	Pt. 50 & 51	13-131 (M. Tiersma)	\$ 1,590.00	\$ 2,770.00	\$ 4,360.00
7	Pt. 52 & 53	13-132 (H. Van Soelen)	2,640.00	4,600.00	7,240.00
7	Pt. 53	13-134 (C. Skotniski)	1,180.00	2,050.00	3,230.00
Total Allowances			\$ 5,410.00	\$ 9,420.00	\$ 14,830.00
Total Allowances in the Township of Wainfleet			\$ 14,830.00		
TOTAL ALLOWANCES ON THE MAIN DRAIN					\$ 44,880.00
TOTAL ALLOWANCES ON THE CARTER DRAIN					\$ 44,880.00

SCHEDULE 'B' - COST ESTIMATE

CARTER DRAIN

Haldimand County

We have made an estimate of the cost of the proposed work which is outlined in detail as follows:

MAIN DRAIN

4287 meters of open ditch reconstruction (Approx. 7500m ³)	\$	30,000.00
Installation of 3-10m long sediment traps at Sta 0+540, Sta. 1+930, and Sta. 2+870	\$	900.00
Seeding of ditch banks and buffer strips (approx. 25000 m ²)	\$	9,000.00
Levelling of excavated material	\$	8,000.00
Clearing & grubbing with mechanical brushing.	\$	27,000.00
Construct the following helical corrugated aluminized steel pipes as new farm / road culverts including removal and disposal of existing structure (where applicable):		
Sta. 0+558± (Road Allowance)		
Supply & delivery of 12 m - 1800mm dia, 2.8mm thick, aluminized 125mm x 25mm cor.		
Installation of pipe including supply and installation of bedding and backfill including breaking up of exist. concrete for use as rip-rap and disposal of any unacceptable material	\$	6,000.00
Supply and installation of quarry stone riprap (8m ³) & broken concrete	\$	5,500.00
	\$	1,200.00
Sta. 1+948± 5-174 (J. & S. Mans)		
Supply & delivery of 12 m - 1600mm dia, 2.8mm thick, aluminized 125mm x 25mm cor.		
Installation of pipe including supply and installation of bedding and backfill including breaking up of exist. concrete for use as rip-rap and disposal of any unacceptable material	\$	4,800.00
Supply and installation of quarry stone riprap (8m ³) & broken concrete	\$	4,600.00
	\$	1,200.00
Sta. 2+918± (Young Road)		
Supply & delivery of 4m - 1500mm dia, 2.8mm thick, Aluminized C.S.P with 125mm x 25mm cor. including coupler	\$	2,000.00
Removal and Re-installation of existing 14m-1500mm pipe including installing additional 4m extension, supply and installation of bedding and backfill materials, including disposal of any unacceptable material	\$	7,700.00
Supply and installation of additional quarry stone riprap (8m ³) & existing	\$	1,700.00
Surface Restoration with Hot Mix Asphalt as specified on drawings	\$	4,500.00
Sta. 3+640± 5-158 (M. & N. Mans.)		
Supply & delivery of 12 m - 1400mm dia, 2.8mm thick, alum. 125mm x 25mm cor.	\$	4,100.00
Installation of pipe including supply and installation of bedding and backfill	\$	4,200.00
Supply and installation of quarry stone riprap (8m ³)	\$	1,200.00
Sta. 3+755± 5-158 (M. & N. Mans.)		
Supply & delivery of 12 m - 1200mm dia, 2.8mm thick, alum. 125mm x 25mm cor.	\$	3,900.00
Installation of pipe including supply and installation of bedding and backfill	\$	3,700.00
Supply and installation of quarry stone riprap (8m ³)	\$	1,200.00

SCHEDULE 'B' - COST ESTIMATE (cont'd)

**CARTER DRAIN
Haldimand County****MAIN DRAIN (cont'd)**

Sta. 3+993± 5-018-75 (F. & E. Victoria) Former Railway	
Supply & delivery of 18 m - 1200mm dia, 2.8mm thick, alum. 125mm x 25mm cor.	\$ 6,100.00
Installation of pipe including supply and installation of bedding and backfill	\$ 7,200.00
Supply and installation of quarry stone riprap (8m³)	\$ 1,200.00
Sta. 4+425± 5-020 (Hutchinson Road.)	
Supply & delivery of 18 m - 1200mm dia, 2.8mm thick, alum. 125mm x 25mm cor.	\$ 6,800.00
Installation of pipe including supply and installation of bedding and backfill	\$ 9,000.00
Supply and installation of quarry stone riprap (8m³)	\$ 1,200.00
Remove and Dispose of Existing culverts at Sta. 1+140 and Sta. 2+643	\$ 2,500.00
Supply and Installation of Rock Chutes and quarry stone rip-rap protection around pipes where noted on drawings (18 Locations - Approx 65 cu.m Required)	\$ 9,000.00
22.0 meters of 914mm, 11.1mm thick, smooth wall steel pipe	
Supply	\$ 9,900.00
Installation under railway by jack and bore	\$ 19,900.00
Contingencies	\$ 9,000.00
Allowances under Sections 29 & 30 of the Drainage Act	\$ 44,880.00
ADMINISTRATION	
Interest and Net Harmonized Sales Tax	\$ 6,370.00
Survey, Plan and Final Report	\$ 43,900.00
Soils Report for Railway	\$ 7,810.00
Expenses	\$ 2,900.00
Supervision and Final Inspection	\$ 2,940.00
TOTAL ESTIMATED COST	\$ <u>323,000.00</u>

SCHEDULE 'C' - ASSESSMENT FOR CONSTRUCTION

CARTER DRAIN

Haldimand County

Job No. 205140

April 16, 2018

* = Non-agricultural

CON.	LOT	HECTARES AFFECTED	ROLL No. (OWNER)	CULVERT BENEFIT	BENEFIT	OUTLET	TOTAL	
MAIN DRAIN								
Haldimand County								
<i>Geographic Township of Moulton</i>								
2	Pt. 13,14, 15	5.2	1-188 (1013022 Ontario Inc)	\$	\$	\$ 3,272.00	\$ 3,272.00	
2	Pt. 14 & 15	13.7	1-205 (T. Petter)		910.00	11,557.00	12,467.00	
*	2	Pt. 14 & 15	2.1	1-204 (M. & D. & J. Disher)		1,105.00	1,105.00	
*	2	Pt. 15	2.8	1-205-20 (H. & S. Hall)		2,211.00	2,211.00	
*	2	Pt. 15	3.4	1-205-10 (K. Petter)		2,689.00	2,689.00	
2	Pt.16 & 17	11.6	5-020-50 (R. & E. Dale)			3,852.00	3,852.00	
2	Pt.16 & 17	2.7	5-018-50 (F. & E. Vitoria)			740.00	740.00	
2	Pt. 18	4.9	5-024 (J. & T. Scholman)			1,471.00	1,471.00	
*	2	Pt. 18	1.0	5-020-75 (E. Dale)		167.00	167.00	
*	2	Pt. 18 & 19	1.4	5-025 (P. Davies)		392.00	392.00	
2	Pt. 18 & 19	7.9	5-155 (Bulk Growers Holding Ltd.)			1,891.00	1,891.00	
*	2	Pt. 19	0.4	5-156 (J. & S. Lane)		144.00	144.00	
*	2	Pt. 19	0.7	5-174-50 (N. Mans)		236.00	236.00	
2	Pt. 19	4.0	5-176 (J. & B. Stevenson)			659.00	659.00	
2	Pt. 19,20, 21	31.0	5-173 (Green Leaf Financial Capital)		17,510.00	4,504.00	22,014.00	
2	Pt. 19,20, 21	35.7	5-174 (J. & S. Mans)	5,945.00	9,580.00	3,972.00	19,497.00	
2	Pt. 19,20, 21	33.5	5-175 (C. & M. Packham)			2,644.00	2,644.00	
2	Pt.16 & A	18.4	5-157 (E. Mazur)		6,960.00	10,382.00	17,342.00	
2	Pt. 18,19, A	22.7	5-158 (M. & N. Mans)	10,405.00	18,740.00	6,097.00	35,242.00	
2	Pt. A	3.7	5-159 (E. & J. Bouman)			965.00	965.00	
*	2	Pt. 16,17,A B	1.9	5-018-75 (F. & E. Vitoria)	10,329.00	470.00	1,342.00	12,141.00
2	Pt. A & B	16.9	5-161 (J. Lomoro & 2027479 Ontario Inc.)		1,260.00	4,333.00	5,593.00	
*	2	Pt. B	8.9	5-182 (R. Hunter)		4,889.00	4,889.00	
*	2	Pt. B	4.6	5-052-10 (E. & G. Hunter)		1,320.00	1,320.00	
*	2	Pt. B	0.2	5-052 (D. & P. Blanchard)		125.00	125.00	
*	2	Pt. B	5.4	5-053 (R. Oleszek)		1,104.00	1,104.00	
*	2	Pt. B	1.1	5-161-90 (S. & T. Crumb)		127.00	127.00	
*	2	Pt. B	1.4	5-160-50 (R. & D. Dickhout)		365.00	365.00	
3	Pt. 1	22.8	5-117 (Heeg Dale Company Ltd.)			1,460.00	1,460.00	
3	Pt.2 & 3	29.2	5-116-50 (Tiersdale Holsteins Ltd.)			2,114.00	2,114.00	
3	Pt. 3	12.4	5-177 (P. Gracey)			1,104.00	1,104.00	
*	3	Pt. 3	1.4	5-178 (A. & I. Hartstein)		125.00	125.00	
3	Pt. 3	2.5	5-114 (P. & H. Tiersma)			223.00	223.00	
*	3	Pt. 4	0.1	5-067 (A. Tutolo)		64.00	64.00	
*	3	Pt. 4	0.2	5-068 (Ontario Aboriginal Housing Support Servies Corp.)		133.00	133.00	
*	3	Pt. 4	0.2	5-069 (C. Brewer)		133.00	133.00	
*	3	Pt. 4	0.2	5-070 (D. & D. Maloney)		133.00	133.00	
*	3	Pt. 4	0.2	5-071 (J. Houser)		114.00	114.00	

SCHEDULE 'C' - ASSESSMENT FOR CONSTRUCTION (Cont'd)

CARTER DRAIN
Haldimand County

* = Non-agricultural

CON.	LOT	HECTARES AFFECTED	ROLL No. (OWNER)	CULVERT BENEFIT	BENEFIT	OUTLET	TOTAL
------	-----	----------------------	------------------	--------------------	---------	--------	-------

MAIN DRAIN

Hadlimand County

Geographic Township of Moulton

*	3	Pt. 4	0.5	5-073 (J. & J. Houser)		263.00	263.00
*	3	Pt. 4	0.2	5-074 (E. & M. Kelly)		133.00	133.00
*	3	Pt. 4	0.2	5-075 (F. & W. Vanderveelde)		133.00	133.00
*	3	Pt. 4	0.2	5-076 (J. & D. Van Der Beek)		133.00	133.00
*	3	Pt. 4	0.5	5-078 (G. & C. Fair)		263.00	263.00
*	3	Pt. 4	0.2	5-079 (V. Gage)		133.00	133.00
*	3	Pt. 4	0.2	5-080 (W. Schipper)		133.00	133.00
*	3	Pt. 4	0.5	5-082 (C. Linde)		294.00	294.00
*	3	Pt. 4	0.2	5-083 (Haldimand County)		133.00	133.00
*	3	Pt. 4	0.2	5-084 (L. & D. Hatcher)		133.00	133.00
*	3	Pt. 4	0.2	5-085 (S. Grant & P. Komenda)		133.00	133.00
*	3	Pt. 4	0.2	5-086 (T. Forestell)		133.00	133.00
*	3	Pt. 4	0.5	5-087 (R. & A. Maxwell)		270.00	270.00
*	3	Pt. 4	0.2	5-089 (J. & B. Hunter)		133.00	133.00
*	3	Pt. 4	0.2	5-090 (J. & S. Kingma)		133.00	133.00
*	3	Pt. 4	0.2	5-091 (G. Tocher & R. Shelly)		31.00	31.00
*	3	Pt. 4	0.2	5-092 (D. Barless & K. Clark)		31.00	31.00
*	3	Pt. 4	0.5	5-094 (T. & J. Thompson)		63.00	63.00
*	3	Pt. 4	0.2	5-095 (S. & J. Parker)		31.00	31.00
*	3	Pt. 4	1.0	5-096 (F. Mihalicz)		131.00	131.00
*	3	Pt. 4	1.5	5-162 (G. Turner)		195.00	195.00
	3	Pt. 4 & 5	13.0	5-163 (L. & B. Riebot)		3,410.00	3,410.00
*	3	Pt. 4 & 5	4.8	5-081(D. & E. Douwes)		1,066.00	1,066.00
	3	Pt. 4 & 5	12.7	5-165 (K. & L. Luttjehuizen)		1,719.00	1,719.00
*	3	Pt. 5	0.6	5-166 (S. Metcalfe)		77.00	77.00
*	3	Pt. 5	3.6	5-168-50 (Y. Wu)		316.00	316.00
*	3	Pt. 4,5, 6	1.4	5-164 (M. Van Kuren)		708.00	708.00
*		Right-of-Way	7.7	Canadian Pacific Railway	510.00	9,330.00	9,840.00

=====

TOTAL ASSESSMENT ON LANDS \$ 55,940.00 \$ 97,819.00 \$ 180,438.00

=====

*	Hutchinson Road	1.3	Halimand County	\$ 420.00	\$ 3,394.00	\$ 3,814.00
*	Young Road	2.6	Halimand County	420.00	1,415.00	1,835.00
*	Hines Road	2.1	Halimand County		1,957.00	1,957.00
*	½ Wainfleet/Dunnvill	1.2	Halimand County		336.00	336.00

=====

TOTAL ASSESSMENT ON ROADS \$ 840.00 \$ 7,102.00 \$ 7,942.00

=====

SCHEDULE 'C' - ASSESSMENT FOR CONSTRUCTION (Cont'd)

CARTER DRAIN
Haldimand County

* = Non-agricultural

CON.	LOT	HECTARES AFFECTED	ROLL No. (OWNER)	CULVERT BENEFIT	BENEFIT	OUTLET	TOTAL
------	-----	----------------------	------------------	--------------------	---------	--------	-------

MAIN DRAIN

Hadlimand County

SPECIAL ASSESSMENT against Halimand County
for the increased cost of reinstalling and extending a 1500mm C.S.P.
under Young Road on the Main Drain \$ 19,370.00

SPECIAL ASSESSMENT against Halimand County
for the increased cost of installing a 1200mm C.S.P.
under Hutchinson Road on the Main Drain \$ 20,710.00

SPECIAL ASSESSMENT against Canadian Pacific Railway
for the increased cost of a soils report and boring a 914.4mm (36") 11.1mm
thick smooth wall steel pipe under their Railway on the Main Drain \$ 46,240.00

Total Assessment in the Hadlimand County **\$ 274,700.00**

Township of Wainfleet

7	Pt. 50 & 51	0.8	13-065-01 (W Oosterhoff)	\$	\$	\$	11.00	\$	11.00
7	Pt. 50 & 51	5.4	13-064 (M. Wagter)				216.00		216.00
7	Pt. 50 & 51	15.4	13-131 (M. Tiersma)			8,090.00	206.00		8,296.00
7	Pt. 51	1.6	13-066 (M. Tiersma)				21.00		21.00
7	Pt. 52 & 53	38.1	13-132 (H. Van Soelen)			13,410.00	1,629.00		15,039.00
7	Pt. 53	14.7	13-134 (C. Skotniski)			5,970.00	982.00		6,952.00
7	Pt. 54	0.4	13-135 (Wegelin)				30.00		30.00

=====

TOTAL ASSESSMENT ON LANDS **\$ 27,470.00 \$ 3,095.00 \$ 30,565.00**

=====

* Road All. Lot 51/52	1.8	Township of Wainfleet	\$	\$ 2,260.00	\$	126.00	\$	2,386.00
* Road All. Lot 53/54	0.3	Township of Wainfleet				7.00		7.00
* Road All. Conc. 7	0.6	Township of Wainfleet				93.00		93.00
* ½ Wainfleet/Dunnvill	1.2	Township of Wainfleet				179.00		179.00

=====

TOTAL ASSESSMENT ON ROADS **\$ 2,260.00 \$ 405.00 \$ 2,665.00**

=====

SPECIAL ASSESSMENT against the Township of Wainfleet
for the increased cost of installing a 1800mm C.S.P.
pipe under the Road Allowance between Lot 51 and 52 on the Main Drain \$ 15,070.00

Total Assessment in the Township of Wainfleet **\$ 48,300.00**

TOTAL ASSESSMENT ON THE MAIN DRAIN **\$ 323,000.00**

TOTAL ASSESSMENT ON THE CARTER DRAIN **\$ 323,000.00**

SCHEDULE 'D' - ASSESSMENT FOR MAINTENANCE

CARTER DRAIN

Haldimand County

Job No. 205140

April 16, 2018

CON.	LOT	HECTARES AFFECTED	ROLL No. (OWNER)	PERCENTAGE OF MAINTENANCE COST
MAIN DRAIN				
Haldimand County				
<i>Geographic Township of Moulton</i>				
2	Pt. 13,14, 15	5.2	1-188 (1013022 Ontario Inc)	2.2 %
2	Pt. 14 & 15	13.7	1-205 (T. Petter)	7.9
* 2	Pt. 14 & 15	2.1	1-204 (M. & D. & J. Disher)	0.7
* 2	Pt. 15	2.8	1-205-20 (H. & S. Hall)	1.5
* 2	Pt. 15	3.4	1-205-10 (K. Petter)	1.8
2	Pt.16 & 17	11.6	5-020-50 (R. & E. Dale)	2.5
2	Pt.16 & 17	2.7	5-018-50 (F. & E. Vitoria)	0.5
2	Pt. 18	4.9	5-024 (J. & T. Scholman)	1.0
* 2	Pt. 18	1.0	5-020-75 (E. Dale)	0.1
* 2	Pt. 18 & 19	1.4	5-025 (P. Davies)	0.3
2	Pt. 18 & 19	7.9	5-155 (Bulk Growers Holding Ltd.)	1.2
* 2	Pt. 19	0.4	5-156 (J. & S. Lane)	0.1
* 2	Pt. 19	0.7	5-174-50 (N. Mans)	0.2
2	Pt. 19	4.0	5-176 (J. & B. Stevenson)	0.4
2	Pt. 19,20, 21	31.0	5-173 (Green Leaf Financial Capital)	8.7
2	Pt. 19,20, 21	35.7	5-174 (J. & S. Mans)	5.8
2	Pt. 19,20, 21	33.5	5-175 (C. & M. Packham)	1.7
2	Pt.16 & A	18.4	5-157 (E. Mazur)	9.1
2	Pt. 18,19, A	22.7	5-158 (M. & N. Mans)	10.0
2	Pt. A	3.7	5-159 (E. & J. Bouman)	0.6
* 2	Pt. 16,17,A B	1.9	5-018-75 (F. & E. Vitoria)	1.0
2	Pt. A & B	16.9	5-161 (J. Lomoro & 2027479 Ontario Inc.)	3.3
* 2	Pt. B	8.9	5-182 (R. Hunter)	3.2
* 2	Pt. B	4.6	5-052-10 (E. & G. Hunter)	0.9
* 2	Pt. B	0.2	5-052 (D. & P. Blanchard)	0.1
* 2	Pt. B	5.4	5-053 (R. Oleszek)	0.7
* 2	Pt. B	1.1	5-161-90 (S. & T. Crumb)	0.1
* 2	Pt. B	1.4	5-160-50 (R. & D. Dickhout)	0.2
3	Pt. 1	22.8	5-117 (Heeg Dale Company Ltd.)	1.0
3	Pt.2 & 3	29.2	5-116-50 (Tiersdale Holsteins Ltd.)	1.4
3	Pt. 3	12.4	5-177 (P. Gracey)	0.7
* 3	Pt. 3	1.4	5-178 (A. & I. Hartstein)	0.1
3	Pt. 3	2.5	5-114 (P. & H. Tiersma)	0.1
* 3	Pt. 4	0.1	5-067 (A. Tutolo)	0.1
* 3	Pt. 4	0.2	5-068 (Ontario Aboriginal Housing Support Servies Corp.)	0.1
* 3	Pt. 4	0.2	5-069 (C. Brewer)	0.1
* 3	Pt. 4	0.2	5-070 (D. & D. Maloney)	0.1
* 3	Pt. 4	0.2	5-071 (J. Houser)	0.1

SCHEDULE 'D' - ASSESSMENT FOR MAINTENANCE (Cont'd)

CARTER DRAIN
Haldimand County

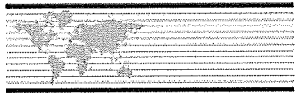
CON.	LOT	HECTARES AFFECTED	ROLL No. (OWNER)	PERCENTAGE OF MAINTENANCE COST
MAIN DRAIN (cont'd)				
Hadlimand County				
<i>Geographic Township of Moulton</i>				
* 3	Pt. 4	0.5	5-073 (J. & J. Houser)	0.2 %
* 3	Pt. 4	0.2	5-074 (E. & M. Kelly)	0.1
* 3	Pt. 4	0.2	5-075 (F. & W. Vandervelde)	0.1
* 3	Pt. 4	0.2	5-076 (J. & D. Van Der Beek)	0.1
* 3	Pt. 4	0.5	5-078 (G. & C. Fair)	0.2
* 3	Pt. 4	0.2	5-079 (V. Gage)	0.1
* 3	Pt. 4	0.2	5-080 (W. Schipper)	0.1
* 3	Pt. 4	0.5	5-082 (C. Linde)	0.2
* 3	Pt. 4	0.2	5-083 (Haldimand County)	0.1
* 3	Pt. 4	0.2	5-084 (L. & D. Hatcher)	0.1
* 3	Pt. 4	0.2	5-085 (S. Grant & P. Komenda)	0.1
* 3	Pt. 4	0.2	5-086 (T. Forestell)	0.1
* 3	Pt. 4	0.5	5-087 (R. & A. Maxwell)	0.2
* 3	Pt. 4	0.2	5-089 (J. & B. Hunter)	0.1
* 3	Pt. 4	0.2	5-090 (J. & S. Kingma)	0.1
* 3	Pt. 4	0.2	5-091 (G. Tocher & R. Shelly)	0.1
* 3	Pt. 4	0.2	5-092 (D. Barless & K. Clark)	0.1
* 3	Pt. 4	0.5	5-094 (T. & J. Thompson)	0.1
* 3	Pt. 4	0.2	5-095 (S. & J. Parker)	0.1
* 3	Pt. 4	1.0	5-096 (F. Mihalicz)	0.1
* 3	Pt. 4	1.5	5-162 (G. Turner)	0.1
3	Pt. 4 & 5	13.0	5-163 (L. & B. Riebot)	2.2
3	Pt. 4 & 5	4.8	5-081(D. & E. Douwes)	0.7
3	Pt. 4 & 5	12.7	5-165 (K. & L. Luttjehuizen)	1.1
3	Pt. 5	0.6	5-166 (S. Metcalfe)	0.1
3	Pt. 5	3.6	5-168-50 (Y. Wu)	0.2
3	Pt. 4,5, 6	1.4	5-164 (M. Van Kuren)	0.5
* Right-of-Way		7.7	Canadian Pacific Railway	5.8
TOTAL ASSESSMENT ON LANDS				82.7 %
Hutchinson Road		1.3	Halimand County	2.4 %
Young Road		2.6	Halimand County	1.1
Hines Road		2.1	Halimand County	1.3
½ Wainfleet/Dunn'		1.2	Halimand County	0.2
TOTAL ASSESSMENT ON ROADS				5.0 %
Total Assessment in Hadlimand County				87.7 %

SCHEDULE 'D' - ASSESSMENT FOR MAINTENANCE (Cont'd)

CARTER DRAIN
Haldimand County

CON.	LOT	HECTARES AFFECTED	ROLL No. (OWNER)	PERCENTAGE OF MAINTENANCE COST
MAIN DRAIN (cont'd)				
Township of Wainfleet				
7	Pt. 50 & 51	0.8	13-065-01 (W Oosterhoff)	0.1 %
7	Pt. 50 & 51	5.4	13-064 (M. Wagter)	0.1
7	Pt. 50 & 51	15.4	13-131 (M. Tiersma)	2.8
7	Pt. 51	1.6	13-066 (M. Tiersma)	0.1
7	Pt. 52 & 53	38.1	13-132 (H. Van Soelen)	5.3
7	Pt. 53	14.7	13-134 (C. Skotniski)	2.6
7	Pt. 54	0.4	13-135 (Wegelin)	0.1
				=====
TOTAL ASSESSMENT ON LANDS				11.1 %
				=====
	Road All. Lot 51/52	1.8	Township of Wainfleet	0.9 %
	Road All. Lot 53/54	0.3	Township of Wainfleet	0.1
	Road All. Conc. 7	0.6	Township of Wainfleet	0.1
	½ Wainfleet/Dunnville	1.2	Township of Wainfleet	0.1
				=====
TOTAL ASSESSMENT ON ROADS				1.2 %
				=====
Total Assessment in Township of Wainfleet				12.3 %
				=====
TOTAL ASSESSMENT FOR MAINTENANCE ON THE MAIN DRAIN				100.0 %
				=====

APPENDIX A



April 2018

GEOTECHNICAL EXPLORATION

Carter Drain Canadian Pacific Rail Undercrossing South of Young Road Haldimand County, Ontario

Submitted to:
Mr. Brandon Widner, B.Eng.
Spriet Associates Limited
155 York Street
London, ON N6A 1A8

REPORT



Report Number: 1777029-R01

Distribution:

1 E-Copy - Spriet Associates Limited
1 E-Copy - Golder Associates Ltd.





Table of Contents

1.0	INTRODUCTION.....	1
2.0	SITE DESCRIPTION AND PHYSIOGRAPHY	1
3.0	FIELD PROCEDURES.....	1
4.0	SUBSURFACE CONDITIONS.....	2
5.0	DISCUSSION.....	2
5.1	Trenchless Crossing.....	3
5.1.1	Jack and Bore	3
5.1.2	Pipe Ramming	4
5.1.3	Settlements.....	4
5.1.4	Settlement Monitoring.....	4
5.2	Excavations and Embankment Stability.....	5
6.0	GEOTECHNICAL INSPECTIONS AND TESTING	6

Important Information and Limitations of this Report

Method of Soil Classification

Abbreviations and Terms Used on Records of Boreholes and Test Pits

List of Symbols

Records of Boreholes

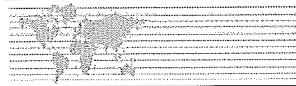
FIGURES

Figure 1: Location Plan

Figure 2: Profile Along Carter Drain

Figure 3: Grain Size Distribution – Silty Clay

Figure 4: Settlement Monitoring Plan



GEOTECHNICAL EXPLORATION CARTER DRAIN CPR UNDERCROSSING

1.0 INTRODUCTION

This report provides the results of the geotechnical exploration and testing program carried out for the design of the undercrossing of the Canadian Pacific Railway (CPR) about 750 metres west of Young Road along the CPR alignment that is to be completed as part of the Carter Drain construction. The site is located to the south of Young Road and to the west of Hines Road in Haldimand County, Ontario, at the approximate location shown on the Key Plan, Figure 1. The purpose of the exploration was to assess the subsurface soil and groundwater conditions at the site and to provide geotechnical engineering recommendations for the design of the proposed trenchless undercrossing of the Carter Drain under the CPR track and embankment.

This report should be read in conjunction with the attached document "Important Information and Limitations of This Report", which comprises an integral component hereof. The reader's attention is specifically drawn to this material, as it is essential for the proper use and interpretation of the information presented and discussed herein.

2.0 SITE DESCRIPTION AND PHYSIOGRAPHY

The proposed undercrossing of the CPR track is located approximately 750 metres west of Young Road along the CPR alignment. The vertical alignment survey provided to Golder indicates that the rail embankment is about 2.5 metres in height and the invert of the drain is about 4.5 metres below the top of the embankment. The drain crosses agricultural fields to the north and south of the railway.

The site is located in the physiographic region of southwestern Ontario known as the Haldimand Clay Plains.¹ Drift thickness is reported to be from approximately 15 to 45 metres in the area¹. The underlying bedrock consists primarily of dolostone, shale, gypsum and salt of the Salina Formation and Upper Silurian group.²

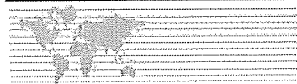
3.0 FIELD PROCEDURES

The field work for this exploration was carried out on May 10, 2017 at which time two boreholes were drilled at the approximate locations shown on the Location Plan, Figure 1. The boreholes were drilled using track-mounted drilling equipment supplied and operated by a specialist drilling contractor. The soil stratigraphy and groundwater conditions encountered in the boreholes are shown in detail on the attached Record of Borehole sheets.

Standard penetration testing and sampling was carried out at suitable intervals of depth in each of the boreholes using 35 millimetre inside diameter split spoon sampling equipment and an automatic hammer in accordance with ASTM D1586 "Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils". All of the samples were brought to our laboratory for further examination and representative classification testing. The results of the field and laboratory testing are shown on the Record of Borehole sheets and on Figures 2 and 3.

¹ The Physiography of Southern Ontario; Ontario Geological Survey, Special Volume 2. By Chapman and Putnam, 1984.

² Paleozoic Geology Map of Southern Ontario; Ontario Geological Survey Miscellaneous Release—Data 219



Groundwater conditions were observed in the boreholes during drilling. The encountered groundwater levels are shown on the Record of Borehole sheets. Upon completion of drilling, sampling and logging, the boreholes were backfilled in accordance with Ontario Regulation (O. Reg.) 903 amended to O. Reg. 372/07.

The boreholes were located in the field by a member of our engineering staff who also obtained underground utility clearances, supervised the drilling, logged the boreholes, and cared for the samples obtained. The ground surface elevations at the borehole locations were referenced to a benchmark shown on the drawings provided by Spriet Associates Limited. The benchmark is described as the top of the south end of the steel culvert with an elevation of 177.88 metres, referenced to geodetic datum.

4.0 SUBSURFACE CONDITIONS

The subsurface conditions encountered in the boreholes drilled at the site are shown in detail on the attached Record of Borehole sheets. The following discussion has been simplified in terms of major soil strata for the purposes of geotechnical design. The soil boundaries indicated are inferred from non-continuous samples and observations of drilling and sampling resistance and typically represent transitions from one soil type to another rather than exact planes of geological change. Further, subsurface conditions may vary between and beyond the borehole locations.

The boreholes encountered surficial topsoil overlying layers of silty clay to the depths explored.

Topsoil was encountered at ground surface in both boreholes. The surficial clayey topsoil was approximately 240 to 400 millimetres thick. Materials designated as topsoil in this report were classified solely based on visual and textural evidence. Testing of organic content or for other nutrients was not carried out; therefore, the materials classified as topsoil cannot necessarily be relied upon for support and growth of landscaping vegetation without supplemental soil nutrient analyses.

Layers of silty clay 1.1 to 5 metres thick were encountered beneath the topsoil in both boreholes. The silty clay exhibited SPT N values, as defined by ASTM D1586, ranging from 4 to 16 blows per 0.3 metres of penetration with water contents of about 22 to 43 per cent. The results of the grain size analysis carried out on a sample of the silty clay are shown on Figure 3.

Both boreholes remained dry during drilling on May 10, 2017, however, it should be noted that groundwater levels will vary seasonally and due to significant weather events.

5.0 DISCUSSION

This section of the report provides our interpretation of the factual geotechnical data obtained during the exploration and it is intended for guidance of the design engineer. Where comments are made on construction, they are provided only to highlight those aspects which could affect the design of the project. Contractors bidding on or undertaking the works should make their own interpretation of the subsurface information provided as it affects their proposed construction means and methods, equipment selection, scheduling, and the like.



5.1 Trenchless Crossing

Based on the information provided to Golder, the CPR undercrossing for the Carter Drain will consist of the trenchless installation of a 914 millimetre diameter pipe. The proposed pipe invert elevations are about 4.5 metres below the top of the embankment, which extends approximately 2.5 metres above ground surface. The results of the boreholes indicate that the undercrossing will generally encounter stiff to very stiff silty clay within the crossing window.

The following two trenchless installation techniques are discussed within this report from a geotechnical perspective:

- Jacking and boring; and
- Pipe ramming.

Careful control of grade will be required due to the gravity drainage requirements of the proposed installation.

The trenchless crossing of the CPR right-of-way must be conducted in accordance with CPR regulations and Transport Canada standards. All trenchless work must be carried out by an experienced specialist contractor employing only qualified workers, skilled in their trade, under the direction of an experienced foreman. The contractor's work plan should include a method of sealing the ends of the bore at the end of each work day or in case of an emergency. A procedure for compensation grouting should also be provided should uncontrolled loss of ground occur. It is recommended that the geotechnical aspects of the contractor's work plan for the proposed undercrossing, including the design of any excavation support systems for the working pits, be reviewed by this office prior to construction. The trenchless contractor is advised to carefully expose any underground utilities that traverse the undercrossing path to confirm their locations and elevations prior to commencement of the work.

5.1.1 Jack and Bore

With the jack and bore method, entry and receiving pits are first excavated to accommodate the jacking equipment at the entry pit and connections to the main pipe at the receiving pit. Based on the topography at the site, the entry and exit pits will be up to about two metres deep. The pipe is advanced by jacking with simultaneous removal of spoils using helical augers within the pipe. Successive lengths of pipe are welded together prior to each advance. The lead pipe is generally equipped with a shield or thickened leading end to create a minor amount of overbreak to reduce shear stress due to friction or adhesion.

The main advantage of this system is that, with suitable soil conditions and good workmanship, acceptable settlement generally occurs due to the simultaneous installation of the pipe. To reduce over excavation and loss of ground with the resulting potential for post installation settlements, CPR typically requires that the auger head be kept a minimum of 0.75 metres behind the lead end of the pipe at all times. Conventional jack and bore systems are the preferred alternative from a geotechnical perspective provided the auger is kept at least 0.75 metres inside the casing pipe.



5.1.2 Pipe Ramming

Pipe ramming utilizes a large, horizontal percussion hammer to drive a steel pipe horizontally into the ground. In most instances, the ground within the pipe is not removed until the full length of the pipe is driven. Partial removal of material from within the pipe may be needed to reduce friction and increase driving efficiency. Entry and receiving pits of sufficient dimensions will also be required for pipe assembly, retrieval, and to accommodate the percussion hammer. Following installation of the pipe, the annular space is cleaned of soil using helical augers.

Pipe ramming is considered to be a geotechnically feasible method of installation. Compared to the jack and bore option, pipe ramming is more versatile in handling variable and saturated ground conditions with less risk of ground loss at the pipe face because a larger soil plug is typically maintained inside the casing during the driving phase. However, the installation should be carefully monitored as pipe ramming has the potential to cause heaving at the ground surface as the pipe displaces the surrounding ground or cause vibration-induced settlement of the materials comprising the rail embankment.

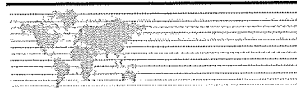
5.1.3 Settlements and Heaving

Some settlement or heaving may occur even with careful workmanship. With proper construction procedures, the ground surface settlements or rises should be less than 10 millimetres. A review threshold settlement or rise value of 10 millimetres should be used for the undercrossing with the alert level settlement or rise set at 15 millimetres. Elevation monitoring of the undercrossing should be carried out prior to, during and following the pipe installation as detailed below. Should the 10 millimetre movement review level be reached, the survey should be repeated immediately and the contractor's methodology reviewed, appropriate adjustments incorporated and the survey frequency increased. Should the 15 millimetre alert movement level be reached, the work should cease, preparation should be made to bulkhead the pipe and CPR personnel should be notified. The survey should be repeated and checked. The appropriate revisions should be made to the trenchless procedure and the bore should only proceed on approval from CPR. The trenchless installations should be monitored by qualified geotechnical personnel.

5.1.4 Elevation Monitoring

A monitoring program utilizing an array of shallow elevation monitors and two deep monitors is recommended. The shallow monitors would consist of plates with steel riser rods installed at subballast level at the end of the ties or steel rods driven through the ballast. An array of 10 shallow monitors is recommended for the undercrossing location as outlined on Figure 4. One row should be placed at the end of the ties south of the tracks and one row placed at the end of the ties north of the tracks. Each row should have one shallow elevation monitor installed above the pipe centreline with additional monitors offset at intervals of 2.0 metres. In addition, two deep monitoring points should be installed on the pipe centreline on each side of the tracks. The deep monitors should be installed one metre above the obvert level, concreted in place and a sleeve provided around the remainder of the rod. The suggested locations of the deep monitors are also shown on Figure 4.

The monitors should be installed by Golder Associates Ltd. (Golder) and the subsequent survey monitoring should be carried out by the Contract Administrator with the results being promptly reviewed by Golder on an ongoing basis. The results should also be provided to CPR on a daily basis. Surveying should be carried out using



GEOTECHNICAL EXPLORATION CARTER DRAIN CPR UNDERCROSSING

equipment and crews capable of achieving a repeatable precision of ± 2 millimetres. A baseline survey should be carried out at least twice prior to construction with the points referenced to two independent benchmarks. During construction, monitoring should be carried out daily and, depending on the magnitude of any movements detected during construction, for a period of two to three months following the crossing installation.

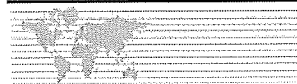
5.2 Excavations and Embankment Stability

Based on the results of the boreholes, excavations such as those required for the entry and exit pits will encounter surficial topsoil and silty clay. It is anticipated that groundwater control can be achieved by pumping from properly constructed and filtered sumps in the base of the excavations, as required. Surface water should be directed away from all open excavations.

In accordance with the current Occupational Health and Safety Act and Regulations for Construction Projects (OHSA) criteria, the working pit slopes should be inclined at 1 horizontal to 1 vertical or flatter. Based on CPR criteria, no unsupported excavations are permitted within the zone of influence of the tracks defined as a line extending downward at an inclination of 1.5 horizontal to 1.0 vertical from a point 3.0 metres beyond the inside of the nearest rail. Further, depending on the width (parallel to the CPR embankment) of any planned unsupported excavations that are outside of the zone of influence, but at or near the toe of the CPR embankment, the stability of the embankment and excavation should be evaluated. All excavation support systems should be designed with due consideration of CPR embankment and train surcharge loads. At the time of this report, it was understood that the entry and exit pits would be outside of the CPR right-of-way and outside the aforementioned zone of influence.

Adequate erosion or scour protection measures should be implemented at both the inlet and outlet ends of the new drainage pipe. The condition of the CPR embankment should be reinstated should excavations encroaching upon the embankment side slopes be required. Based on the results of the boreholes and the current OHSA criteria, the silty clay would be classified as a Type 2 soil.

Care will be required to ensure that adequate support is provided for all existing utilities, if any, that are located in the zone of influence of the excavations as defined by a line drawn from the base of the excavation upwards and outwards at an inclination of 1 horizontal to 1 vertical. Properly designed temporary support systems could be used to limit the extent of the excavations and reduce potential impacts on adjacent services.



6.0 GEOTECHNICAL INSPECTIONS AND TESTING

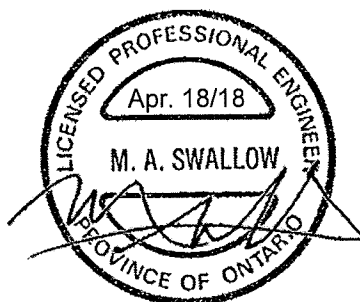
A regular program of geotechnical inspection and monitoring will be required during construction of the undercrossing to ensure that the intent of the design recommendations provided is being met, that the various project specifications are being consistently achieved and that the appropriate CPR protocols are followed.

The factual data, interpretation and recommendations in this report pertain to a specific project as described in the report and are not applicable to any other project or site location. If the project is modified in concept, location or elevation, or if the project is not initiated within twelve months of the date of the report, Golder Associates Ltd. should be given an opportunity to confirm that the recommendations are still valid. The subject geotechnical exploration and this report address only the geotechnical aspects of the proposed project; potential environmental impacts or related issues are beyond the defined scope of this work and have not been addressed.

We trust that this report provides all of the geotechnical information presently required. Should any point require additional clarification, or should you require further assistance, please contact this office.

GOLDER ASSOCIATES LTD.

Jordan Kiss, M.E.Sc., EIT
Geotechnical Engineer in Training

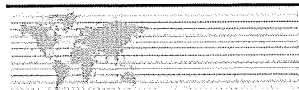


Mark A. Swallow, P.E., P.Eng.
Principal and Senior Practice Leader

JK/BT/MAS/cr

Golder, Golder Associates and the GA globe design are trademarks of Golder Associates Corporation.

[https://golderassociates.sharepoint.com/sites/12980g/deliverables/1777029-r01_apr_18_18_\(final\)_carter_drain.docx](https://golderassociates.sharepoint.com/sites/12980g/deliverables/1777029-r01_apr_18_18_(final)_carter_drain.docx)



IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder can not be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.



IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

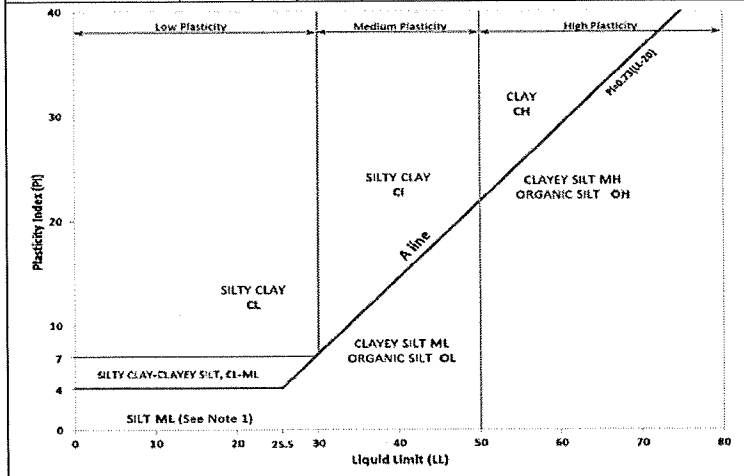
Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.



METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil	Gradation or Plasticity	$C_u = \frac{D_{60}}{D_{10}}$		$C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$	Organic Content	USCS Group Symbol	Group Name							
				<4	≥4											
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Poorly Graded	<4	≤1 or ≥3	≤30%		GP	GRAVEL							
			Well Graded	≥4	1 to 3			GW	GRAVEL							
			Below A Line	n/a				GM	SILTY GRAVEL							
			Above A Line	n/a				GC	CLAYEY GRAVEL							
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Poorly Graded	<6	≤1 or ≥3			SP	SAND							
			Well Graded	≥6	1 to 3			SW	SAND							
			Below A Line	n/a				SM	SILTY SAND							
			Above A Line	n/a				SC	CLAYEY SAND							
			Organic or Inorganic	Soil Group	Type of Soil			Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
									Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PL and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT					
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT					
			Liquid Limit ≥50	Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT					
				Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT					
			CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30%	CL	SILTY CLAY				
					None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY				
		Liquid Limit ≥50		None	High	Shiny	<1 mm	High	(see Note 2)	CH	CLAY					
		HIGHLY ORGANIC SOILS (Organic Content >30% by mass)	Peat and mineral soil mixtures						30% to 75%	PT	SILTY PEAT, SANDY PEAT					
				Predominantly peat, may contain some mineral soil, fibrous or amorphous peat					75% to 100%		PEAT					

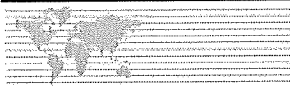


Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML. For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between “clean” and “dirty” sand or gravel. For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
 Note 2 – For soils with <5% organic content, include the descriptor “trace organics” for soils with between 5% and 30% organic content include the prefix “organic” before the Primary name.





ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse	19 to 75	0.75 to 3
	Fine	4.75 to 19	(4) to 0.75
SAND	Coarse	2.00 to 4.75	(10) to (4)
	Medium	0.425 to 2.00	(40) to (10)
	Fine	0.075 to 0.425	(200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (i.e., SAND and GRAVEL, SAND and CLAY)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), 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.) split-spoon sampler for a distance of 300 mm (12 in.).

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

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 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

NON-COHESIVE (COHESIONLESS) SOILS

Compactness ²	
Term	SPT 'N' (blows/0.3m) ¹
Very Loose	0 - 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects.

2. Definition of compactness descriptions based on SPT 'N' ranges from Terzaghi and Peck (1967) and correspond to typical average N₆₀ values.

Field Moisture Condition	
Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
FS	Foil sample
GS	Grab Sample
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size
TP	Thin-walled, piston – note size
WS	Wash sample

SOIL TESTS

w	water content
PL, w _p	plastic limit
LL, w _L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D _R	relative density (specific gravity, G _s)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO ₄	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

COHESIVE SOILS

Consistency		
Term	Undrained Shear Strength (kPa)	SPT 'N' ^{1,2} (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content	
Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.



LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
$\ln x$	natural logarithm of x
$\log_{10} x$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ϵ	linear strain
ϵ_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress = $(\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
e_c	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

* Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1
2

$$\tau = c' + \sigma' \tan \phi'$$

$$\text{shear strength} = (\text{compressive strength})/2$$

PROJECT: 1777029

RECORD OF BOREHOLE BH-102

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

BORING DATE: May 10, 2017
 DRILLING CONTRACTOR: London Soil Test Ltd.

DATUM: GEODETIC

HAMMER TYPE: Auto Hammer

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES			ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE		BLOWS/0.3m	20		40		10 ⁻⁶		10 ⁻³			
									SHEAR STRENGTH Cu, kPa		SHEAR STRENGTH		WATER CONTENT PERCENT		WATER CONTENT PERCENT			
0		GROUND SURFACE		177.53														
		TOPSOIL, clayey; black		177.29														
1		(CL) SILTY CLAY, some sand; brown; stiff		176.01	1	SS	10									Borehole dry during drilling on May 10, 2017.		
2				176.01	2	SS	12											
3				176.01	3	SS	13											
4				176.01	4	SS	6											
5				176.01	5	SS	4											
6				176.01	6	SS	5											
7		END OF BOREHOLE		170.98														
8				170.98														
9				170.98														

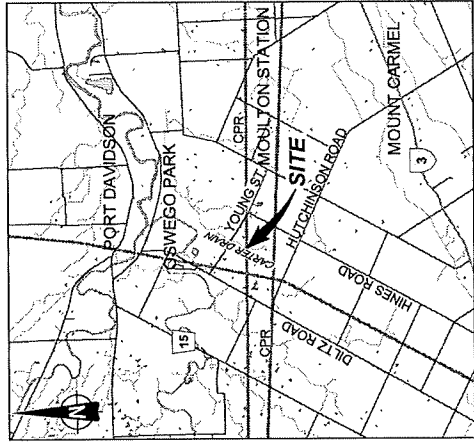
LDN_BHS_07_1777029.GPJ GLDR_LON.GDT_07/06/17 DATA INPUT: LMK

DEPTH SCALE

1: 50

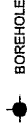


LOGGED: MR
 CHECKED: *[Signature]*



KEY PLAN

LEGEND



BOREHOLE

REFERENCE

PLAN BASED ON BING IMAGERY AS OF MAY 25, 2017
(IMAGE DATE UNKNOWN);
AND CANMAP STREETFILES V 2008.

NOTES

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH
ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE ONLY.

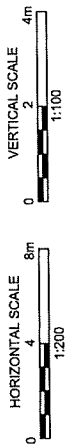
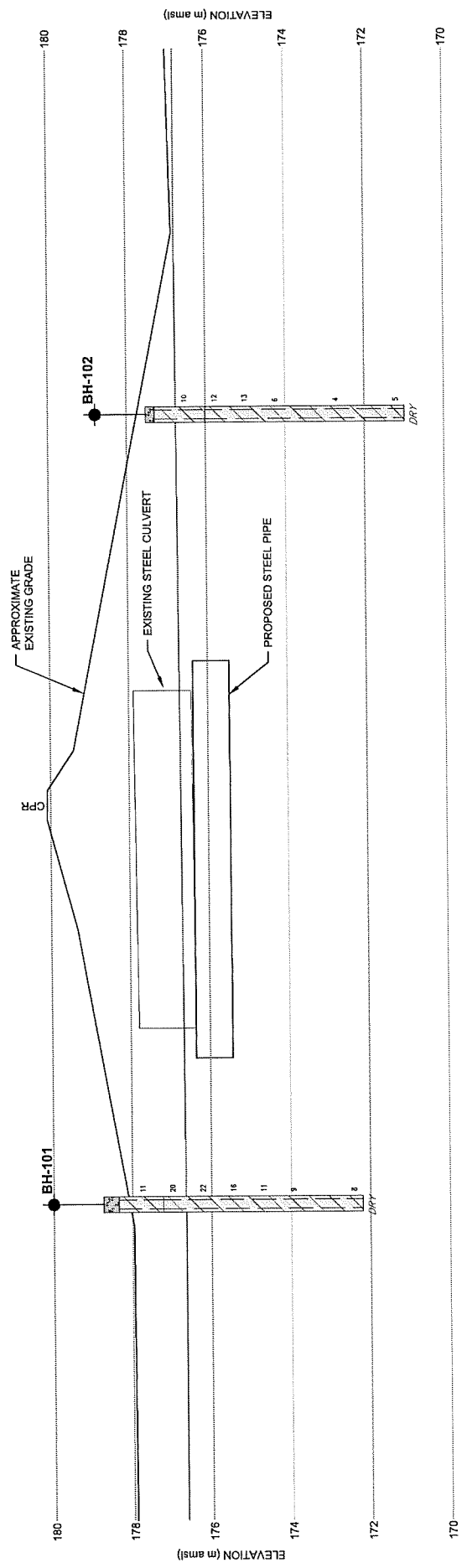
PROJECT CARTER DRAIN CPR UNDERCROSSING
TITLE SOUTH OF YOUNG ROAD
HALDIMAND COUNTY, ON

LOCATION PLAN

PROJECT NO.		FILE NO.	
1777029		1777029-R1001	
SCALE	AS SHOWN	SCALE	AS SHOWN
CHECK	DATE	CHECK	DATE
	May 2017		






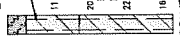
FIGURE 1



REFERENCE
 DRAWING BASED ON SECTION PROVIDED BY SPRIET ASSOCIATES LIMITED, CARTER DRAIN, HALDIMAND COUNTY, JOB No. 205140, PROFILE, DRAWING No. 2 OF 2, DECEMBER 2016.

NOTES
 THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.
 ALL LOCATIONS ARE APPROXIMATE ONLY.

SIMPLIFIED STRATIGRAPHY
 TOPSOIL
 SILTY CLAY

LEGEND
 BOREHOLE
 STRATA PLOT
 FOR DETAILS REFER TO RECORD OF BOREHOLES
 BOREHOLE DRY DURING DRILLING

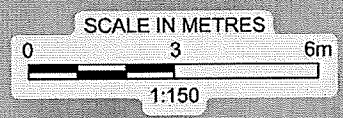
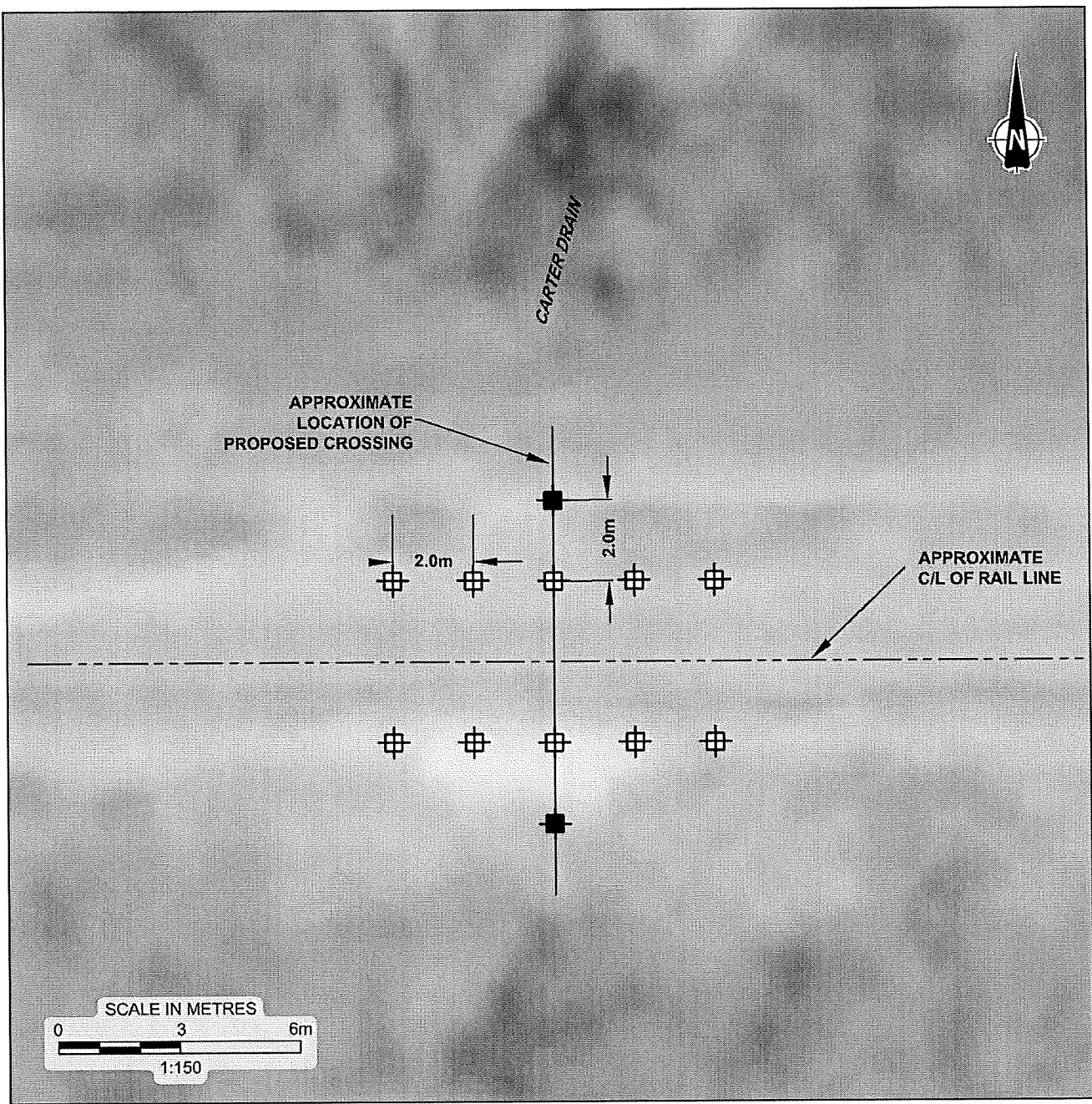
PROJECT: CARTER DRAIN CPR UNDERCROSSING SOUTH OF YOUNG ROAD HALDIMAND COUNTY, ON

TITLE: PROFILE ALONG CARTER DRAIN

PROJECT No.	177029	FILE No.	177029-R01001
DATE	AS SHOWN	SCALE	AS SHOWN
DATE	17/06/2017	DATE	17/06/2017
DATE	17/06/2017	DATE	17/06/2017

Golder Associates

FIGURE 2



LEGEND

- SHALLOW SETTLEMENT MONITOR
- DEEP SETTLEMENT MONITOR

REFERENCE

PLAN BASED ON BING IMAGERY AS OF MAY 25, 2017 (IMAGE DATE UNKNOWN).

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE ONLY.

PROJECT	CARTER DRAIN CPR UNDERCROSSING SOUTH OF YOUNG ROAD HALDIMAND COUNTY, ON		
TITLE	PROPOSED SETTLEMENT MONITORING LOCATIONS		
	PROJECT No. 1777029	FILE No. 1777029-R01004	
	CADD DCH	June 9/17	SCALE AS SHOWN REV.
	CHECK		FIGURE 4



Drawing file: 1777029-R01004.dwg Jun 09, 2017 - 11:55am

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

For more information, visit golder.com

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 44 1628 851851
North America	+ 1 800 275 3281
South America	+ 56 2 2616 2000

solutions@golder.com
www.golder.com

Golder Associates Ltd.
309 Exeter Road, Unit #1
London, Ontario, N6L 1C1
Canada
T: +1 (519) 652 0099



SCHEDULE OF NET ASSESSMENT

CARTER DRAIN

Haldimand County

(FOR INFORMATION PURPOSES ONLY)

Job No. 205140

April 16, 2018

* = Non-agricultural

ROLL NUMBER (OWNER)	TOTAL ASSESSMENT	GRANT	ALLOWANCES	APPROX. NET
Haldimand County				
1-188 (1013022 Ontario Inc)	\$ 3,272.00	\$ 1,091.00	\$	2,181.00
1-205 (T. Petter)	12,467.00	4,156.00	60.00	8,251.00
* 1-204 (M. & D. & J. Disher)	1,105.00			1,105.00
* 1-205-20 (H. & S. Hall)	2,211.00			2,211.00
* 1-205-10 (K. Petter)	2,689.00			2,689.00
5-020-50 (R. & E. Dale)	3,852.00	1,284.00		2,568.00
5-018-50 (F. & E. Vitoria)	740.00	247.00		493.00
5-024 (J. & T. Scholman)	1,471.00	490.00		981.00
* 5-020-75 (E. Dale)	167.00			167.00
* 5-025 (P. Davies)	392.00			392.00
5-155 (Bulk Growers Holding Ltd.)	1,891.00	630.00		1,261.00
* 5-156 (J. & S. Lane)	144.00			144.00
* 5-174-50 (N. Mans)	236.00			236.00
5-176 (J. & B. Stevenson)	659.00	220.00		439.00
5-173 (Green Leaf Financial Capital)	22,014.00	7,338.00	9,100.00	5,576.00
5-174 (J. & S. Mans)	19,497.00	6,499.00	4,860.00	8,138.00
5-175 (C. & M. Packham)	2,644.00	881.00		1,763.00
5-157 (E. Mazur)	17,342.00	5,781.00	4,490.00	7,071.00
5-158 (M. & N. Mans)	35,242.00	11,747.00	10,560.00	12,935.00
5-159 (E. & J. Bouman)	965.00	322.00		643.00
* 5-018-75 (F. & E. Vitoria)	12,141.00		270.00	11,871.00
5-161 (J. Lomoro & 2027479 Ontario Inc.)	5,593.00	1,864.00	710.00	3,019.00
* 5-182 (R. Hunter)	4,889.00			4,889.00
* 5-052-10 (E. & G. Hunter)	1,320.00			1,320.00
* 5-052 (D. & P. Blanchard)	125.00			125.00
* 5-053 (R. Oleszek)	1,104.00			1,104.00
* 5-161-90 (S. & T. Crumb)	127.00			127.00
* 5-160-50 (R. & D. Dickhout)	365.00			365.00
5-117 (Heeg Dale Company Ltd.)	1,460.00	487.00		973.00
5-116-50 (Tiersdale Holsteins Ltd.)	2,114.00	705.00		1,409.00
5-177 (P. Gracey)	1,104.00	368.00		736.00
* 5-178 (A. & I. Hartstein)	125.00			125.00
5-114 (P. & H. Tiersma)	223.00	74.00		149.00
* 5-067 (A. Tutolo)	64.00			64.00
* 5-068 (Ontario Aboriginal Housing Support	133.00			133.00
* 5-069 (C. Brewer)	133.00			133.00
* 5-070 (D. & D. Maloney)	133.00			133.00
* 5-071 (J. Houser)	114.00			114.00
* 5-073 (J. & J. Houser)	263.00			263.00
* 5-074 (E. & M. Kelly)	133.00			133.00
* 5-075 (F. & W. Vandervelde)	133.00			133.00
* 5-076 (J. & D. Van Der Beek)	133.00			133.00
* 5-078 (G. & C. Fair)	263.00			263.00
* 5-079 (V. Gage)	133.00			133.00
* 5-080 (W. Schipper)	133.00			133.00

SCHEDULE OF NET ASSESSMENT (cont'd)

CARTER DRAIN
Haldimand County

* = Non-agricultural

ROLL NUMBER (OWNER)	TOTAL ASSESSMENT	GRANT	ALLOWANCES	APPROX. NET
* 5-082 (C. Linde)	294.00			294.00
* 5-083 (Haldimand County)	133.00			133.00
* 5-084 (L. & D. Hatcher)	133.00			133.00
* 5-085 (S. Grant & P. Komenda)	133.00			133.00
* 5-086 (T. Forestell)	133.00			133.00
* 5-087 (R. & A. Maxwell)	270.00			270.00
* 5-089 (J. & B. Hunter)	133.00			133.00
* 5-090 (J. & S. Kingma)	133.00			133.00
* 5-091 (G. Tocher & R. Shelly)	31.00			31.00
* 5-092 (D. Barless & K. Clark)	31.00			31.00
* 5-094 (T. & J. Thompson)	63.00			63.00
* 5-095 (S. & J. Parker)	31.00			31.00
* 5-096 (F. Mihalicz)	131.00			131.00
* 5-162 (G. Turner)	195.00			195.00
5-163 (L. & B. Riebot)	3,410.00	1,137.00		2,273.00
* 5-081(D. & E. Douwes)	1,066.00			1,066.00
5-165 (K. & L. Lutjehuisen)	1,719.00	573.00		1,146.00
* 5-166 (S. Metcalfe)	77.00			77.00
* 5-168-50 (Y. Wu)	316.00			316.00
* 5-164 (M. Van Kuren)	708.00			708.00
* Canadian Pacific Railway	9,840.00			9,840.00
Special Assessment	46,240.00			46,240.00
* Hutchinson Road	\$ 3,814.00	\$	\$	\$ 3,814.00
Special Assessment	20,710.00			20,710.00
* Young Road	1,835.00			1,835.00
Special Assessment	19,370.00			19,370.00
* Hines Road	1,957.00			1,957.00
* ½ Wainfleet/Dunnville Townline	336.00			336.00
Total - Haldimand County	\$ 274,700.00	\$ 45,894.00	\$ 30,050.00	\$ 198,756.00
Township of Wainfleet				
13-065-01 (W Oosterhoff)	\$ 11.00	\$ 4.00	\$	\$ 7.00
13-064 (M. Wagter)	216.00	72.00		144.00
13-131 (M. Tiersma)	8,296.00	2,765.00	4,360.00	1,171.00
13-066 (M. Tiersma)	21.00	7.00		14.00
13-132 (H. Van Soelen)	15,039.00	5,013.00	7,240.00	2,786.00
13-134 (C. Skotniski)	6,952.00	2,317.00	3,230.00	1,405.00
13-135 (Wegelin)	30.00	10.00		20.00
* Township of Wainfleet	2,386.00			2,386.00
* Special Assessment	15,070.00			15,070.00
* Township of Wainfleet	7.00			7.00
* Township of Wainfleet	93.00			93.00
* Township of Wainfleet	179.00			179.00
Total - Township of Wainfleet	\$ 48,300.00	\$ 10,188.00	\$ 14,830.00	\$ 23,282.00
TOTALS	\$ 323,000.00	\$ 56,082.00	\$ 44,880.00	\$ 222,038.00