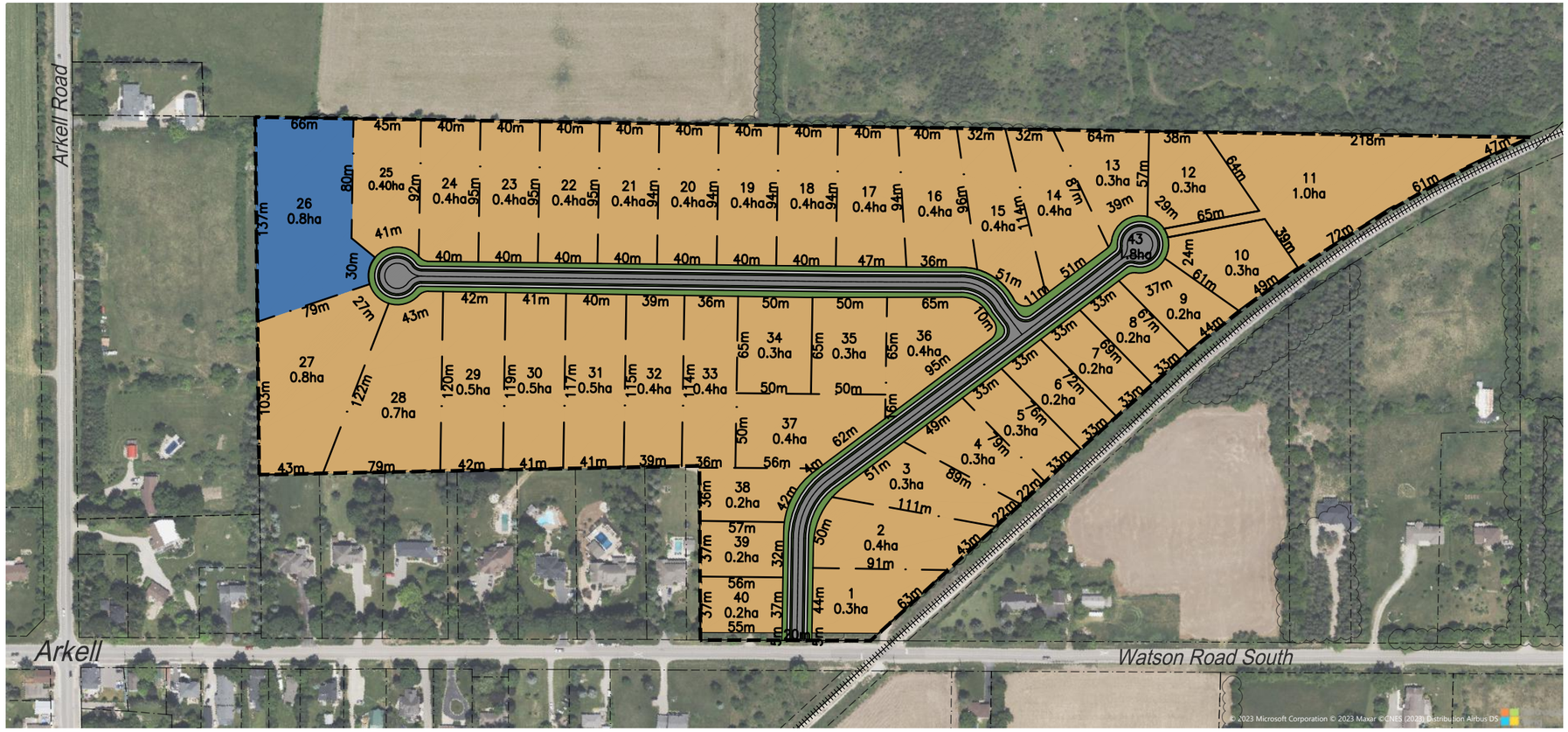
Conceptual Plan
39 Residential Lots

Part of Lots 7,8 & 9 Concession 10
Assessment Roll Number 230100000803480000
ARKELL, ONTARIO



Notes

1. All Coordinates Were Determined Using NAD83 CSRS - Zone 17.
2. Structural Locations Have Not Been Confirmed.
3. This Is Not a Plan Of Survey.
4. Proposed "Draft Plan Of Subdivision - Kukovica" Supplied By Van Harten / Jeffrey E. Buisman - O.L.S.
5. Delination of CLI Class 3/5 Polygon taken from AgMaps.
5. Aerial Imagery Provided By Microsoft Corporation @ 2022 Maxar CNES (2022) Distribution Airbus DS.
7. Coordinates on This Plan Are UTM, ZONE 17, NAD83 (CSRS-2010) Adjustment and Are Based on GPS Observations From a Network of Permanent GPS Reference Stations.

Legend

- Existing Railway
- Subject Lands
- Proposed Lot Line
- Existing Lot Line
- Proposed Stormwater Management Facility / Pond
- Future Road Widening (5m)
- Proposed Roadway

Parcel Area Table

Lot #	Area	Frontage (m)
1	0.3ha	44
2	0.4ha	50
3	0.3ha	51
4	0.3ha	49
5	0.3ha	33
6	0.2ha	33
7	0.2ha	33
8	0.2ha	33
9	0.2ha	37
10	0.3ha	24
11	1.0ha	109
12	0.3ha	32

Parcel Area Table

Lot #	Area	Frontage (m)
13	0.3ha	39
14	0.4ha	51
15	0.4ha	51
16	0.4ha	36
17	0.4ha	47
18	0.4ha	40
19	0.4ha	40
20	0.4ha	40
21	0.4ha	40
22	0.4ha	40
23	0.4ha	40
24	0.4ha	40

Parcel Area Table

Lot #	Area	Frontage (m)
25	0.4ha	41
26	0.8ha	SWMP
27	0.8ha	27
28	0.7ha	43
29	0.5ha	42
30	0.5ha	41
31	0.5ha	40
32	0.4ha	39
33	0.4ha	36
34	0.3ha	50
35	0.3ha	50
36	0.4ha	65

Parcel Area Table

Lot #	Area	Frontage (m)
37	0.4ha	62
38	0.2ha	42
39	0.2ha	32
40	0.2ha	37
41	0.0ha	Road Widening
42	0.0ha	Road Widening
43	1.8ha	Roadway

Client: Sloot Construction Inc. & 1000286480 Ontario Inc.

SAI
PLANNING. AGROLOGY. ENVIRONMENTAL.

Stovel and Associates Inc.
651 Orangeville Road,
Fergus ON
N1M 1T9
P: 519-766-8042
E: stovel.associates@outlook.com

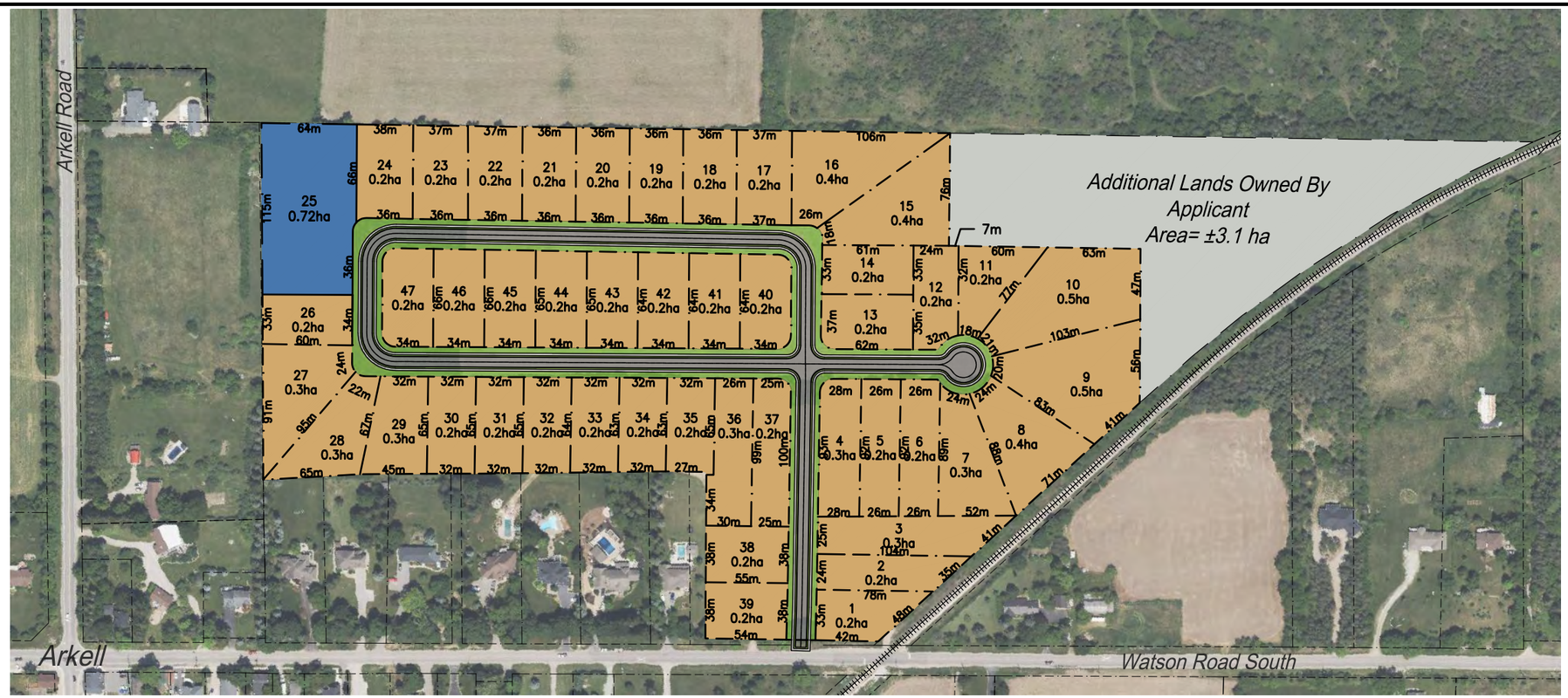
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W E
S

DRAFT

Date : 04/24/2023

0 100 200 Meters

Scale 1:3500



Conceptual Plan
46 Residential Lots

Part of Lots 7,8 & 9 Concession 10
Assessment Roll Number 230100008034800000
ARKELL, ONTARIO

Notes

1. All Coordinates Were Determined Using NAD83 CSRS - Zone 17.
2. Structural Locations Have Not Been Confirmed.
3. This Is Not a Plan Of Survey.
4. Proposed "Draft Plan Of Subdivision - Kukovica" Supplied By Van Harten / Jeffrey E. Buisman - O.L.S.
5. Aerial Imagery Provided By Microsoft Corporation @ 2022 Maxar CNES (2022) Distribution Airbus DS.
7. Coordinates on This Plan Are UTM, ZONE 17, NAD83 (CSRS-2010) Adjustment and Are Based on GPS Observations From a Network of Permanent GPS Reference Stations.

Legend

- Existing Railway
- Subject Lands
- Proposed Lot Line
- Existing Lot Line
- Proposed Stormwater Management Facility / Pond
- Proposed Roadway
- Additional Lands Owned By Applicant

Parcel Area Table

Parcel #	Area	Frontage (m)
1	0.2ha	33m
2	0.2ha	24m
3	0.3ha	25m
4	0.3ha	28m
5	0.2ha	26m
6	0.2ha	26m
7	0.3ha	24m
8	0.4ha	24m
9	0.5ha	20m
10	0.5ha	21m
11	0.2ha	18m
12	0.2ha	32m

Parcel Area Table

Parcel #	Area	Frontage (m)
13	0.2ha	37m
14	0.2ha	33m
15	0.4ha	18m
16	0.4ha	26m
17	0.2ha	37m
18	0.2ha	36m
19	0.2ha	36m
20	0.2ha	36m
21	0.2ha	36m
22	0.2ha	36m
23	0.2ha	36m
24	0.2ha	36m

Parcel Area Table

Parcel #	Area	Frontage (m)
25	0.7ha	SWMP
26	0.2ha	34m
27	0.3ha	24m
28	0.3ha	22m
29	0.3ha	32m
30	0.2ha	32m
31	0.2ha	32m
32	0.2ha	32m
33	0.2ha	32m
34	0.2ha	32m
35	0.2ha	32m
36	0.3ha	26m

Parcel Area Table

Parcel #	Area	Frontage (m)
37	0.2ha	25m
38	0.2ha	38m
39	0.2ha	38m
40	0.2ha	34m
41	0.2ha	34m
42	0.2ha	34m
43	0.2ha	34m
44	0.2ha	34m
45	0.2ha	34m
46	0.2ha	34m
47	0.2ha	34m

Client: Sloot Construction Inc. & 1000286480 Ontario Inc.

Stovel and Associates Inc.
651 Orangeville Road,
Fergus ON
N1M 1T9
P: 519-766-8042
E: stovel.associates@outlook.com

N
W E
S

DRAFT

Date : 04/24/2023

0 100 200 Meters

Scale 1:3500

APPENDIX A

WATER WELL RECORDS

FOR THE TEST WELLS (2022)

Ontario — Ministry of the Environment, Conservation and Parks

Measurements recorded in: ☐ Metric ☑ Imperial

Well Tag No. (Place Sticker and/or Print Below): Tag#:A356357

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 1

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
	1000286480 Ontario Inc.		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
275 Hanlon Creek Blvd	Guelph.	ONT	N1COA1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Watson Rd.	Puslinch	PT 7	10

County/District/Municipality	City/Town/Village	Province	Postal Code
Wellington	Arkell / Puslinch	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	17	567656	4820825		

Overburden and Bedrock Materials/Abandonment Sealing Record (see instructions on the back of this form)

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Brown	Sandy Clay			0	3
Brown	Sand Gravel	Stones		3	19
Grey	Silt Clay	Stones		19	39
Brown	Limestone		(Guelph)	39	88
DK Grey	Limestone	(Shaley)	(Eramosa)	88	136
Grey	Limestone		(Gasport)	136	238

Annular Space

Depth Set at (m/ft) From	Depth Set at (m/ft) To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
0	42	Bentonite Slurry Sand.	100 gals

Method of Construction

☐ Cable Tool ☐ Diamond
☑ Rotary (Conventional) ☐ Jetting
☐ Rotary (Reverse) ☐ Driving
☐ Boring ☐ Digging
☐ Air percussion
☐ Other, specify

Well Use

☐ Public ☐ Commercial ☐ Not used
☑ Domestic ☐ Municipal ☐ Dewatering
☐ Livestock ☐ Test Hole ☐ Monitoring
☐ Irrigation ☐ Cooling & Air Conditioning
☐ Industrial
☐ Other, specify

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
6.125	Steel	.219	+2	42
5.125	Steel-Packs	.188	17	142
5"	Open Hole		142	238

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
	NA.			

Status of Well

☑ Water Supply
☐ Replacement Well
☑ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☐ Other, specify

Water Details

Water found at Depth (m/ft)	Gas	Kind of Water	Fresh	Untested	Other, specify
58	☐		☑	☐	Cased off
106	☐		☑	☐	Cased off
206-238	☐		☑	☐	

Hole Diameter

Depth (m/ft) From	Depth (m/ft) To	Diameter (cm/in)
0	42'	9"
42	142	6.18"
142	238	5.0"

Results of Well Yield Testing

After test of well yield, water was:
☑ Clear and sand free
☐ Other, specify

If pumping discontinued, give reason:

Pump intake set at (m/ft): 150

Pumping rate (l/min / GPM): 1-8 / 10

Duration of pumping: 6 hrs + 0 min

Final water level end of pumping (m/ft): 98.55

If flowing give rate (l/min/GPM): —

Recommended pump depth (m/ft): 125

Recommended pump rate (l/min/GPM): 10-15

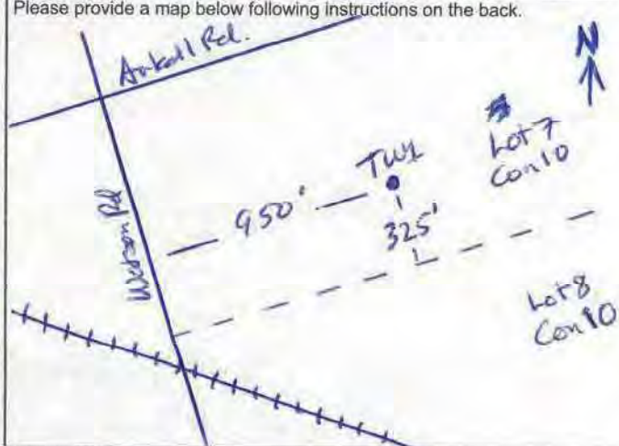
Well production (l/min/GPM): 20

Disinfected? ☑ Yes ☐ No

Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level	81.25		
1	86.2	1	93.7
2	86.2	2	94.3
3	86.25	3	94.15
4	86.4	4	94.0
5	86.6	5	93.9
10	87.15	10	93.4
15	87.6	15	93.0
20	88.1	20	92.6
25	88.45	25	92.3
30	88.8	30	92.0
40	89.5	40	91.55
50	90.2	50	91.1
60	90.7	60	90.7

Map of Well Location

Please provide a map below following instructions on the back.



Comments: Arkell TW1-22

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
SD HOPPER DRILLING	7643

Business Address (Street Number/Name)	Municipality
3014 RD 119	ST MARYS

Province	Postal Code	Business E-mail Address
ON	N4X1C9	info@hopperwells.ca

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
5192717860	HOPPER SHAWN

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
2315	[redacted]	2022/12/05

Well owner's information package delivered	Date Package Delivered	Ministry Use Only
☐ Yes ☑ No	Y Y Y Y M M D D	Audit No. Z400399
	Date Work Completed: 2022/11/25	Received

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Ministry's Copy

Ontario — Ministry of the Environment, Conservation and Parks

Measurements recorded in: ☐ Metric ☑ Imperial

Well Tag No. (Place Sticker and/or Print Below): Tag#:A356358

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 1

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
	1000286480 Ontario Inc.		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
275 Harlen Creek Blvd.	Guelph.	ONT	N1C0A1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Watson Rd.	Puslinch	PT 8	10

County/District/Municipality	City/Town/Village	Province	Postal Code
Wellington	Arkell/Puslinch	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 8 3	17	567754	4820545		

Overburden and Bedrock Materials/Abandonment Sealing Record (see instructions on the back of this form)

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Brown	Sandy Clay			0	2
Brown	Sand Gravel	Silt		2	22
Brown	Sand	Silt		22	24
Grey	Silty Clay	Stones		24	46
T Brown	Limestone			46	93
)K Grey Brn	Limestone			93	142
Grey	Limestone			142	241

Annular Space

Depth Set at (m/ft) From	Depth Set at (m/ft) To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
0	49	Bentonite Slurry Sand.	120 gals

Method of Construction

☐ Cable Tool ☐ Diamond
☑ Rotary (Conventional) ☐ Jetting
☐ Rotary (Reverse) ☐ Driving
☐ Boring ☐ Digging
☐ Air percussion
☐ Other, specify

Well Use

☐ Public ☐ Commercial ☐ Not used
☑ Domestic ☐ Municipal ☐ Dewatering
☐ Livestock ☑ Test Hole ☐ Monitoring
☐ Irrigation ☐ Cooling & Air Conditioning
☐ Industrial
☐ Other, specify

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
6.125	Steel	.219	+2	49
5.125	Steel Packer	.188	25	145
5"	Open Hole		145	241

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
	NA.			

Status of Well

☑ Water Supply
☐ Replacement Well
☑ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☐ Other, specify

Water Details

Water found at Depth (m/ft)	Gas	Kind of Water	Other, specify
210	☐	☑ Fresh ☐ Untested	
225	☐	☑ Fresh ☐ Untested	
	☐	☐ Fresh ☐ Untested	

Hole Diameter

Depth (m/ft) From	Depth (m/ft) To	Diameter (cm/in)
0	49	9"
49	145	6.125"
145	241	5"

Results of Well Yield Testing

After test of well yield, water was:
☑ Clear and sand free
☐ Other, specify

If pumping discontinued, give reason:

Pump intake set at (m/ft): 160'

Pumping rate (l/min / GPM): 1 GPM 10

Duration of pumping: 6 hrs + 0 min

Final water level end of pumping (m/ft): 152'7"

If flowing give rate (l/min/GPM): —

Recommended pump depth (m/ft): 160'

Recommended pump rate (l/min/GPM): 10

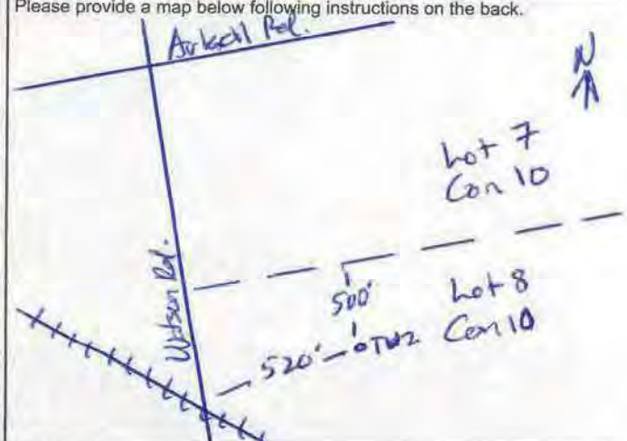
Well production (l/min/GPM): 12

Disinfected? ☑ Yes ☐ No

Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level	72.6		
1	85.2	1	129
2	90	2	115.7
3	93.5	3	108.9
4	96.1	4	103.6
5	97.7	5	99.7
10	102.6	10	91.1
15	104.4	15	89.0
20	105.3	20	87.9
25	105.9	25	87.05
30	106.3	30	86.4
40	106.9	40	85.4
50	107.2	50	83.2
60	107.6	60	82.3

Map of Well Location

Please provide a map below following instructions on the back.



Comments: Arkell TW2-22

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
SD HOPPER DRILLING	7643

Business Address (Street Number/Name)	Municipality
3014 RD 119	ST MARYS

Province	Postal Code	Business E-mail Address
ONT	N4X1C9	info@hopperwells.ca

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
5192717860	HOPPER, SHAWN

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
2315	[redacted]	2022/12/09

Well owner's information package delivered	Date Package Delivered	Date Work Completed
☐ Yes ☑ No		2022/11/25

Ministry Use Only

Audit No. Z400400

Received

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Ministry's Copy

Ontario — Ministry of the Environment, Conservation and Parks

Measurements recorded in: ☐ Metric ☑ Imperial

Well Tag No. (Place Sticker and/or Print Below): Tag#:A356359

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 1

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
	1000286480 Ontario Inc.		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
275 Harlon Creek Blvd	Guelph	ONT	N1C0A1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
WATSON RD	Puslinch	PT 8	Con 10

County/District/Municipality	City/Town/Village	Province	Postal Code
Wellington	Arkell / Puslinch	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	17	567607	4820507		

Overburden and Bedrock Materials/Abandonment Sealing Record (see instructions on the back of this form)

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Brown	Sand Clay	Stones		0	3
Brown	Sand Gravel	Boulders		3	27'
Brown/Grey	Silt Clay	Stones		27	51
LT Brown	Limestone			51	96
DK Grey Brown	Limestone			96	153'
Grey	Limestone			153	261

Annular Space

Depth Set at (m/ft) From	Depth Set at (m/ft) To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
0	53	Bentonite Slurry Sand	120 gals

Method of Construction

☐ Cable Tool ☐ Diamond
☑ Rotary (Conventional) ☐ Jetting
☐ Rotary (Reverse) ☐ Driving
☐ Boring ☐ Digging
☐ Air percussion
☐ Other, specify

Well Use

☐ Public ☐ Commercial ☐ Not used
☑ Domestic ☐ Municipal ☐ Dewatering
☐ Livestock ☑ Test Hole ☐ Monitoring
☐ Irrigation ☐ Cooling & Air Conditioning
☐ Industrial
☐ Other, specify

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
6.125	Steel	.219	+2	53
5.125	Steel Packer	.188	53	155
5"	Open Hole		155	261

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
	NA.			

Status of Well

☑ Water Supply
☐ Replacement Well
☑ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☐ Other, specify

Water Details

Water found at Depth	Kind of Water	
192 (m/ft) ☐ Gas	☑ Fresh ☐ Untested ☐ Other, specify 378 TDS	
231 (m/ft) ☐ Gas	☑ Fresh ☐ Untested ☐ Other, specify	
255 (m/ft) ☐ Gas	☑ Fresh ☐ Untested ☐ Other, specify	

Hole Diameter

Depth (m/ft) From	Depth (m/ft) To	Diameter (cm/in)
0	53	9"
53	155	6.125"
155	261	5.0"

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
SD HOPPER DRILLING	7643

Business Address (Street Number/Name)	Municipality	Province	Postal Code	Business E-mail Address
3014 RD 119	ST MARYS	ONT	N4X1C9	info@hopperwells.ca

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
5192717860	HOPPER, SHAWN

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
2315	[redacted]	2022/12/09

Results of Well Yield Testing

After test of well yield, water was:
☑ Clear and sand free
☐ Other, specify

If pumping discontinued, give reason:

Pump intake set at (m/ft): 150'

Pumping rate (l/min / GPM): 1 gpm — 10

Duration of pumping: 6 hrs + 0 min

Final water level end of pumping (m/ft): 79.1

If flowing give rate (l/min/GPM): —

Recommended pump depth (m/ft): 100'

Recommended pump rate (l/min/GPM): 15

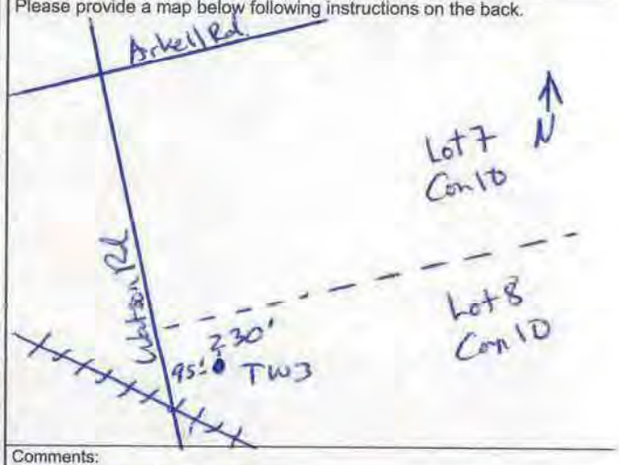
Well production (l/min/GPM): 20

Disinfected? ☑ Yes ☐ No

Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level	52.3		
1	59.8	1	60.6
2	61.5	2	56.3
3	65.0	3	56.0
4	70.1	4	55.7
5	73.4	5	55.3
10	85.8	10	54.2
15	90.5	15	53.2
20	92.4	20	52.9
25	93.5	25	52.8
30	94.2	30	52.7
40	94.9	40	52.6
50	94.8	50	52.6
60	94.9	60	52.6

Map of Well Location

Please provide a map below following instructions on the back.



Comments: Arkell TW3

Well owner's information package delivered	Date Package Delivered	Ministry Use Only
☐ Yes ☑ No		Audit No. Z400401
	Date Work Completed: 2022/11/25	Received

APPENDIX C

LAB REPORTS ON WATER QUALITY TESTING AT THE TEST WELLS (2022)

CASH CLIENTS - WATERLOO
ATTN: Scott Stovel
651 Orangeville Road
Fergus ON N1M 1T9

Date Received: 21-NOV-22
Report Date: 09-DEC-22 08:11 (MT)
Version: FINAL

Client Phone: 228-820-0343

Certificate of Analysis

Lab Work Order #: L2741043
Project P.O. #: NOT SUBMITTED
Job Reference: ARKELL PROPERTY
C of C Numbers:
Legal Site Desc:

Candice Hunter
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ARKELL PROPERTY

Sample Details Grouping / Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	Guideline Limits #2
L2741043-1 TW 1							
Sampled By: SS on 21-NOV-22 @ 14:15							
Matrix: WATER							
Physical Tests							
Color, True	3.6		2.0	T.C.U.	02-DEC-22		
Hardness (as CaCO3)	365	HTC	2.4	mg/L	25-NOV-22		*80-100
pH	8.23		0.10	pH units	25-NOV-22		6.5-8.5
Total Dissolved Solids	446	DLDS	20	mg/L	24-NOV-22		500
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	226		10	mg/L	25-NOV-22		30-500
Ammonia, Total (as N)	0.174		0.010	mg/L	25-NOV-22		
Chloride (Cl)	31.0		0.50	mg/L	25-NOV-22		250
Fluoride (F)	0.89		0.10	mg/L	25-NOV-22	1.5	
Nitrate (as N)	<0.020		0.020	mg/L	25-NOV-22	10	
Nitrite (as N)	<0.010		0.010	mg/L	25-NOV-22	1	
Total Kjeldahl Nitrogen	0.252		0.050	mg/L	25-NOV-22		
Total Organic Nitrogen	0.078		0.050	mg/L	06-DEC-22		
Phosphorus, Total	0.0066		0.0030	mg/L	25-NOV-22		
Sulfate (SO4)	107		0.30	mg/L	25-NOV-22		500
Sulphide (as S)	0.182		0.018	mg/L	24-NOV-22		*0.05
Cyanides							
Cyanide, Free	<2.0		2.0	ug/L	25-NOV-22	200	
Organic / Inorganic Carbon							
Dissolved Carbon Filtration Location	LAB			No Unit	23-NOV-22		
Dissolved Organic Carbon	<0.50		0.50	mg/L	28-NOV-22		5
Bacteriological Tests							
Escherichia Coli	0		0	MPN/100mL	23-NOV-22	0	
Heterotrophic Plate Count	58		0	CFU/mL	23-NOV-22		
Total Coliforms	0		0	MPN/100mL	23-NOV-22	0	
Total Metals							
Antimony (Sb)	5.50		0.60	ug/L	25-NOV-22	6	
Arsenic (As)	6.1		1.0	ug/L	25-NOV-22	10.0	
Barium (Ba)	32		10	ug/L	25-NOV-22	1000	
Boron (B)	<50		50	ug/L	25-NOV-22	5000	
Cadmium (Cd)	<0.10		0.10	ug/L	25-NOV-22	5	
Calcium (Ca)	88.9		0.50	mg/L	25-NOV-22		
Chromium (Cr)	1.0		1.0	ug/L	25-NOV-22	50	
Magnesium (Mg)	34.7		0.50	mg/L	25-NOV-22		
Selenium (Se)	<5.0		5.0	ug/L	25-NOV-22	50	
Uranium (U)	<5.0		5.0	ug/L	25-NOV-22	20	
Volatile Organic Compounds							
Benzene	<0.50		0.50	ug/L	24-NOV-22	1	
Carbon tetrachloride	<0.20		0.20	ug/L	24-NOV-22	2	
Monochlorobenzene	<0.50		0.50	ug/L	24-NOV-22	80	30
1,2-Dichlorobenzene	<0.50		0.50	ug/L	24-NOV-22	200	3
1,4-Dichlorobenzene	<0.50		0.50	ug/L	24-NOV-22	5	1
1,2-Dichloroethane	<0.50		0.50	ug/L	24-NOV-22	5	
1,1-dichloroethylene (vinylidene chlorid	<0.50		0.50	ug/L	24-NOV-22	14	

** Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
* Analytical result for this parameter exceeds Guideline Limit listed on this report. Guideline Limits applied:

Ontario Drinking Water Regulation (ODWQS) JAN.1,2020 = [Suite] - ON-DW-STANDARD+GUIDELINES

#1: Schedule 1 (Microbiological) and 2 (Chemical) Standards (JAN,2020) **#2: Ontario DW Aesthetic and Operational Guidelines (June, 2006)**

ARKELL PROPERTY

Sample Details Grouping / Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	#2
L2741043-1 TW 1							
Sampled By: SS on 21-NOV-22 @ 14:15							
Matrix: WATER							
Volatile Organic Compounds							
Dichloromethane	<5.0		5.0	ug/L	24-NOV-22	50	
Ethylbenzene	<0.50		0.50	ug/L	24-NOV-22	140	2.4
Tetrachloroethylene (perchloroethylene)	<0.50		0.50	ug/L	24-NOV-22	10	
Toluene	<0.50		0.50	ug/L	24-NOV-22	60	24
Trichloroethylene	<0.50		0.50	ug/L	24-NOV-22	5	
Vinyl chloride	<0.20		0.20	ug/L	24-NOV-22	1	
o-xylene	<0.50		0.50	ug/L	24-NOV-22		
m/p-xylene	<1.0		1.0	ug/L	24-NOV-22		
Xylenes (Total)	<1.5		1.5	ug/L	24-NOV-22	90	300
Surrogate: 4-Bromofluorobenzene	89.7		70-130	%	24-NOV-22		
Surrogate: 1,4-Difluorobenzene	97.9		70-130	%	24-NOV-22		
Polycyclic Aromatic Hydrocarbons							
Benzo(a)pyrene	<0.0050		0.0050	ug/L	24-NOV-22	0.01	
Surrogate: Chrysene d12	84.3		50-150	%	24-NOV-22		
Semi-Volatile Organics							
Aldrin + Dieldrin	<0.14		0.14	ug/L	22-NOV-22	0.7	
N-Nitrosodimethylamine	<0.00090	SRU	0.00090	ug/L	08-DEC-22	0.009	
Surrogate: N-Nitrosodimethylamine-d6	105.0		50-150	%	08-DEC-22		
Organochlorine Pesticides							
a-chlordane	<0.10		0.10	ug/L	02-DEC-22		
g-chlordane	<0.10		0.10	ug/L	02-DEC-22		
pp-DDD	<0.10		0.10	ug/L	02-DEC-22		
pp-DDE	<0.10		0.10	ug/L	02-DEC-22		
op-DDT	<0.10		0.10	ug/L	02-DEC-22		
pp-DDT	<0.10		0.10	ug/L	02-DEC-22		
Oxychlordane	<0.10		0.10	ug/L	02-DEC-22		
Surrogate: Decachlorobiphenyl	116.8		50-150	%	02-DEC-22		
Surrogate: Tetrachloro-m-xylene	117.1		50-150	%	02-DEC-22		
Herbicides							
AMPA	<0.50		0.50	ug/L	02-DEC-22		
Bromoxynil	<0.20		0.20	ug/L	24-NOV-22	5	
2,4-D	<0.20		0.20	ug/L	24-NOV-22	100	
Dicamba	<0.20		0.20	ug/L	24-NOV-22	120	
Dinoseb	<0.20		0.20	ug/L	24-NOV-22	10	
Glyphosate	<5.0		5.0	ug/L	02-DEC-22	280	
MCPA	<0.20		0.20	ug/L	24-NOV-22	100	
Picloram	<0.20		0.20	ug/L	24-NOV-22	190	
2,4,5-TP	<0.20		0.20	ug/L	24-NOV-22		
Surrogate: 2,4-Dichlorophenylacetic Acid	112.0		50-130	%	24-NOV-22		
Carbamate Pesticides							
Aldicarb	<0.90		0.90	ug/L	28-NOV-22	9	
Pesticides							
Alachlor	<0.10		0.10	ug/L	01-DEC-22	5	
Atrazine	<0.10		0.10	ug/L	01-DEC-22		
Atrazine & Metabolites	<0.20		0.20	ug/L	01-DEC-22	5	
Azinphos-methyl	<0.10		0.10	ug/L	01-DEC-22	20	

** Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
* Analytical result for this parameter exceeds Guideline Limit listed on this report. Guideline Limits applied:

Ontario Drinking Water Regulation (ODWQS) JAN.1,2020 = [Suite] - ON-DW-STANDARD+GUIDELINES

#1: Schedule 1 (Microbiological) and 2 (Chemical) Standards (JAN,2020) **#2: Ontario DW Aesthetic and Operational Guidelines (June, 2006)**

ARKELL PROPERTY

Sample Details Grouping / Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	#2		
L2741043-1 TW 1									
Sampled By: SS on 21-NOV-22 @ 14:15									
Matrix: WATER									
Pesticides									
Carbaryl	<0.20		0.20	ug/L	01-DEC-22	90			
Carbofuran	<0.20		0.20	ug/L	01-DEC-22	90			
Chlorpyriphos	<0.10		0.10	ug/L	01-DEC-22	90			
Diazinon	<0.10		0.10	ug/L	01-DEC-22	20			
2,4-Dichlorophenol	<0.30		0.30	ug/L	01-DEC-22	900	0.3		
Dimethoate	<0.10		0.10	ug/L	01-DEC-22	20			
Diquat	<1.0		1.0	ug/L	25-NOV-22	70			
Diuron	<1.0		1.0	ug/L	28-NOV-22	150			
Atrazine-desethyl	<0.10		0.10	ug/L	01-DEC-22				
Malathion	<0.10		0.10	ug/L	01-DEC-22	190			
Diclofop-methyl	<0.20		0.20	ug/L	01-DEC-22	9			
Metolachlor	<0.10		0.10	ug/L	01-DEC-22	50			
Metribuzin	<0.10		0.10	ug/L	01-DEC-22	80			
Paraquat	<1.0		1.0	ug/L	25-NOV-22	10			
Pentachlorophenol	<0.50		0.50	ug/L	01-DEC-22	60	30		
Phorate	<0.10		0.10	ug/L	01-DEC-22	2			
Prometryne	<0.10		0.10	ug/L	01-DEC-22	1			
Simazine	<0.10		0.10	ug/L	01-DEC-22	10			
Terbufos	<0.20		0.20	ug/L	01-DEC-22	1			
2,3,4,6-Tetrachlorophenol	<0.50		0.50	ug/L	01-DEC-22	100	1		
Triallate	<0.10		0.10	ug/L	01-DEC-22	230			
2,4,6-Trichlorophenol	<0.50		0.50	ug/L	01-DEC-22	5	2		
Trifluralin	<0.10		0.10	ug/L	01-DEC-22	45			
Surrogate: 2-Fluorobiphenyl	87.7		40-130	%	01-DEC-22				
Surrogate: 2,4,6-Tribromophenol	83.6		40-150	%	01-DEC-22				

** Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
* Analytical result for this parameter exceeds Guideline Limit listed on this report. Guideline Limits applied:

Ontario Drinking Water Regulation (ODWQS) JAN.1,2020 = [Suite] - ON-DW-STANDARD+GUIDELINES

#1: Schedule 1 (Microbiological) and 2 (Chemical) Standards (JAN,2020) **#2: Ontario DW Aesthetic and Operational Guidelines (June, 2006)**

Reference Information

Sample Parameter Qualifier key listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
SRU	Sample Received Unpreserved. Results may be biased low for indicated parameter(s)

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference***
ACIDS-ONT-DW-WT	Water	O.Reg 170/03 Acids	SW846 8270
Pesticides are extracted from an aqueous sample using separate aliquots of solvent, extracts are concentrated down to a certain volume and analyzed on the GC/MSD.			
ALD+DIEL-CALC-WT	Water	Aldrin + Dieldrin Calculation	CALCULATION
This calculation represents the sum of the aldrin and dieldrin analyzed for in a given sample.			
ALDICARB-DW-LCMS-WT	Water	Aldicarb in Drinking Water	E3501
An aliquot of water sample is diluted 1:1 using acetonitrile and analyzed using LC/MS/MS			
ALK-ONT-DW-WT	Water	Alkalinity, Total (as CaCO3)	EPA 310.2
BAP-ONT-DW-WT	Water	Benzo(a)pyrene in Drinking Water	SW 846 8270
CL-IC-N-ONT-DW-WT	Water	Chloride by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CN-FREE-ONT-DW-WT	Water	Free Cyanide in Drinking Water by CFA	ASTM 7237
This analysis is carried out using procedures adapted from ASTM Method 7237 "Free Cyanide with Flow Injection Analysis (FIA) Utilizing Gas Diffusion Separation and Amperometric Detection". Free cyanide is determined by in-line gas diffusion at pH 6 with final determination by colourimetric analysis.			
COLOUR-ONT-DW-WT	Water	Colour, True Drinking Water	APHA 2120C
True Colour is measured spectrophotometrically by comparison to platinum-cobalt standards using the single wavelength method . Colour measurements can be highly pH dependent, and apply to the pH of the sample as received (at time of testing), without pH adjustment. Concurrent measurement of sample pH is recommended.			
DIQUAT-DW-LCMS-WT	Water	Diquat in Water by LC/MS-MS	E3503
An aliquot of the sample is taken and internal standard is added. The sample is analyzed by LC/MS/MS.			
DIURON-DW-LCMS-WT	Water	Diuron in Drinking Water	E3501
An aliquot of water sample is diluted 1:1 using acetonitrile and analyzed using LC/MS/MS			
DOC-ONT-DW-WT	Water	Dissolved Organic Carbon	APHA 5310B
Sample is filtered through a 0.45um filter, then injected into a heated reaction chamber which is packed with an oxidative catalyst. The water is vaporized and the organic carbon is oxidized to carbon dioxide. The carbon dioxide is transported in a carrier gas and is measured by a non-dispersive infrared detector.			
EC-SCREEN-WT	Water	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-DW-IC-WT	Water	Fluoride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
GLYPHOSATE-ONT-DW-WT	Water	Glyphosate in Drinking Water	MOE E3500
This analysis is carried out using procedures adapted from ON MOE E3500 "Glyphosate". Glyphosate is determined by direct injection by LC-MS/MS on a sample that bas been derivatized.			
HARDNESS-CALC-WT	Water	Hardness	APHA 2340 B
Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.			
HPC-DW-MF-WT	Water	Heterotrophic Plate Count	SM 9215D
A 1mL volume of sample is filtered through a membrane, the membrane is placed on mHPC agar and incubated for 48–2h@35–0.5 C. Method ID: WT-TM-1200			
MET-ONT-DW-WT	Water	Drinking Water Metals	EPA 6020A
MISC-ONT-DW-WT	Water	O.Reg 170/03 Miscellaneous Pesticides	SW846 8270
Pesticides are extracted from an aqueous sample using separate aliquots of solvent, extracts are concentrated down to a certain volume and analyzed on the GC/MSD.			

Reference Information

N-T-ORG-CALC-WT	Water	Total Organic Nitrogen (Calculation)	APHA 4500-NORG (TKN)/NH3-NITROGEN (NH3)

Total Organic Nitrogen is a calculated parameter. Total Organic Nitrogen = Total Kjeldahl Nitrogen - Ammonia.

NDMA-DW-LCMS-WT	Water	NDMA to meet Ont Reg 170/03	QWI-ORG/WP239

An aliquot of sample is solid phase extracted followed by liquid chromatography tandem mass spectrometry instead of direct injection.

NH3-F-WT	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-DW-IC-WT	Water	Nitrite in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-DW-IC-WT	Water	Nitrate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

OCPEST-ONT-DW-WT	Water	O.Reg 170/03 OC Pesticides	SW846 8270

Pesticides are extracted from an aqueous sample using separate aliquots of solvent, extracts are concentrated and analyzed on the GC/MSD.

P-T-COL-DW-WT	Water	Total P in Water by Colour	APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is deteremined colourimetrically after persulphate digestion of the sample.

PAHERB-ONT-DW-WT	Water	O.Reg 170/03 PA Herbicides	MOE E3552

Water samples are analyzed by direct injection without sample preparation using liquid chromatography tandem mass spectrometry (LC-MS/MS).

PARAQUAT-ONT-DW-WT	Water	Paraquat in Water by LC/MS-MS	E3503

An aliquot of the sample is taken and internal standard is added. The sample is analyzed by LC/MS/MS.

PH-ONT-DW-WT	Water	pH	APHA 4500 H-Electrode

Water samples are analyzed directly by a calibrated pH meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011). Holdtime for samples under this regulation is 28 days

SO4-IC-N-ONT-DW-WT	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

SOLIDS-TDS-ONT-DW-WT	Water	Total Dissolved Solids	APHA 2540C

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

SULPHIDE-ONT-DW-WT	Water	Sulphide (as S)	APHA 4500S2D

This analysis is carried out using procedures adapted from APHA Method 4500-S2-D "Methylene Blue Method". Sulphide is determined colourmetrically.

TC,EC-QT51-DW-WT	Water	Total Coliform and E. Coli	APHA 9223B

This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture of hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is obtained by comparing the positive responses to a probability table.

TKN-F-WT	Water	TKN in Water by Fluorescence	J. ENVIRON. MONIT., 2005,7,37-42,RSC

Total Kjeldahl Nitrogen is determined using block digestion followed by Flow-injection analysis with fluorescence detection

TURB-MET-WT	Water	Turbidity on preserved metals sample	APHA 2130 B

Sample result is based on a comparison of the intensity of the light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. Sample readings are obtained from a Nephelometer.

VOC-ONT-DW-WT	Water	Volatile Organics (O.Reg 170/03)	SW846 8260

Liquid samples are analyzed by headspace GC/MSD.

*** ALS test methods may incorporate modifications from specified reference methods to improve performance.

Reference Information

Chain of Custody numbers:

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location	Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA		

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, fitness for a particular purpose, or non-infringement. ALS assumes no responsibility for errors or omissions in the information. Guideline limits are not adjusted for the hardness, pH or temperature of the sample (the most conservative values are used). Measurement uncertainty is not applied to test results prior to comparison with specified criteria values.

Quality Control Report

Workorder: L2741043 Report Date: 09-DEC-22

Client: CASH CLIENTS - WATERLOO
651 Orangeville Road
Fergus ON N1M 1T9
Contact: Scott Stovel

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ACIDS-ONT-DW-WT	Water							
Batch R5900444								
WG3774472-2 LCS								
2,4-Dichlorophenol			96.7		%		50-140	01-DEC-22
2,4,6-Trichlorophenol			98.7		%		50-140	01-DEC-22
2,3,4,6-Tetrachlorophenol			101.0		%		50-140	01-DEC-22
Pentachlorophenol			134.1	LCS-H	%		60-130	01-DEC-22
WG3774472-1 MB								
2,4-Dichlorophenol			<0.30		ug/L		0.3	01-DEC-22
2,4,6-Trichlorophenol			<0.50		ug/L		0.5	01-DEC-22
2,3,4,6-Tetrachlorophenol			<0.50		ug/L		0.5	01-DEC-22
Pentachlorophenol			<0.50		ug/L		0.5	01-DEC-22
Surrogate: 2,4,6-Tribromophenol			81.6		%		40-150	01-DEC-22
ALDICARB-DW-LCMS-WT	Water							
Batch R5899018								
WG3774232-3 DUP		**WG3774232-5**						
Aldicarb		<0.90	<0.90	RPD-NA	ug/L	N/A	30	28-NOV-22
WG3774232-2 LCS								
Aldicarb			99.1		%		80-120	28-NOV-22
WG3774232-1 MB								
Aldicarb			<0.90		ug/L		0.9	28-NOV-22
WG3774232-4 MS		**WG3774232-5**						
Aldicarb			104.9		%		70-130	28-NOV-22
ALK-ONT-DW-WT	Water							
Batch R5898200								
WG3774169-4 DUP		**WG3774169-3**						
Alkalinity, Total (as CaCO3)		265	272		mg/L	2.4	20	25-NOV-22
WG3774169-2 LCS								
Alkalinity, Total (as CaCO3)			99.2		%		85-115	25-NOV-22
WG3774169-1 MB								
Alkalinity, Total (as CaCO3)			<10		mg/L		10	25-NOV-22
BAP-ONT-DW-WT	Water							
Batch R5897128								
WG3773751-2 LCS								
Benzo(a)pyrene			90.1		%		60-130	24-NOV-22
WG3773751-1 MB								
Benzo(a)pyrene			<0.0050		ug/L		0.005	24-NOV-22
Surrogate: Chrysene d12			78.6		%		50-150	24-NOV-22

Quality Control Report

Client: CASH CLIENTS - WATERLOO
651 Orangeville Road
Fergus ON N1M 1T9
Contact: Scott Stovel

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-IC-N-ONT-DW-WT	Water							
Batch R5898242								
WG3774247-4 DUP		**WG3774247-3**						
Chloride (Cl)		36.6	36.0		mg/L	1.7	25	25-NOV-22
WG3774247-2 LCS								
Chloride (Cl)			103.0		%		70-130	25-NOV-22
WG3774247-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	25-NOV-22
WG3774247-5 MS		**WG3774247-3**						
Chloride (Cl)			100.2		%		70-130	25-NOV-22
CN-FREE-ONT-DW-WT	Water							
Batch R5898480								
WG3774197-9 DUP		**WG3774197-8**						
Cyanide, Free		<2.0	<2.0	RPD-NA	ug/L	N/A	20	25-NOV-22
WG3774197-7 LCS								
Cyanide, Free			96.2		%		80-120	25-NOV-22
WG3774197-6 MB								
Cyanide, Free			<2.0		ug/L		2	25-NOV-22
WG3774197-10 MS		**WG3774197-8**						
Cyanide, Free			107.7		%		75-125	25-NOV-22
COLOUR-ONT-DW-WT	Water							
Batch R5901356								
WG3774984-3 DUP		**L2741043-1**						
Color, True		3.6	4.6	J	T.C.U.	1.0	4	02-DEC-22
WG3774984-2 LCS								
Color, True			112.7		%		70-130	02-DEC-22
WG3774984-1 MB								
Color, True			<2.0		T.C.U.		2	02-DEC-22
DIQUAT-DW-LCMS-WT	Water							
Batch R5898376								
WG3773951-3 DUP		**WG3773951-5**						
Diquat		<1.0	<1.0	RPD-NA	ug/L	N/A	30	25-NOV-22
WG3773951-2 LCS								
Diquat			99.7		%		70-130	25-NOV-22
WG3773951-1 MB								
Diquat			<1.0		ug/L		1	25-NOV-22
WG3773951-4 MS		**WG3773951-5**						
Diquat			107.0		%		70-130	25-NOV-22
DIURON-DW-LCMS-WT	Water							

Quality Control Report

Client: CASH CLIENTS - WATERLOO
651 Orangeville Road
Fergus ON N1M 1T9
Contact: Scott Stovel

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
DIURON-DW-LCMS-WT	Water							
Batch R5899018								
WG3774232-3 DUP		**WG3774232-5**						
Diuron		<1.0	<1.0	RPD-NA	ug/L	N/A	30	28-NOV-22
WG3774232-2 LCS								
Diuron			94.7		%		50-140	28-NOV-22
WG3774232-1 MB								
Diuron			<1.0		ug/L		1	28-NOV-22
WG3774232-4 MS		**WG3774232-5**						
Diuron			88.3		%		50-150	28-NOV-22
DOC-ONT-DW-WT	Water							
Batch R5899038								
WG3773872-3 DUP		**WG3773872-5**						
Dissolved Organic Carbon		6.68	6.96		mg/L	4.2	20	28-NOV-22
WG3773872-2 LCS								
Dissolved Organic Carbon			94.8		%		80-120	28-NOV-22
WG3773872-1 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	28-NOV-22
WG3773872-4 MS		**WG3773872-5**						
Dissolved Organic Carbon			N/A	MS-B	%		-	28-NOV-22
F-DW-IC-WT	Water							
Batch R5898242								
WG3774247-4 DUP		**WG3774247-3**						
Fluoride (F)		<0.10	<0.10	RPD-NA	mg/L	N/A	20	25-NOV-22
WG3774247-2 LCS								
Fluoride (F)			103.9		%		90-110	25-NOV-22
WG3774247-1 MB								
Fluoride (F)			<0.10		mg/L		0.1	25-NOV-22
WG3774247-5 MS		**WG3774247-3**						
Fluoride (F)			100.2		%		75-125	25-NOV-22
GLYPHOSATE-ONT-DW-WT	Water							
Batch R5901678								
WG3774664-3 DUP		**L2740735-1**						
Glyphosate		<5.0	<5.0	RPD-NA	ug/L	N/A	30	02-DEC-22
AMPA		<0.50	<0.50	RPD-NA	ug/L	N/A	40	02-DEC-22
WG3774664-2 LCS								
Glyphosate			96.2		%		70-130	02-DEC-22
AMPA			90.6		%		70-130	02-DEC-22
WG3774664-1 MB								

Quality Control Report

Client: CASH CLIENTS - WATERLOO
651 Orangeville Road
Fergus ON N1M 1T9
Contact: Scott Stovel

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
GLYPHOSATE-ONT-DW-WT	Water							
Batch R5901678								
WG3774664-1 MB								
Glyphosate			<5.0		ug/L		5	02-DEC-22
AMPA			<0.50		ug/L		0.5	02-DEC-22
WG3774664-4 MS		**L2740735-1**						
Glyphosate			98.2		%		70-130	02-DEC-22
AMPA			88.7		%		70-130	02-DEC-22
HPC-DW-MF-WT	Water							
Batch R5897656								
WG3773789-3 DUP		**L2741043-1**						
Heterotrophic Plate Count		58	51		CFU/mL	13	65	23-NOV-22
WG3773789-1 MB								
Heterotrophic Plate Count			0		CFU/mL		1	23-NOV-22
WG3773789-2 MB								
Heterotrophic Plate Count			0		CFU/mL		1	23-NOV-22
MET-ONT-DW-WT	Water							
Batch R5897578								
WG3774106-4 DUP		**WG3774106-3**						
Antimony (Sb)		5.50	5.57		ug/L	1.3	25	25-NOV-22
Arsenic (As)		6.1	5.9		ug/L	2.9	25	25-NOV-22
Barium (Ba)		32	32		ug/L	0.2	25	25-NOV-22
Boron (B)		<50	<50	RPD-NA	ug/L	N/A	25	25-NOV-22
Cadmium (Cd)		<0.10	<0.10	RPD-NA	ug/L	N/A	25	25-NOV-22
Calcium (Ca)		88.9	89.0		mg/L	0.2	25	25-NOV-22
Chromium (Cr)		1.0	1.2		ug/L	15	25	25-NOV-22
Magnesium (Mg)		34.7	34.6		mg/L	0.3	25	25-NOV-22
Selenium (Se)		1.1	1.2		ug/L	5.6	25	25-NOV-22
Uranium (U)		<2.0	<2.0	RPD-NA	ug/L	N/A	25	25-NOV-22
WG3774106-2 LCS								
Antimony (Sb)			99.4		%		70-130	25-NOV-22
Arsenic (As)			105.8		%		70-130	25-NOV-22
Barium (Ba)			104.3		%		70-130	25-NOV-22
Boron (B)			98.4		%		70-130	25-NOV-22
Cadmium (Cd)			104.4		%		70-130	25-NOV-22
Calcium (Ca)			104.6		%		70-130	25-NOV-22
Chromium (Cr)			102.6		%		70-130	25-NOV-22

Quality Control Report

Client: CASH CLIENTS - WATERLOO
651 Orangeville Road
Fergus ON N1M 1T9
Contact: Scott Stovel

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-ONT-DW-WT	Water							
Batch R5897578								
WG3774106-2 LCS								
Magnesium (Mg)			107.6		%		70-130	25-NOV-22
Selenium (Se)			103.1		%		70-130	25-NOV-22
Uranium (U)			105.7		%		70-130	25-NOV-22
WG3774106-1 MB								
Antimony (Sb)			<0.60		ug/L		0.6	25-NOV-22
Arsenic (As)			<1.0		ug/L		1	25-NOV-22
Barium (Ba)			<10		ug/L		10	25-NOV-22
Boron (B)			<50		ug/L		50	25-NOV-22
Cadmium (Cd)			<0.10		ug/L		0.1	25-NOV-22
Calcium (Ca)			<0.50		mg/L		0.5	25-NOV-22
Chromium (Cr)			<1.0		ug/L		1	25-NOV-22
Magnesium (Mg)			<0.50		mg/L		0.5	25-NOV-22
Selenium (Se)			<1.0		ug/L		1	25-NOV-22
Uranium (U)			<2.0		ug/L		2	25-NOV-22
WG3774106-5 MS		**WG3774106-3**						
Antimony (Sb)			98.6		%		70-130	25-NOV-22
Arsenic (As)			110.0		%		70-130	25-NOV-22
Barium (Ba)			N/A	MS-B	%		-	25-NOV-22
Boron (B)			95.1		%		70-130	25-NOV-22
Cadmium (Cd)			103.3		%		70-130	25-NOV-22
Calcium (Ca)			N/A	MS-B	%		-	25-NOV-22
Chromium (Cr)			99.7		%		70-130	25-NOV-22
Magnesium (Mg)			N/A	MS-B	%		-	25-NOV-22
Selenium (Se)			110.8		%		70-130	25-NOV-22
Uranium (U)			N/A	MS-B	%		-	25-NOV-22
MISC-ONT-DW-WT	Water							
Batch R5900417								
WG3774712-2 LCS								
Alachlor			102.5		%		60-130	01-DEC-22
Atrazine			105.1		%		60-130	01-DEC-22
Atrazine-desethyl			61.1		%		50-130	01-DEC-22
Azinphos-methyl			122.4		%		60-140	01-DEC-22
Carbaryl			155.4	LCS-H	%		50-140	01-DEC-22
Carbofuran			120.5		%		60-140	01-DEC-22

Quality Control Report

Client: CASH CLIENTS - WATERLOO
651 Orangeville Road
Fergus ON N1M 1T9
Contact: Scott Stovel

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MISC-ONT-DW-WT	Water							
Batch R5900417								
WG3774712-2 LCS								
Chlorpyriphos			100.0		%		60-130	01-DEC-22
Diazinon			87.3		%		60-130	01-DEC-22
Diclofop-methyl			103.9		%		60-140	01-DEC-22
Dimethoate			121.4		%		60-130	01-DEC-22
Malathion			99.6		%		60-130	01-DEC-22
Metribuzin			116.6		%		60-130	01-DEC-22
Metolachlor			107.2		%		60-130	01-DEC-22
Phorate			89.8		%		30-140	01-DEC-22
Prometryne			96.5		%		60-130	01-DEC-22
Simazine			93.9		%		60-130	01-DEC-22
Terbufos			86.1		%		60-130	01-DEC-22
Triallate			92.5		%		60-130	01-DEC-22
Trifluralin			95.2		%		60-130	01-DEC-22
WG3774712-1 MB								
Alachlor			<0.10		ug/L		0.1	01-DEC-22
Atrazine			<0.10		ug/L		0.1	01-DEC-22
Atrazine-desethyl			<0.10		ug/L		0.1	01-DEC-22
Azinphos-methyl			<0.10		ug/L		0.1	01-DEC-22
Carbaryl			<0.20		ug/L		0.2	01-DEC-22
Carbofuran			<0.20		ug/L		0.2	01-DEC-22
Chlorpyriphos			<0.10		ug/L		0.1	01-DEC-22
Diazinon			<0.10		ug/L		0.1	01-DEC-22
Diclofop-methyl			<0.20		ug/L		0.2	01-DEC-22
Dimethoate			<0.10		ug/L		0.1	01-DEC-22
Malathion			<0.10		ug/L		0.1	01-DEC-22
Metribuzin			<0.10		ug/L		0.1	01-DEC-22
Metolachlor			<0.10		ug/L		0.1	01-DEC-22
Phorate			<0.10		ug/L		0.1	01-DEC-22
Prometryne			<0.10		ug/L		0.1	01-DEC-22
Simazine			<0.10		ug/L		0.1	01-DEC-22
Terbufos			<0.20		ug/L		0.2	01-DEC-22
Triallate			<0.10		ug/L		0.1	01-DEC-22
Trifluralin			<0.10		ug/L		0.1	01-DEC-22
Surrogate: 2-Fluorobiphenyl			91.2		%		40-130	01-DEC-22

Quality Control Report

Client: CASH CLIENTS - WATERLOO
651 Orangeville Road
Fergus ON N1M 1T9
Contact: Scott Stovel

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NDMA-DW-LCMS-WT	Water							
Batch R5903600								
WG3774768-4 DUP		**WG3774768-5**						
N-Nitrosodimethylamine		<0.00090	<0.00090	RPD-NA	ug/L	N/A	30	08-DEC-22
WG3774768-2 LCS								
N-Nitrosodimethylamine			104.2		%		50-150	08-DEC-22
WG3774768-1 MB								
N-Nitrosodimethylamine			<0.00090		ug/L		0.0009	08-DEC-22
Surrogate: N-Nitrosodimethylamine-d6			106.0		%		50-150	08-DEC-22
WG3774768-3 MS		**WG3774768-6**						
N-Nitrosodimethylamine			104.4		%		50-150	08-DEC-22
NH3-F-WT	Water							
Batch R5898259								
WG3774065-3 DUP		**WG3774065-5**						
Ammonia, Total (as N)		0.646	0.635		mg/L	1.7	20	28-NOV-22
WG3774065-2 LCS								
Ammonia, Total (as N)			97.2		%		85-115	25-NOV-22
WG3774065-1 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	25-NOV-22
WG3774065-4 MS		**WG3774065-5**						
Ammonia, Total (as N)			N/A	MS-B	%		-	28-NOV-22
NO2-DW-IC-WT	Water							
Batch R5898242								
WG3774247-4 DUP		**WG3774247-3**						
Nitrite (as N)		<0.010	<0.010	RPD-NA	mg/L	N/A	20	25-NOV-22
WG3774247-2 LCS								
Nitrite (as N)			104.3		%		90-110	25-NOV-22
WG3774247-1 MB								
Nitrite (as N)			<0.010		mg/L		0.01	25-NOV-22
WG3774247-5 MS		**WG3774247-3**						
Nitrite (as N)			100.6		%		75-125	25-NOV-22
NO3-DW-IC-WT	Water							
Batch R5898242								
WG3774247-4 DUP		**WG3774247-3**						
Nitrate (as N)		6.59	6.48		mg/L	1.7	20	25-NOV-22
WG3774247-2 LCS								
Nitrate (as N)			102.0		%		90-110	25-NOV-22
WG3774247-1 MB								
Nitrate (as N)			<0.020		mg/L		0.02	25-NOV-22

Quality Control Report

Client: CASH CLIENTS - WATERLOO
651 Orangeville Road
Fergus ON N1M 1T9
Contact: Scott Stovel

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-DW-IC-WT	Water							
Batch R5898242								
WG3774247-5 MS		**WG3774247-3**						
Nitrate (as N)			N/A	MS-B	%		-	25-NOV-22
OCPEST-ONT-DW-WT	Water							
Batch R5901077								
WG3773941-2 LCS								
a-chlordane			117.2		%		50-150	02-DEC-22
g-chlordane			117.0		%		50-150	02-DEC-22
pp-DDD			123.6		%		50-150	02-DEC-22
pp-DDE			98.4		%		50-150	02-DEC-22
op-DDT			101.7		%		50-150	02-DEC-22
pp-DDT			110.3		%		50-150	02-DEC-22
Oxychlordane			77.7		%		50-150	02-DEC-22
WG3773941-1 MB								
a-chlordane			<0.10		ug/L		0.1	02-DEC-22
g-chlordane			<0.10		ug/L		0.1	02-DEC-22
pp-DDD			<0.10		ug/L		0.1	02-DEC-22
pp-DDE			<0.10		ug/L		0.1	02-DEC-22
op-DDT			<0.10		ug/L		0.1	02-DEC-22
pp-DDT			<0.10		ug/L		0.1	02-DEC-22
Oxychlordane			<0.10		ug/L		0.1	02-DEC-22
Surrogate: Decachlorobiphenyl			93.4		%		50-150	02-DEC-22
Surrogate: Tetrachloro-m-xylene			83.7		%		50-150	02-DEC-22
P-T-COL-DW-WT	Water							
Batch R5898156								
WG3774063-3 DUP		**L2741043-1**						
Phosphorus, Total		0.0066	0.0048	J	mg/L	0.0018	0.006	25-NOV-22
WG3774063-2 LCS								
Phosphorus, Total			101.9		%		80-120	25-NOV-22
WG3774063-1 MB								
Phosphorus, Total			<0.0030		mg/L		0.003	25-NOV-22
WG3774063-4 MS		**L2741043-1**						
Phosphorus, Total			97.7		%		70-130	25-NOV-22
PAHERB-ONT-DW-WT	Water							

Quality Control Report

Client: CASH CLIENTS - WATERLOO
651 Orangeville Road
Fergus ON N1M 1T9
Contact: Scott Stovel

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAHERB-ONT-DW-WT	Water							
Batch R5897577								
WG3774132-3 DUP		**WG3774132-5**						
Dicamba		<0.20	<0.20	RPD-NA	ug/L	N/A	30	24-NOV-22
Bromoxynil		<0.20	<0.20	RPD-NA	ug/L	N/A	30	24-NOV-22
2,4-D		<0.20	<0.20	RPD-NA	ug/L	N/A	30	24-NOV-22
2,4,5-TP		<0.20	<0.20	RPD-NA	ug/L	N/A	50	24-NOV-22
Dinoseb		<0.20	<0.20	RPD-NA	ug/L	N/A	50	24-NOV-22
Picloram		<0.20	<0.20	RPD-NA	ug/L	N/A	30	24-NOV-22
MCPA		<0.20	<0.20	RPD-NA	ug/L	N/A	30	24-NOV-22
WG3774132-2 LCS								
Dicamba			95.9		%		65-130	24-NOV-22
Bromoxynil			109.5		%		65-130	24-NOV-22
2,4-D			105.1		%		65-130	24-NOV-22
2,4,5-TP			104.4		%		50-150	24-NOV-22
Dinoseb			99.6		%		50-150	24-NOV-22
Picloram			99.7		%		50-150	24-NOV-22
MCPA			108.3		%		65-130	24-NOV-22
WG3774132-1 MB								
Dicamba			<0.20		ug/L		0.2	24-NOV-22
Bromoxynil			<0.20		ug/L		0.2	24-NOV-22
2,4-D			<0.20		ug/L		0.2	24-NOV-22
2,4,5-TP			<0.20		ug/L		0.2	24-NOV-22
Dinoseb			<0.20		ug/L		0.2	24-NOV-22
Picloram			<0.20		ug/L		0.2	24-NOV-22
MCPA			<0.20		ug/L		0.2	24-NOV-22
Surrogate: 2,4-Dichlorophenylacetic Acid			130.0		%		50-130	24-NOV-22
WG3774132-4 MS		**WG3774132-5**						
Dicamba			100.8		%		50-150	24-NOV-22
Bromoxynil			139.6		%		50-150	24-NOV-22
2,4-D			126.3		%		50-150	24-NOV-22
2,4,5-TP			129.6		%		50-150	24-NOV-22
Dinoseb			117.7		%		50-150	24-NOV-22
Picloram			94.2		%		50-150	24-NOV-22
MCPA			135.5		%		50-150	24-NOV-22
PARAQUAT-ONT-DW-WT	Water							

Quality Control Report

Client: CASH CLIENTS - WATERLOO
651 Orangeville Road
Fergus ON N1M 1T9
Contact: Scott Stovel

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PARAQUAT-ONT-DW-WT	Water							
Batch R5898376								
WG3773951-3 DUP		**WG3773951-5**						
Paraquat		<1.0	<1.0	RPD-NA	ug/L	N/A	30	25-NOV-22
WG3773951-2 LCS								
Paraquat			86.8		%		70-130	25-NOV-22
WG3773951-1 MB								
Paraquat			<1.0		ug/L		1	25-NOV-22
WG3773951-4 MS		**WG3773951-5**						
Paraquat			80.0		%		70-130	25-NOV-22
PH-ONT-DW-WT	Water							
Batch R5898200								
WG3774169-4 DUP		**WG3774169-3**						
pH		8.04	8.03	J	pH units	0.01	0.2	25-NOV-22
WG3774169-2 LCS								
pH			7.06		pH units		6.9-7.1	25-NOV-22
SO4-IC-N-ONT-DW-WT	Water							
Batch R5898242								
WG3774247-4 DUP		**WG3774247-3**						
Sulfate (SO4)		34.7	34.2		mg/L	1.7	20	25-NOV-22
WG3774247-2 LCS								
Sulfate (SO4)			104.4		%		90-110	25-NOV-22
WG3774247-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	25-NOV-22
WG3774247-5 MS		**WG3774247-3**						
Sulfate (SO4)			99.7		%		75-125	25-NOV-22
SOLIDS-TDS-ONT-DW-WT	Water							
Batch R5897371								
WG3773803-3 DUP		**WG3773803-4**						
Total Dissolved Solids		453	446		mg/L	1.6	25	24-NOV-22
WG3773803-2 LCS								
Total Dissolved Solids			102.0		%		70-130	24-NOV-22
WG3773803-1 MB								
Total Dissolved Solids			<10		mg/L		10	24-NOV-22
SULPHIDE-ONT-DW-WT	Water							
Batch R5897374								
WG3774030-3 DUP		**L2741043-1**						
Sulphide (as S)		0.182	0.188		mg/L	3.2	20	24-NOV-22
WG3774030-2 LCS								

Quality Control Report

Client: CASH CLIENTS - WATERLOO
651 Orangeville Road
Fergus ON N1M 1T9
Contact: Scott Stovel

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SULPHIDE-ONT-DW-WT	Water							
Batch R5897374								
WG3774030-2 LCS								
Sulphide (as S)			85.7		%		75-125	24-NOV-22
WG3774030-1 MB								
Sulphide (as S)			<0.018		mg/L		0.018	24-NOV-22
WG3774030-4 MS		**L2741043-1**						
Sulphide (as S)			N/A	MS-B	%		-	24-NOV-22
TC,EC-QT51-DW-WT	Water							
Batch R5896956								
WG3773830-2 DUP		**L2741043-1**						
Total Coliforms		0	0		MPN/100mL	0.0	65	23-NOV-22
Escherichia Coli		0	0		MPN/100mL	0.0	65	23-NOV-22
WG3773830-1 MB								
Total Coliforms			0		MPN/100mL		1	23-NOV-22
Escherichia Coli			0		MPN/100mL		1	23-NOV-22
TKN-F-WT	Water							
Batch R5898158								
WG3774060-3 DUP		**WG3774060-5**						
Total Kjeldahl Nitrogen		1.03	0.972		mg/L	6.2	20	25-NOV-22
WG3774060-2 LCS								
Total Kjeldahl Nitrogen			114.3		%		75-125	25-NOV-22
WG3774060-1 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	25-NOV-22
WG3774060-4 MS		**WG3774060-5**						
Total Kjeldahl Nitrogen			110.2		%		70-130	25-NOV-22
VOC-ONT-DW-WT	Water							
Batch R5897156								
WG3773823-4 DUP		**L2740735-1**						
1,1-dichloroethylene (vinylidene chlorid		<0.50	<0.50	RPD-NA	ug/L	N/A	30	24-NOV-22
1,2-Dichlorobenzene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	24-NOV-22
1,2-Dichloroethane		<0.50	<0.50	RPD-NA	ug/L	N/A	30	24-NOV-22
1,4-Dichlorobenzene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	24-NOV-22
Benzene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	24-NOV-22
Carbon tetrachloride		<0.20	<0.20	RPD-NA	ug/L	N/A	30	24-NOV-22
Dichloromethane		<5.0	<5.0	RPD-NA	ug/L	N/A	30	24-NOV-22
Ethylbenzene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	24-NOV-22
Monochlorobenzene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	24-NOV-22

Quality Control Report

Client: CASH CLIENTS - WATERLOO
651 Orangeville Road
Fergus ON N1M 1T9
Contact: Scott Stovel

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-ONT-DW-WT	Water							
Batch	**R5897156**							
WG3773823-4	**DUP**	**L2740735-1**						
Tetrachloroethylene (perchloroethylene)		<0.50	<0.50	RPD-NA	ug/L	N/A	30	24-NOV-22
Toluene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	24-NOV-22
Trichloroethylene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	24-NOV-22
m/p-xylene		<1.0	<1.0	RPD-NA	ug/L	N/A	30	24-NOV-22
o-xylene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	24-NOV-22
Vinyl chloride		<0.20	<0.20	RPD-NA	ug/L	N/A	30	24-NOV-22
WG3773823-1	**LCS**							
1,1-dichloroethylene (vinylidene chlorid			97.1		%		70-130	24-NOV-22
1,2-Dichlorobenzene			100.8		%		70-130	24-NOV-22
1,2-Dichloroethane			93.1		%		70-130	24-NOV-22
1,4-Dichlorobenzene			103.7		%		70-130	24-NOV-22
Benzene			103.9		%		70-130	24-NOV-22
Carbon tetrachloride			100.5		%		70-130	24-NOV-22
Dichloromethane			95.3		%		70-130	24-NOV-22
Ethylbenzene			101.3		%		70-130	24-NOV-22
Monochlorobenzene			95.5		%		70-130	24-NOV-22
Tetrachloroethylene (perchloroethylene)			98.4		%		70-130	24-NOV-22
Toluene			99.96		%		70-130	24-NOV-22
Trichloroethylene			96.0		%		70-130	24-NOV-22
m/p-xylene			102.3		%		70-130	24-NOV-22
o-xylene			99.4		%		70-130	24-NOV-22
Vinyl chloride			86.1		%		60-140	24-NOV-22
WG3773823-2	**MB**							
1,1-dichloroethylene (vinylidene chlorid			<0.50		ug/L		0.5	23-NOV-22
1,2-Dichlorobenzene			<0.50		ug/L		0.5	23-NOV-22
1,2-Dichloroethane			<0.50		ug/L		0.5	23-NOV-22
1,4-Dichlorobenzene			<0.50		ug/L		0.5	23-NOV-22
Surrogate: 1,4-Difluorobenzene			98.8		%		70-130	23-NOV-22
Benzene			<0.50		ug/L		0.5	23-NOV-22
Carbon tetrachloride			<0.20		ug/L		0.2	23-NOV-22
Dichloromethane			<5.0		ug/L		5	23-NOV-22
Ethylbenzene			<0.50		ug/L		0.5	23-NOV-22
Monochlorobenzene			<0.50		ug/L		0.5	23-NOV-22
Tetrachloroethylene (perchloroethylene)			<0.50		ug/L		0.5	23-NOV-22

Quality Control Report

Client: CASH CLIENTS - WATERLOO
651 Orangeville Road
Fergus ON N1M 1T9
Contact: Scott Stovel

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-ONT-DW-WT	Water							
Batch R5897156								
WG3773823-2 MB								
Toluene			<0.50		ug/L		0.5	23-NOV-22
Trichloroethylene			<0.50		ug/L		0.5	23-NOV-22
m/p-xylene			<1.0		ug/L		1	23-NOV-22
o-xylene			<0.50		ug/L		0.5	23-NOV-22
Vinyl chloride			<0.20		ug/L		0.2	23-NOV-22
Surrogate: 4-Bromofluorobenzene			92.4		%		70-130	23-NOV-22
WG3773823-5 MS		**L2740735-1**						
1,1-dichloroethylene (vinylidene chlorid			91.2		%		70-130	24-NOV-22
1,2-Dichlorobenzene			98.7		%		70-130	24-NOV-22
1,2-Dichloroethane			100.6		%		70-130	24-NOV-22
1,4-Dichlorobenzene			97.7		%		70-130	24-NOV-22
Benzene			103.2		%		70-130	24-NOV-22
Carbon tetrachloride			95.1		%		70-130	24-NOV-22
Dichloromethane			97.5		%		70-130	24-NOV-22
Ethylbenzene			93.9		%		70-130	24-NOV-22
Monochlorobenzene			92.8		%		70-130	24-NOV-22
Tetrachloroethylene (perchloroethylene)			88.7		%		70-130	24-NOV-22
Toluene			95.1		%		50-150	24-NOV-22
Trichloroethylene			90.3		%		70-130	24-NOV-22
m/p-xylene			95.0		%		70-130	24-NOV-22
o-xylene			93.8		%		50-150	24-NOV-22
Vinyl chloride			79.7		%		70-130	24-NOV-22

Quality Control Report

Workorder: L2741043 Report Date: 09-DEC-22

Client: CASH CLIENTS - WATERLOO
651 Orangeville Road
Fergus ON N1M 1T9
Contact: Scott Stovel

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
LCS-H	Lab Control Sample recovery was above ALS DQO. Non-detected sample results are considered reliable. Other results, if reported, have been qualified.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

25-November-2022

ALS Laboratory (Waterloo)
Attn : Candice Hunter

60 Northland Road, Unit # 1
Waterloo, ON
N2V 2B8, Canada

Phone: 519-866-6910
Fax:

Date Rec. : 24 November 2022
LR Report: **CA18398-NOV22**

Copy: #1

CERTIFICATE OF ANALYSIS
Final Report

Sample ID	Sample Date & Time	Temperature Upon Receipt °C	Microcystin (Quantitative) ug/L
1: Analysis Start Date		---	25-Nov-22
2: Analysis Start Time		---	09:20
3: Analysis Completed Date		---	25-Nov-22
4: Analysis Completed Time		---	12:24
5: MAC		--	1.5
6: MDL		---	0.1
7: NR L2741043-1 TW 1	21-Nov-22 14:15	9.0	<0.1

MAC - Maximum Acceptable Concentration
MDL - SGS Method Detection Limit
NR - Not regulated / reportable under applicable Provincial drinking water regulations as per client.

Method Descriptions

Parameter	Description	SGS Method Code
Microcystin (Quantitative)	Microcystin (quantitative using ELISA)	ME-CA-[ENV]MIC-LAK-AN-014

[redacted]

Kimberley Didsbury
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0003134933

Results relate only to the sample tested. Data reported represents the sample submitted to SGS. Reproduction of this analytical report in full or in part is prohibited without prior written approval. Please refer to SGS General Conditions of Services located at https://www.sgs.ca/en/terms-and-conditions (Printed copies are available upon request.)
Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.
SGS Canada Inc. Environment-Health & Safety statement of conformity decision rule does not consider uncertainty when analytical results are compared to a specified standard or regulation.

Chain of Custody (COC) / Analytical Request Form

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2741043-COFC

Report To	Contact and company name below will appear on the final report	Reports / Recipients		Turnaround Time (TAT) Requested	
Company:	Stovel and Associates Inc	Select Report Format:	PDF ✓ EXCEL EDD (DIGITAL)	☑ Routine [R] if received by 3pm M-F - no surcharges apply	AFFIX ALS BARCODE LABEL HERE (ALS use only)
Contact:	Scott Stovel	Merge QC/QCI Reports with COA	YES NO N-A	☐ 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimum	
Phone:	226-820-0343	Compare Results to Criteria on Report	provide details below if box checked	☐ 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimum	
	Company address below will appear on the final report	Select Distribution:	✓ EMAIL MAIL FAX	☐ 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimum	
Street:	651 Orangeville Road	Email 1 or Fax	robstoveljr@outlook.com	☐ 1 day [E] if received by 3pm M-F - 100% rush surcharge minimum	
City/Province:	Fergus, ON	Email 2	scott.stovel@gmail.com	Same day [E2] if received by 10am M-S - 200% rush surcharge. Additional fees may apply to rush requests on weekends, statutory holidays and non-routine tests	
Postal Code:	N1M 1T9	Email 3	stovel.associates@outlook.com	Date and Time Required for all E&P TATs:	
Invoice To	Same as Report To YES NO	Invoice Recipients		For tests that can not be performed according to the TAT requested, you will be contacted.	
	Copy of Invoice with Report YES NO	Select Invoice Distribution:	EMAIL MAIL FAX		
Company:		Email 1 or Fax	scott.stovel@gmail.com		
Contact:		Email 2	stovel.associates@outlook.com		

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:	15161/ Q90084	AFE/Cost Center	PO#
Job #:	ARKELL PROPERTY	Major/Minor Code	Routing Code:
PO / AFE:	[redacted]	Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only):		ALS Contact: Candice Hunter	Sampler: [redacted]

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	ACIDS, OC PEST, MISC PEST	Colour, Alk, Ph, Cl, F, NO2/NO3	TDS, SO4	Sulfide	TC,EC, HPC	Metals, Hardness	Diquat, Diuron, Aldicarb, Glyphosate	NDMA	PAHERB, PARAQUAT, PCB	VOC	Microcystin, Gross Alpha, Beta	DOC	Cyanide Free	Total Organic N	SAMPLES ON HOLD	EXTENDED STORAGE REQUIRED	SUSPECTED HAZARD (see notes)
	TW 1	21-11-2022	14:15	Water		R	R	R	R	R	R	R	R	R	R	R	R	R	R			

Drinking Water (DW) Samples[1] (client use)	Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)
Are samples taken from a Regulated DW System? YES NO	
Are samples for human consumption/ use? ☑ YES ☐ NO	

SAMPLE RECEIPT DETAILS (lab use only)

Cooling Method: NONE X ICE X ICE PACKS FROZEN COOLING INITIATED

Submission Comments identified on Sample Receipt Notification: YES NO

Cooler Custody Seals Intact: YES N/A Sample Custody Seals Intact: YES N/A

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
				8.0°C			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by: CBB	Date: 11/21/22	Time: 15:00

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1 If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**

OS-569 VW-115 OR-074

L-253 N-432 GC-118 SC-147 CW-448 MM-447

CERTIFICATE OF ANALYSIS

Work Order	: **WT2222903**	Page	: 1 of 4
Client	: **Cash Clients Canada**	Laboratory	: Waterloo - Environmental
Contact	: Scott Stovel	Account Manager	: Candice Hunter
Address	: 651 Orangeville Road Fergus ON Canada N1M 1T9	Address	: 60 Northland Road, Unit 1 Waterloo ON Canada N2V 2B8
Telephone	: ----	Telephone	: +1 519 886 6910
Project	: ----	Date Samples Received	: 23-Nov-2022 17:25
PO	: ----	Date Analysis Commenced	: 24-Nov-2022
C-O-C number	: ----	Issue Date	: 30-Nov-2022 11:28
Sampler	: CLIENT		
Site	: ----		
Quote number	: Stovel and Associates Inc.		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Amanda Ganouri-Lumsden	Department Manager - Microbiology and Prep	Microbiology, Waterloo, Ontario
Greg Pokocky	Supervisor - Inorganic	Inorganics, Waterloo, Ontario
Greg Pokocky	Supervisor - Inorganic	Metals, Waterloo, Ontario

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances
LOR: Limit of Reporting (detection limit).

Unit	*Description*
CFU/mL	colony forming units per millilitre
mg/L	milligrams per litre
MPN/100mL	most probable number per hundred millilitres

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Qualifiers

Qualifier	*Description*
BODL	*Limit of Reporting for BOD was increased to account for the largest volume of sample tested.*
DLHC	*Detection Limit Raised: Dilution required due to high concentration of test analyte(s).*

Analytical Results

Sub-Matrix: Water
(Matrix: Water)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	TW2	TW2- MID	TW2- END	----	----
					Client sampling date / time	23-Nov-2022 12:10	23-Nov-2022 13:20	23-Nov-2022 15:05	----	----
						WT2222903-001	WT2222903-002	WT2222903-003	--------	--------
						Result	Result	Result	---	---
Anions and Nutrients										
nitrite (as N)	14797-65-0	E235.NO2	0.010	mg/L		<0.010	----	<0.010	----	----
nitrate (as N)	14797-55-8	E235.NO3	0.020	mg/L		<0.020	----	<0.020	----	----
nitrate + nitrite (as N)	----	EC235.N+N	0.0200	mg/L		<0.0224	----	<0.0224	----	----
Microbiological Tests										
coliforms, Escherichia coli [E. coli]	----	E010	1	MPN/100mL		Not Detected	----	Not Detected	----	----
coliforms, total	----	E010	1	MPN/100mL		Not Detected	----	Not Detected	----	----
heterotrophic plate count [HPC]	----	E012.HPC	1	CFU/mL		31	----	13	----	----
Total Metals										
aluminum, total	7429-90-5	E420	0.0030	mg/L		0.478	----	0.192	----	----
antimony, total	7440-36-0	E420	0.00010	mg/L		0.00067	----	0.00030	----	----
arsenic, total	7440-38-2	E420	0.00010	mg/L		0.00187	----	0.00095	----	----
barium, total	7440-39-3	E420	0.00010	mg/L		0.0411	----	0.0370	----	----
beryllium, total	7440-41-7	E420	0.000020	mg/L		0.000023	----	<0.000020	----	----
bismuth, total	7440-69-9	E420	0.000050	mg/L		<0.000050	----	<0.000050	----	----
boron, total	7440-42-8	E420	0.010	mg/L		0.047	----	0.046	----	----
cadmium, total	7440-43-9	E420	0.0000050	mg/L		0.0000621	----	0.0000203	----	----
calcium, total	7440-70-2	E420	0.050	mg/L		80.7	----	73.6	----	----
cesium, total	7440-46-2	E420	0.000010	mg/L		0.000055	----	0.000028	----	----
chromium, total	7440-47-3	E420	0.00050	mg/L		0.00191	----	0.00169	----	----
cobalt, total	7440-48-4	E420	0.00010	mg/L		0.00061	----	0.00024	----	----
copper, total	7440-50-8	E420	0.00050	mg/L		0.00119	----	0.00066	----	----
iron, total	7439-89-6	E420	0.010	mg/L		1.11	----	0.355	----	----
lead, total	7439-92-1	E420	0.000050	mg/L		0.0219	----	0.00668	----	----
lithium, total	7439-93-2	E420	0.0010	mg/L		0.0132	----	0.0124	----	----
magnesium, total	7439-95-4	E420	0.0050	mg/L		32.8	----	31.1	----	----
manganese, total	7439-96-5	E420	0.00010	mg/L		0.0399	----	0.0148	----	----
mercury, total	7439-97-6	E508	0.0000050	mg/L		----	<0.0000050	----	----	----
molybdenum, total	7439-98-7	E420	0.000050	mg/L		0.0120	----	0.00526	----	----
nickel, total	7440-02-0	E420	0.00050	mg/L		0.00452	----	0.00176	----	----

Analytical Results

Sub-Matrix: Water (Matrix: Water)					Client sample ID	TW2	TW2- MID	TW2- END	----	----
					Client sampling date / time	23-Nov-2022 12:10	23-Nov-2022 13:20	23-Nov-2022 15:05	----	----
Analyte	CAS Number	Method	LOR	Unit		WT2222903-001	WT2222903-002	WT2222903-003	--------	--------
						Result	Result	Result	---	----
Total Metals										
phosphorus, total	7723-14-0	E420	0.050	mg/L		<0.050	----	<0.050	----	----
potassium, total	7440-09-7	E420	0.050	mg/L		2.02	----	1.97	----	----
rubidium, total	7440-17-7	E420	0.00020	mg/L		0.00207	----	0.00173	----	----
selenium, total	7782-49-2	E420	0.000050	mg/L		<0.000050	----	<0.000050	----	----
silicon, total	7440-21-3	E420	0.10	mg/L		6.56	----	5.98	----	----
silver, total	7440-22-4	E420	0.000010	mg/L		0.000015	----	0.000012	----	----
sodium, total	7440-23-5	E420	0.050	mg/L		13.4	----	13.0	----	----
strontium, total	7440-24-6	E420	0.00020	mg/L		13.5 DLHC	----	14.0 DLHC	----	----
sulfur, total	7704-34-9	E420	0.50	mg/L		23.3	----	22.5	----	----
tellurium, total	13494-80-9	E420	0.00020	mg/L		0.00134	----	0.00124	----	----
thallium, total	7440-28-0	E420	0.000010	mg/L		0.000016	----	<0.000010	----	----
thorium, total	7440-29-1	E420	0.00010	mg/L		0.00015	----	<0.00010	----	----
tin, total	7440-31-5	E420	0.00010	mg/L		0.00059	----	0.00046	----	----
titanium, total	7440-32-6	E420	0.00030	mg/L		0.0180	----	0.00773	----	----
tungsten, total	7440-33-7	E420	0.00010	mg/L		<0.00010	----	<0.00010	----	----
uranium, total	7440-61-1	E420	0.000010	mg/L		0.000074	----	0.000027	----	----
vanadium, total	7440-62-2	E420	0.00050	mg/L		0.00085	----	<0.00050	----	----
zinc, total	7440-66-6	E420	0.0030	mg/L		0.0594	----	0.0202	----	----
zirconium, total	7440-67-7	E420	0.00020	mg/L		0.00036	----	<0.00020	----	----
Aggregate Organics										
biochemical oxygen demand [BOD]	----	E550	2.0	mg/L		----	<3.0 BODL	----	----	----
carbonaceous biochemical oxygen demand [CBOD]	----	E555	2.0	mg/L		----	<3.0 BODL	----	----	----

Please refer to the General Comments section for an explanation of any qualifiers detected.

ALS Canada Ltd.

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **WT2222903**	Page	: 1 of 7
Client	: **Cash Clients Canada**	Laboratory	: Waterloo - Environmental
Contact	: Scott Stovel	Account Manager	: Candice Hunter
Address	: 651 Orangeville Road Fergus ON Canada N1M 1T9	Address	: 60 Northland Road, Unit 1 Waterloo, Ontario Canada N2V 2B8
Telephone	: ----	Telephone	: +1 519 886 6910
Project	: ----	Date Samples Received	: 23-Nov-2022 17:25
PO	: ----	Issue Date	: 30-Nov-2022 11:28
C-O-C number	: ----		
Sampler	: CLIENT		
Site	: ----		
Quote number	: Stovel and Associates Inc.		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number: Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO: Data Quality Objective.
LOR: Limit of Reporting (detection limit).
RPD: Relative Percent Difference.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Duplicate outliers occur.
- No Laboratory Control Sample (LCS) outliers occur
- No Matrix Spike outliers occur.
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

- Quality Control Sample Frequency Outliers occur - please see following pages for full details.

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 00:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 00:00 is used for calculation purposes.

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Aggregate Organics : Biochemical Oxygen Demand - 5 day										
HDPE [BOD HT-4d]										
TW2- MID	E550	23-Nov-2022	----	----	----		24-Nov-2022	4 days	0 days	✓
Aggregate Organics : Biochemical Oxygen Demand (Carbonaceous) - 5 day										
HDPE [BOD HT-4d]										
TW2- MID	E555	23-Nov-2022	----	----	----		24-Nov-2022	4 days	0 days	✓
Anions and Nutrients : Nitrate in Water by IC										
HDPE [ON MECP]										
TW2	E235.NO3	23-Nov-2022	24-Nov-2022	----	----		25-Nov-2022	7 days	2 days	✓
Anions and Nutrients : Nitrate in Water by IC										
HDPE [ON MECP]										
TW2- END	E235.NO3	23-Nov-2022	24-Nov-2022	----	----		25-Nov-2022	7 days	2 days	✓
Anions and Nutrients : Nitrite in Water by IC										
HDPE [ON MECP]										
TW2	E235.NO2	23-Nov-2022	24-Nov-2022	----	----		25-Nov-2022	7 days	2 days	✓
Anions and Nutrients : Nitrite in Water by IC										
HDPE [ON MECP]										
TW2- END	E235.NO2	23-Nov-2022	24-Nov-2022	----	----		25-Nov-2022	7 days	2 days	✓
Microbiological Tests : Heterotrophic Plate Count by MF (MF-mHPC)										
Sterile HDPE (Sodium thiosulphate) [ON MECP]										
TW2- END	E012.HPC	23-Nov-2022	----	----	----		24-Nov-2022	48 hrs	16 hrs	✓

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Microbiological Tests : Heterotrophic Plate Count by MF (MF-mHPC)										
Sterile HDPE (Sodium thiosulphate) [ON MECP]										
TW2	E012.HPC	23-Nov-2022	----	----	----		24-Nov-2022	48 hrs	19 hrs	✓
Microbiological Tests : Total Coliforms and E. coli (Enzyme Substrate)										
Sterile HDPE (Sodium thiosulphate) [ON MECP]										
TW2- END	E010	23-Nov-2022	----	----	----		24-Nov-2022	48 hrs	19 hrs	✓
Microbiological Tests : Total Coliforms and E. coli (Enzyme Substrate)										
Sterile HDPE (Sodium thiosulphate) [ON MECP]										
TW2	E010	23-Nov-2022	----	----	----		24-Nov-2022	48 hrs	21 hrs	✓
Total Metals : Total Mercury in Water by CVAAS										
Glass vial total (hydrochloric acid)										
TW2- MID	E508	23-Nov-2022	25-Nov-2022	----	----		25-Nov-2022	28 days	2 days	✓
Total Metals : Total metals in Water by CRC ICPMS										
HDPE total (nitric acid)										
TW2	E420	23-Nov-2022	27-Nov-2022	----	----		28-Nov-2022	180 days	4 days	✓
Total Metals : Total metals in Water by CRC ICPMS										
HDPE total (nitric acid)										
TW2- END	E420	23-Nov-2022	27-Nov-2022	----	----		28-Nov-2022	180 days	4 days	✓

Legend & Qualifier Definitions

Rec. HT: ALS recommended hold time (see units).

Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Water**

Evaluation: ✗ = QC frequency outside specification; ✓ = QC frequency within specification.

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	*Method*	*QC Lot #*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*
Laboratory Duplicates (DUP)							
Biochemical Oxygen Demand - 5 day	E550	756005	1	20	5.0	5.0	✓
Biochemical Oxygen Demand (Carbonaceous) - 5 day	E555	756006	1	20	5.0	5.0	✓
Heterotrophic Plate Count by MF (MF-mHPC)	E012.HPC	756360	1	18	5.5	5.0	✓
Nitrate in Water by IC	E235.NO3	756672	1	14	7.1	5.0	✓
Nitrite in Water by IC	E235.NO2	756671	1	14	7.1	5.0	✓
Total Coliforms and E. coli (Enzyme Substrate)	E010	755849	0	10	0.0	5.0	✗
Total Mercury in Water by CVAAS	E508	757387	1	2	50.0	5.0	✓
Total metals in Water by CRC ICPMS	E420	759635	1	20	5.0	5.0	✓
Laboratory Control Samples (LCS)							
Biochemical Oxygen Demand - 5 day	E550	756005	1	20	5.0	5.0	✓
Biochemical Oxygen Demand (Carbonaceous) - 5 day	E555	756006	1	20	5.0	5.0	✓
Nitrate in Water by IC	E235.NO3	756672	1	14	7.1	5.0	✓
Nitrite in Water by IC	E235.NO2	756671	1	14	7.1	5.0	✓
Total Mercury in Water by CVAAS	E508	757387	1	2	50.0	5.0	✓
Total metals in Water by CRC ICPMS	E420	759635	1	20	5.0	5.0	✓
Method Blanks (MB)							
Biochemical Oxygen Demand - 5 day	E550	756005	1	20	5.0	5.0	✓
Biochemical Oxygen Demand (Carbonaceous) - 5 day	E555	756006	1	20	5.0	5.0	✓
Heterotrophic Plate Count by MF (MF-mHPC)	E012.HPC	756360	1	18	5.5	5.0	✓
Nitrate in Water by IC	E235.NO3	756672	1	14	7.1	5.0	✓
Nitrite in Water by IC	E235.NO2	756671	1	14	7.1	5.0	✓
Total Coliforms and E. coli (Enzyme Substrate)	E010	755849	1	10	10.0	5.0	✓
Total Mercury in Water by CVAAS	E508	757387	1	2	50.0	5.0	✓
Total metals in Water by CRC ICPMS	E420	759635	1	20	5.0	5.0	✓
Matrix Spikes (MS)							
Nitrate in Water by IC	E235.NO3	756672	1	14	7.1	5.0	✓
Nitrite in Water by IC	E235.NO2	756671	1	14	7.1	5.0	✓
Total Mercury in Water by CVAAS	E508	757387	1	2	50.0	5.0	✓
Total metals in Water by CRC ICPMS	E420	759635	1	20	5.0	5.0	✓

Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by "mod").

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Total Coliforms and E. coli (Enzyme Substrate)	E010 Waterloo - Environmental	Water	APHA 9223 (mod)	The enzyme substrate test simultaneously detects Total Coliforms and E. coli in a 100 mL sample after incubation at 35.0 ±0.5°C for either 18 or 24 hours (dependent on reagent used).
Heterotrophic Plate Count by MF (MF-mHPC)	E012.HPC Waterloo - Environmental	Water	SM 9215D	Following filtration (0.45 µm), and incubation at 35.0 ±0.5°C for 48 hours, the observed colonies are enumerated.
Nitrite in Water by IC	E235.NO2 Waterloo - Environmental	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Nitrate in Water by IC	E235.NO3 Waterloo - Environmental	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Total metals in Water by CRC ICPMS	E420 Waterloo - Environmental	Water	EPA 200.2/6020B (mod)	Water samples are digested with nitric and hydrochloric acids, and analyzed by Collision/Reaction Cell ICPMS. Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.
Total Mercury in Water by CVAAS	E508 Waterloo - Environmental	Water	EPA 1631E (mod)	Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS
Biochemical Oxygen Demand - 5 day	E550 Waterloo - Environmental	Water	APHA 5210 B (mod)	Samples are diluted and incubated for a specified time period, after which the oxygen depletion is measured using a dissolved oxygen meter. Free chlorine is a negative interference in the BOD method; please advise ALS when free chlorine is present in samples.
Biochemical Oxygen Demand (Carbonaceous) - 5 day	E555 Waterloo - Environmental	Water	APHA 5210 B (mod)	Samples are diluted and incubated for a specified time period, after which the oxygen depletion is measured using a dissolved oxygen meter. Nitrification inhibitor is added to samples to prevent nitrogenous compounds from consuming oxygen resulting in only carbonaceous oxygen demand being reported by this method. Free chlorine is a negative interference in the BOD method; please advise ALS when free chlorine is present in samples.

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Nitrate and Nitrite (as N) (Calculation)	EC235.N+N Waterloo - Environmental	Water	EPA 300.0	Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Canada Ltd.

QUALITY CONTROL REPORT

Work Order	: **WT2222903**	Page	: 1 of 10
Client	: Cash Clients Canada	Laboratory	: Waterloo - Environmental
Contact	: Scott Stovel	Account Manager	: Candice Hunter
Address	: 651 Orangeville Road Fergus ON Canada N1M 1T9	Address	: 60 Northland Road, Unit 1 Waterloo, Ontario Canada N2V 2B8
Telephone	:	Telephone	: +1 519 886 6910
Project	: ----	Date Samples Received	: 23-Nov-2022 17:25
PO	: ----	Date Analysis Commenced	: 24-Nov-2022
C-O-C number	: ----	Issue Date	: 30-Nov-2022 11:28
Sampler	: CLIENT ----		
Site	: ----		
Quote number	: Stovel and Associates Inc.		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percent Difference (RPD) and Data Quality Objectives
- Matrix Spike (MS) Report; Recovery and Data Quality Objectives
- Method Blank (MB) Report; Recovery and Data Quality Objectives
- Laboratory Control Sample (LCS) Report; Recovery and Data Quality Objectives

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Amanda Ganouri-Lumsden	Department Manager - Microbiology and Prep	Waterloo Microbiology, Waterloo, Ontario
Greg Pokocky	Supervisor - Inorganic	Waterloo Inorganics, Waterloo, Ontario
Greg Pokocky	Supervisor - Inorganic	Waterloo Metals, Waterloo, Ontario

General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number = Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO = Data Quality Objective.
LOR = Limit of Reporting (detection limit).
RPD = Relative Percent Difference
# = Indicates a QC result that did not meet the ALS DQO.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test-specific).

Sub-Matrix: **Water**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	LOR	Unit	Original Result	Duplicate Result	RPD(%) or Difference	Duplicate Limits	Qualifier
Anions and Nutrients (QC Lot: 756671)											
WT2222923-001	Anonymous	nitrite (as N)	14797-65-0	E235.NO2	0.010	mg/L	<0.010	<0.010	0	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 756672)											
WT2222923-001	Anonymous	nitrate (as N)	14797-55-8	E235.NO3	0.020	mg/L	0.430	0.438	1.72%	20%	----
Microbiological Tests (QC Lot: 756360)											
WT2222840-001	Anonymous	heterotrophic plate count [HPC]	----	E012.HPC	1	CFU/mL	<1	<1	0	Diff <2x LOR	----
Total Metals (QC Lot: 757387)											
WT2222903-002	TW2- MID	mercury, total	7439-97-6	E508	0.0000050	mg/L	<0.0000050	<0.0000050	0	Diff <2x LOR	----
Total Metals (QC Lot: 759635)											
TY2204398-001	Anonymous	aluminum, total	7429-90-5	E420	0.0030	mg/L	<0.0030	<0.0030	0	Diff <2x LOR	----
		antimony, total	7440-36-0	E420	0.00010	mg/L	<0.00010	<0.00010	0	Diff <2x LOR	----
		arsenic, total	7440-38-2	E420	0.00010	mg/L	0.00037	0.00037	0.000002	Diff <2x LOR	----
		barium, total	7440-39-3	E420	0.00010	mg/L	0.0107	0.0104	3.12%	20%	----
		beryllium, total	7440-41-7	E420	0.000020	mg/L	0.000032	<0.000020	0.000012	Diff <2x LOR	----
		bismuth, total	7440-69-9	E420	0.000050	mg/L	<0.000050	<0.000050	0	Diff <2x LOR	----
		boron, total	7440-42-8	E420	0.010	mg/L	<0.010	<0.010	0	Diff <2x LOR	----
		cadmium, total	7440-43-9	E420	0.0000050	mg/L	0.0000054	0.0000059	0.0000005	Diff <2x LOR	----
		calcium, total	7440-70-2	E420	0.050	mg/L	14.0	13.9	0.365%	20%	----
		cesium, total	7440-46-2	E420	0.000010	mg/L	0.000016	<0.000010	0.000006	Diff <2x LOR	----
		chromium, total	7440-47-3	E420	0.00050	mg/L	<0.00050	<0.00050	0	Diff <2x LOR	----
		cobalt, total	7440-48-4	E420	0.00010	mg/L	<0.00010	<0.00010	0	Diff <2x LOR	----
		copper, total	7440-50-8	E420	0.00050	mg/L	0.138	0.139	0.470%	20%	----
		iron, total	7439-89-6	E420	0.010	mg/L	<0.010	<0.010	0	Diff <2x LOR	----
		lead, total	7439-92-1	E420	0.000050	mg/L	<0.000050	<0.000050	0	Diff <2x LOR	----
		lithium, total	7439-93-2	E420	0.0010	mg/L	<0.0010	<0.0010	0	Diff <2x LOR	----
		magnesium, total	7439-95-4	E420	0.0050	mg/L	3.42	3.24	5.40%	20%	----
		manganese, total	7439-96-5	E420	0.00010	mg/L	0.00022	0.00014	0.00008	Diff <2x LOR	----
		molybdenum, total	7439-98-7	E420	0.000050	mg/L	0.000216	0.000144	0.000073	Diff <2x LOR	----
		nickel, total	7440-02-0	E420	0.00050	mg/L	<0.00050	<0.00050	0	Diff <2x LOR	----
		phosphorus, total	7723-14-0	E420	0.050	mg/L	1.06	1.03	2.21%	20%	----
		potassium, total	7440-09-7	E420	0.050	mg/L	0.536	0.522	2.53%	20%	----

Sub-Matrix: **Water**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	*Client sample ID*	*Analyte*	*CAS Number*	*Method*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD(%) or Difference*	*Duplicate Limits*	*Qualifier*
Total Metals (QC Lot: 759635) - continued											
TY2204398-001	Anonymous	rubidium, total	7440-17-7	E420	0.00020	mg/L	0.00077	0.00073	0.00004	Diff <2x LOR	----
		selenium, total	7782-49-2	E420	0.000050	mg/L	0.000079	0.000080	0.000001	Diff <2x LOR	----
		silicon, total	7440-21-3	E420	0.10	mg/L	1.27	1.25	1.61%	20%	----
		silver, total	7440-22-4	E420	0.000010	mg/L	<0.000010	<0.000010	0	Diff <2x LOR	----
		sodium, total	7440-23-5	E420	0.050	mg/L	3.38	3.46	2.10%	20%	----
		strontium, total	7440-24-6	E420	0.00020	mg/L	0.0240	0.0243	1.18%	20%	----
		sulfur, total	7704-34-9	E420	0.50	mg/L	1.18	1.12	0.06	Diff <2x LOR	----
		tellurium, total	13494-80-9	E420	0.00020	mg/L	<0.00020	<0.00020	0	Diff <2x LOR	----
		thallium, total	7440-28-0	E420	0.000010	mg/L	<0.000010	<0.000010	0	Diff <2x LOR	----
		thorium, total	7440-29-1	E420	0.00010	mg/L	<0.00010	<0.00010	0	Diff <2x LOR	----
		tin, total	7440-31-5	E420	0.00010	mg/L	0.00031	0.00014	0.00017	Diff <2x LOR	----
		titanium, total	7440-32-6	E420	0.00030	mg/L	<0.00030	<0.00030	0	Diff <2x LOR	----
		tungsten, total	7440-33-7	E420	0.00010	mg/L	<0.00010	<0.00010	0	Diff <2x LOR	----
		uranium, total	7440-61-1	E420	0.000010	mg/L	0.000049	0.000048	0.000001	Diff <2x LOR	----
		vanadium, total	7440-62-2	E420	0.00050	mg/L	<0.00050	<0.00050	0	Diff <2x LOR	----
		zinc, total	7440-66-6	E420	0.0030	mg/L	0.0139	0.0139	0.00002	Diff <2x LOR	----
		zirconium, total	7440-67-7	E420	0.00020	mg/L	<0.00020	<0.00020	0	Diff <2x LOR	----
Aggregate Organics (QC Lot: 756005)											
WT2222842-001	Anonymous	biochemical oxygen demand [BOD]	----	E550	2.0	mg/L	5.8	6.2	6.0%	30%	----
Aggregate Organics (QC Lot: 756006)											
WT2222727-007	Anonymous	carbonaceous biochemical oxygen demand [CBOD]	----	E555	2.0	mg/L	5.6	4.4	24.6%	30%	----

Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Anions and Nutrients (QCLot: 756671)						
nitrite (as N)	14797-65-0	E235.NO2	0.01	mg/L	<0.010	----
Anions and Nutrients (QCLot: 756672)						
nitrate (as N)	14797-55-8	E235.NO3	0.02	mg/L	<0.020	----
Microbiological Tests (QCLot: 755849)						
coliforms, Escherichia coli [E. coli]	----	E010	1	MPN/100mL	<1	----
coliforms, total	----	E010	1	MPN/100mL	<1	----
Microbiological Tests (QCLot: 756360)						
heterotrophic plate count [HPC]	----	E012.HPC	1	CFU/mL	<1	----
Total Metals (QCLot: 757387)						
mercury, total	7439-97-6	E508	0.000005	mg/L	<0.0000050	----
Total Metals (QCLot: 759635)						
aluminum, total	7429-90-5	E420	0.003	mg/L	<0.0030	----
antimony, total	7440-36-0	E420	0.0001	mg/L	<0.00010	----
arsenic, total	7440-38-2	E420	0.0001	mg/L	<0.00010	----
barium, total	7440-39-3	E420	0.0001	mg/L	<0.00010	----
beryllium, total	7440-41-7	E420	0.00002	mg/L	<0.000020	----
bismuth, total	7440-69-9	E420	0.00005	mg/L	<0.000050	----
boron, total	7440-42-8	E420	0.01	mg/L	<0.010	----
cadmium, total	7440-43-9	E420	0.000005	mg/L	<0.0000050	----
calcium, total	7440-70-2	E420	0.05	mg/L	<0.050	----
cesium, total	7440-46-2	E420	0.00001	mg/L	<0.000010	----
chromium, total	7440-47-3	E420	0.0005	mg/L	<0.00050	----
cobalt, total	7440-48-4	E420	0.0001	mg/L	<0.00010	----
copper, total	7440-50-8	E420	0.0005	mg/L	<0.00050	----
iron, total	7439-89-6	E420	0.01	mg/L	<0.010	----
lead, total	7439-92-1	E420	0.00005	mg/L	<0.000050	----
lithium, total	7439-93-2	E420	0.001	mg/L	<0.0010	----
magnesium, total	7439-95-4	E420	0.005	mg/L	<0.0050	----
manganese, total	7439-96-5	E420	0.0001	mg/L	<0.00010	----
molybdenum, total	7439-98-7	E420	0.00005	mg/L	<0.000050	----
nickel, total	7440-02-0	E420	0.0005	mg/L	<0.00050	----
phosphorus, total	7723-14-0	E420	0.05	mg/L	<0.050	----

Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Total Metals (QCLot: 759635) - continued						
potassium, total	7440-09-7	E420	0.05	mg/L	<0.050	----
rubidium, total	7440-17-7	E420	0.0002	mg/L	<0.00020	----
selenium, total	7782-49-2	E420	0.00005	mg/L	<0.000050	----
silicon, total	7440-21-3	E420	0.1	mg/L	<0.10	----
silver, total	7440-22-4	E420	0.00001	mg/L	<0.000010	----
sodium, total	7440-23-5	E420	0.05	mg/L	<0.050	----
strontium, total	7440-24-6	E420	0.0002	mg/L	<0.00020	----
sulfur, total	7704-34-9	E420	0.5	mg/L	<0.50	----
tellurium, total	13494-80-9	E420	0.0002	mg/L	<0.00020	----
thallium, total	7440-28-0	E420	0.00001	mg/L	<0.000010	----
thorium, total	7440-29-1	E420	0.0001	mg/L	<0.00010	----
tin, total	7440-31-5	E420	0.0001	mg/L	<0.00010	----
titanium, total	7440-32-6	E420	0.0003	mg/L	<0.00030	----
tungsten, total	7440-33-7	E420	0.0001	mg/L	<0.00010	----
uranium, total	7440-61-1	E420	0.00001	mg/L	<0.000010	----
vanadium, total	7440-62-2	E420	0.0005	mg/L	<0.00050	----
zinc, total	7440-66-6	E420	0.003	mg/L	<0.0030	----
zirconium, total	7440-67-7	E420	0.0002	mg/L	<0.00020	----
Aggregate Organics (QCLot: 756005)						
biochemical oxygen demand [BOD]	----	E550	2	mg/L	<2.0	----
Aggregate Organics (QCLot: 756006)						
carbonaceous biochemical oxygen demand [CBOD]	----	E555	2	mg/L	<2.0	----

Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: **Water**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Anions and Nutrients (QCLot: 756671)									
nitrite (as N)	14797-65-0	E235.NO2	0.01	mg/L	0.5 mg/L	102	90.0	110	----
Anions and Nutrients (QCLot: 756672)									
nitrate (as N)	14797-55-8	E235.NO3	0.02	mg/L	2.5 mg/L	101	90.0	110	----
Total Metals (QCLot: 757387)									
mercury, total	7439-97-6	E508	0.000005	mg/L	0.0001 mg/L	106	80.0	120	----
Total Metals (QCLot: 759635)									
aluminum, total	7429-90-5	E420	0.003	mg/L	0.1 mg/L	103	80.0	120	----
antimony, total	7440-36-0	E420	0.0001	mg/L	0.05 mg/L	99.7	80.0	120	----
arsenic, total	7440-38-2	E420	0.0001	mg/L	0.05 mg/L	106	80.0	120	----
barium, total	7440-39-3	E420	0.0001	mg/L	0.0125 mg/L	104	80.0	120	----
beryllium, total	7440-41-7	E420	0.00002	mg/L	0.005 mg/L	100	80.0	120	----
bismuth, total	7440-69-9	E420	0.00005	mg/L	0.05 mg/L	97.7	80.0	120	----
boron, total	7440-42-8	E420	0.01	mg/L	0.05 mg/L	96.5	80.0	120	----
cadmium, total	7440-43-9	E420	0.000005	mg/L	0.005 mg/L	102	80.0	120	----
calcium, total	7440-70-2	E420	0.05	mg/L	2.5 mg/L	103	80.0	120	----
cesium, total	7440-46-2	E420	0.00001	mg/L	0.0025 mg/L	101	80.0	120	----
chromium, total	7440-47-3	E420	0.0005	mg/L	0.0125 mg/L	102	80.0	120	----
cobalt, total	7440-48-4	E420	0.0001	mg/L	0.0125 mg/L	99.8	80.0	120	----
copper, total	7440-50-8	E420	0.0005	mg/L	0.0125 mg/L	97.8	80.0	120	----
iron, total	7439-89-6	E420	0.01	mg/L	0.05 mg/L	100	80.0	120	----
lead, total	7439-92-1	E420	0.00005	mg/L	0.025 mg/L	101	80.0	120	----
lithium, total	7439-93-2	E420	0.001	mg/L	0.0125 mg/L	104	80.0	120	----
magnesium, total	7439-95-4	E420	0.005	mg/L	2.5 mg/L	112	80.0	120	----
manganese, total	7439-96-5	E420	0.0001	mg/L	0.0125 mg/L	100	80.0	120	----
molybdenum, total	7439-98-7	E420	0.00005	mg/L	0.0125 mg/L	99.6	80.0	120	----
nickel, total	7440-02-0	E420	0.0005	mg/L	0.025 mg/L	99.9	80.0	120	----
phosphorus, total	7723-14-0	E420	0.05	mg/L	0.5 mg/L	106	80.0	120	----
potassium, total	7440-09-7	E420	0.05	mg/L	2.5 mg/L	102	80.0	120	----
rubidium, total	7440-17-7	E420	0.0002	mg/L	0.005 mg/L	104	80.0	120	----
selenium, total	7782-49-2	E420	0.00005	mg/L	0.05 mg/L	101	80.0	120	----
silicon, total	7440-21-3	E420	0.1	mg/L	0.5 mg/L	105	80.0	120	----
silver, total	7440-22-4	E420	0.00001	mg/L	0.005 mg/L	93.5	80.0	120	----

Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
					Concentration	LCS	Low	High	Qualifier
Total Metals (QCLot: 759635) - continued									
sodium, total	7440-23-5	E420	0.05	mg/L	2.5 mg/L	104	80.0	120	----
strontium, total	7440-24-6	E420	0.0002	mg/L	0.0125 mg/L	104	80.0	120	----
sulfur, total	7704-34-9	E420	0.5	mg/L	2.5 mg/L	93.3	80.0	120	----
tellurium, total	13494-80-9	E420	0.0002	mg/L	0.005 mg/L	102	80.0	120	----
thallium, total	7440-28-0	E420	0.00001	mg/L	0.05 mg/L	99.6	80.0	120	----
thorium, total	7440-29-1	E420	0.0001	mg/L	0.005 mg/L	101	80.0	120	----
tin, total	7440-31-5	E420	0.0001	mg/L	0.025 mg/L	97.7	80.0	120	----
titanium, total	7440-32-6	E420	0.0003	mg/L	0.0125 mg/L	100	80.0	120	----
tungsten, total	7440-33-7	E420	0.0001	mg/L	0.005 mg/L	98.1	80.0	120	----
uranium, total	7440-61-1	E420	0.00001	mg/L	0.00025 mg/L	101	80.0	120	----
vanadium, total	7440-62-2	E420	0.0005	mg/L	0.025 mg/L	102	80.0	120	----
zinc, total	7440-66-6	E420	0.003	mg/L	0.025 mg/L	100	80.0	120	----
zirconium, total	7440-67-7	E420	0.0002	mg/L	0.005 mg/L	98.8	80.0	120	----
Aggregate Organics (QCLot: 756005)									
biochemical oxygen demand [BOD]	----	E550	2	mg/L	198 mg/L	108	85.0	115	----
Aggregate Organics (QCLot: 756006)									
carbonaceous biochemical oxygen demand [CBOD]	----	E555	2	mg/L	198 mg/L	108	85.0	115	----

Matrix Spike (MS) Report

A Matrix Spike (MS) is a randomly selected intra-laboratory replicate sample that has been fortified (spiked) with test analytes at known concentration, and processed in an identical manner to test samples. Matrix Spikes provide information regarding analyte recovery and potential matrix effects. MS DQO exceedances due to sample matrix may sometimes be unavoidable; in such cases, test results for the associated sample (or similar samples) may be subject to bias. ND = Recovery not determined, background level >= 1x spike level.

Sub-Matrix: **Water**

					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	Concentration	Target	MS	Low	High	Qualifier
Anions and Nutrients (QCLot: 756671)										
WT2222923-001	Anonymous	nitrite (as N)	14797-65-0	E235.NO2	0.492 mg/L	0.5 mg/L	98.4	75.0	125	----
Anions and Nutrients (QCLot: 756672)										
WT2222923-001	Anonymous	nitrate (as N)	14797-55-8	E235.NO3	2.43 mg/L	2.5 mg/L	97.3	75.0	125	----
Total Metals (QCLot: 757387)										
WT2223049-001	Anonymous	mercury, total	7439-97-6	E508	0.000106 mg/L	0.0001 mg/L	106	70.0	130	----
Total Metals (QCLot: 759635)										
TY2204398-002	Anonymous	aluminum, total	7429-90-5	E420	0.103 mg/L	0.1 mg/L	103	70.0	130	----
		antimony, total	7440-36-0	E420	0.0536 mg/L	0.05 mg/L	107	70.0	130	----
		arsenic, total	7440-38-2	E420	0.0524 mg/L	0.05 mg/L	105	70.0	130	----
		barium, total	7440-39-3	E420	0.0123 mg/L	0.0125 mg/L	98.3	70.0	130	----
		beryllium, total	7440-41-7	E420	0.00480 mg/L	0.005 mg/L	96.0	70.0	130	----
		bismuth, total	7440-69-9	E420	0.0481 mg/L	0.05 mg/L	96.2	70.0	130	----
		boron, total	7440-42-8	E420	0.048 mg/L	0.05 mg/L	95.3	70.0	130	----
		cadmium, total	7440-43-9	E420	0.00496 mg/L	0.005 mg/L	99.2	70.0	130	----
		calcium, total	7440-70-2	E420	ND mg/L	2.5 mg/L	ND	70.0	130	----
		cesium, total	7440-46-2	E420	0.00262 mg/L	0.0025 mg/L	105	70.0	130	----
		chromium, total	7440-47-3	E420	0.0129 mg/L	0.0125 mg/L	103	70.0	130	----
		cobalt, total	7440-48-4	E420	0.0128 mg/L	0.0125 mg/L	102	70.0	130	----
		copper, total	7440-50-8	E420	ND mg/L	0.0125 mg/L	ND	70.0	130	----
		iron, total	7439-89-6	E420	0.051 mg/L	0.05 mg/L	102	70.0	130	----
		lead, total	7439-92-1	E420	0.0242 mg/L	0.025 mg/L	96.8	70.0	130	----
		lithium, total	7439-93-2	E420	0.0131 mg/L	0.0125 mg/L	105	70.0	130	----
		magnesium, total	7439-95-4	E420	ND mg/L	2.5 mg/L	ND	70.0	130	----
		manganese, total	7439-96-5	E420	0.0128 mg/L	0.0125 mg/L	102	70.0	130	----
		molybdenum, total	7439-98-7	E420	0.0129 mg/L	0.0125 mg/L	103	70.0	130	----
		nickel, total	7440-02-0	E420	0.0254 mg/L	0.025 mg/L	102	70.0	130	----
		phosphorus, total	7723-14-0	E420	ND mg/L	0.5 mg/L	ND	70.0	130	----
		potassium, total	7440-09-7	E420	2.60 mg/L	2.5 mg/L	104	70.0	130	----
		rubidium, total	7440-17-7	E420	0.00504 mg/L	0.005 mg/L	101	70.0	130	----
		selenium, total	7782-49-2	E420	0.0500 mg/L	0.05 mg/L	100	70.0	130	----

Sub-Matrix: **Water**

					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	Concentration	Target	MS	Low	High	Qualifier
Total Metals (QCLot: 759635) - continued										
TY2204398-002	Anonymous	silicon, total	7440-21-3	E420	ND mg/L	0.5 mg/L	ND	70.0	130	----
		silver, total	7440-22-4	E420	0.00478 mg/L	0.005 mg/L	95.5	70.0	130	----
		sodium, total	7440-23-5	E420	ND mg/L	2.5 mg/L	ND	70.0	130	----
		strontium, total	7440-24-6	E420	ND mg/L	0.0125 mg/L	ND	70.0	130	----
		sulfur, total	7704-34-9	E420	2.49 mg/L	2.5 mg/L	99.7	70.0	130	----
		tellurium, total	13494-80-9	E420	0.00506 mg/L	0.005 mg/L	101	70.0	130	----
		thallium, total	7440-28-0	E420	0.0496 mg/L	0.05 mg/L	99.2	70.0	130	----
		thorium, total	7440-29-1	E420	0.00494 mg/L	0.005 mg/L	98.8	70.0	130	----
		tin, total	7440-31-5	E420	0.0254 mg/L	0.025 mg/L	102	70.0	130	----
		titanium, total	7440-32-6	E420	0.0125 mg/L	0.0125 mg/L	99.7	70.0	130	----
		tungsten, total	7440-33-7	E420	0.00491 mg/L	0.005 mg/L	98.1	70.0	130	----
		uranium, total	7440-61-1	E420	0.000248 mg/L	0.00025 mg/L	99.1	70.0	130	----
		vanadium, total	7440-62-2	E420	0.0260 mg/L	0.025 mg/L	104	70.0	130	----
		zinc, total	7440-66-6	E420	0.0232 mg/L	0.025 mg/L	92.9	70.0	130	----
		zirconium, total	7440-67-7	E420	0.00515 mg/L	0.005 mg/L	103	70.0	130	----

Chain of Custody (COC) / Analytical Request Form

COC Number: 20 -

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

Page

Environmental Division
Waterloo
Work Order Reference
WT2222903

Telephone : +1 519 886 6910

Report To	Contact and company name below will appear on the final report
Company:	Stovel and Associates
Contact:	Scott Stovel
Phone:	228)820-0343
	Company address below will appear on the final report
Street:	651 Orangeville Road
City/Province:	Fergus
Postal Code:	N1M 1T9
Invoice To	Same as Report To ☐ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	

Reports / Recipients

Select Report Format: ☒ PDF ☒ EXCEL ☐ EDD (DIGITAL)
Merge QC/QCI Reports with COA ☐ YES ☐ NO ☐ N/A
☐ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☐ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax: stovel.associates@outlook.com
Email 2: robstoveljr@outlook.com
Email 3: scott.stovel@gmail.com

Invoice Recipients

Select Invoice Distribution: ☒ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax: scott.stovel@gmail.com
Email 2: stovel.associates@outlook.com

Turnaround Time (TAT) Requested

☐ Routine [R] if received by 3pm M-F - no surcharges apply
☐ 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimu
☐ 3 day [P3] if received by 3pm M-F - 25% rush surcharge minim
☐ 2 day [P2] if received by 3pm M-F - 50% rush surcharge minim
☐ 1 day [E] if received by 3pm M-F - 100% rush surcharge minim
Same day [E2] if received by 10am M-S - 200% rush surcharge
fees may apply to rush requests on weekends, statutory holidays
routine tests

Date and Time Required for all E&P TATs:

For tests that can not be performed according to t

Project Information

ALS Account # / Quote #: 15161
Job #: Arkell Property
PO / AFE:
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#
Major/Minor Code: Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only):

ALS Contact: Sampler:

Analysis Request

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	TC,EC,HPC	No2/NO3	Metals	BOD, CBOD	Total mercury/Dissolved	SAMPLES ON HOLD	EXTENDED STORAGE REQUIRED	SUSPECTED HAZARD (see notes)
	TW2	23-11-2022	12:10	Water		✓	✓	✓					
	TW2 - mid	23-11-2022	13:20	water					✓	✓			
	TW2 - End	23-11-2022	15:05	water		✓	✓	✓					

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☒ NO

Are samples for human consumption/ use?
☒ YES ☐ NO

Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)

SAMPLE RECEIPT DETAILS (lab use only)

Cooling Method: ☐ NONE ☐ ICE ☒ ICE PACKS ☐ FROZEN ☐ COOLING INITIATED
Submission Comments identified on Sample Receipt Notification: ☐ YES ☐ NO
Cooler Custody Seals Intact: ☐ YES ☐ N/A Sample Custody Seals Intact: ☐ YES ☐ N/A

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
					13.7		

SHIPMENT RELEASE (client use)

Released by:	Date:	Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by:	Date:	Time:

FINAL SHIPMENT RECEPTION (lab use only)

Received by:	Date:	Time:
KD	11/23/22	16:28

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1 If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

MM451, B303, GC129

ALS Canada Ltd.

right solutions. right partner.

CERTIFICATE OF ANALYSIS

Work Order	: **WT2223236**	Page	: 1 of 4
Client	: **Cash Clients Canada**	Laboratory	: Waterloo - Environmental
Contact	: Scott Stovel	Account Manager	: Khairul Intiar
Address	: 60 Northland Rd. Unit 1 Waterloo ON Canada N2V 2B8	Address	: 60 Northland Road, Unit 1 Waterloo ON Canada N2V 2B8
Telephone	: ----	Telephone	: +1 519 886 6910
Project	: Arkell Property	Date Samples Received	: 26-Nov-2022 12:30
PO	: ----	Date Analysis Commenced	: 26-Nov-2022
C-O-C number	: ----	Issue Date	: 06-Dec-2022 10:30
Sampler	: ----		
Site	: ----		
Quote number	: Waterloo Hub Cash Clients - Khai		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Amanda Ganouri-Lumsden	Department Manager - Microbiology and Prep	Microbiology, Waterloo, Ontario
Jon Fisher	Department Manager - Inorganics	Inorganics, Waterloo, Ontario
Jon Fisher	Department Manager - Inorganics	Metals, Waterloo, Ontario
Ruby Sujeepan		Microbiology, Waterloo, Ontario

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances

LOR: Limit of Reporting (detection limit).

Unit	*Description*
CFU/mL	colony forming units per millilitre
mg/L	milligrams per litre
MPN/100mL	most probable number per hundred millilitres

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Qualifiers

Qualifier	*Description*
BODL	*Limit of Reporting for BOD was increased to account for the largest volume of sample tested.*

Analytical Results

Sub-Matrix: Water
(Matrix: Water)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID: tw3	tw3-mid	tw3-end	----	----
					Client sampling date / time: 25-Nov-2022 14:15	25-Nov-2022 17:05	25-Nov-2022 17:05	----	----
					WT2223236-001	WT2223236-002	WT2223236-003	--------	--------
					Result	Result	Result	---	---
Anions and Nutrients									
nitrite (as N)	14797-65-0	E235.NO2	0.010	mg/L	<0.010	----	<0.010	----	----
nitrate (as N)	14797-55-8	E235.NO3	0.020	mg/L	4.74	----	5.31	----	----
nitrate + nitrite (as N)	----	EC235.N+N	0.0200	mg/L	4.74	----	5.31	----	----
Microbiological Tests									
coliforms, Escherichia coli [E. coli]	----	E010	1	MPN/100mL	Not Detected	----	Not Detected	----	----
coliforms, total	----	E010	1	MPN/100mL	Not Detected	----	Not Detected	----	----
heterotrophic plate count [HPC]	----	E012.HPC	1	CFU/mL	6	----	11	----	----
Total Metals									
aluminum, total	7429-90-5	E420	0.0030	mg/L	0.362	----	0.861	----	----
antimony, total	7440-36-0	E420	0.00010	mg/L	0.00078	----	0.00052	----	----
arsenic, total	7440-38-2	E420	0.00010	mg/L	0.0203	----	0.0502	----	----
barium, total	7440-39-3	E420	0.00010	mg/L	0.0594	----	0.0693	----	----
beryllium, total	7440-41-7	E420	0.000020	mg/L	0.000039	----	0.000093	----	----
bismuth, total	7440-69-9	E420	0.000050	mg/L	<0.000050	----	<0.000050	----	----
boron, total	7440-42-8	E420	0.010	mg/L	0.017	----	0.015	----	----
cadmium, total	7440-43-9	E420	0.0000050	mg/L	0.000148	----	0.000307	----	----
calcium, total	7440-70-2	E420	0.050	mg/L	89.3	----	90.7	----	----
cesium, total	7440-46-2	E420	0.000010	mg/L	0.000030	----	0.000059	----	----
chromium, total	7440-47-3	E420	0.00050	mg/L	0.00276	----	0.00487	----	----
cobalt, total	7440-48-4	E420	0.00010	mg/L	0.00160	----	0.00431	----	----
copper, total	7440-50-8	E420	0.00050	mg/L	0.00490	----	0.0134	----	----
iron, total	7439-89-6	E420	0.010	mg/L	4.52	----	11.7	----	----
lead, total	7439-92-1	E420	0.000050	mg/L	0.123	----	0.332	----	----
lithium, total	7439-93-2	E420	0.0010	mg/L	0.0018	----	0.0019	----	----
magnesium, total	7439-95-4	E420	0.0050	mg/L	34.9	----	35.3	----	----
manganese, total	7439-96-5	E420	0.00010	mg/L	0.176	----	0.530	----	----
mercury, total	7439-97-6	E508	0.0000050	mg/L	----	0.0000083	----	----	----
molybdenum, total	7439-98-7	E420	0.000050	mg/L	0.00209	----	0.00152	----	----
nickel, total	7440-02-0	E420	0.00050	mg/L	0.00490	----	0.00656	----	----

Analytical Results

Sub-Matrix: Water (Matrix: Water)					Client sample ID	tw3	tw3-mid	tw3-end	----	----
					Client sampling date / time	25-Nov-2022 14:15	25-Nov-2022 17:05	25-Nov-2022 17:05	----	----
Analyte	CAS Number	Method	LOR	Unit		WT2223236-001	WT2223236-002	WT2223236-003	--------	--------
						Result	Result	Result	---	----
Total Metals										
phosphorus, total	7723-14-0	E420	0.050	mg/L		<0.050	----	0.101	----	----
potassium, total	7440-09-7	E420	0.050	mg/L		1.81	----	1.98	----	----
rubidium, total	7440-17-7	E420	0.00020	mg/L		0.00145	----	0.00192	----	----
selenium, total	7782-49-2	E420	0.000050	mg/L		0.000233	----	0.000220	----	----
silicon, total	7440-21-3	E420	0.10	mg/L		7.08	----	8.31	----	----
silver, total	7440-22-4	E420	0.000010	mg/L		0.000012	----	0.000025	----	----
sodium, total	7440-23-5	E420	0.050	mg/L		43.1	----	35.2	----	----
strontium, total	7440-24-6	E420	0.00020	mg/L		0.531	----	0.357	----	----
sulfur, total	7704-34-9	E420	0.50	mg/L		9.04	----	8.46	----	----
tellurium, total	13494-80-9	E420	0.00020	mg/L		<0.00020	----	<0.00020	----	----
thallium, total	7440-28-0	E420	0.000010	mg/L		0.000077	----	0.000149	----	----
thorium, total	7440-29-1	E420	0.00010	mg/L		<0.00010	----	0.00016	----	----
tin, total	7440-31-5	E420	0.00010	mg/L		<0.00010	----	<0.00010	----	----
titanium, total	7440-32-6	E420	0.00030	mg/L		0.00746	----	0.0160	----	----
tungsten, total	7440-33-7	E420	0.00010	mg/L		<0.00010	----	<0.00010	----	----
uranium, total	7440-61-1	E420	0.000010	mg/L		0.00103	----	0.000780	----	----
vanadium, total	7440-62-2	E420	0.00050	mg/L		0.00341	----	0.00855	----	----
zinc, total	7440-66-6	E420	0.0030	mg/L		0.187	----	0.401	----	----
zirconium, total	7440-67-7	E420	0.00020	mg/L		0.00084	----	0.00152	----	----
Aggregate Organics										
biochemical oxygen demand [BOD]	----	E550	2.0	mg/L		----	<3.0 BODL	----	----	----
carbonaceous biochemical oxygen demand [CBOD]	----	E555	2.0	mg/L		----	<3.0 BODL	----	----	----

Please refer to the General Comments section for an explanation of any qualifiers detected.

ALS Canada Ltd.

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **WT2223236**	Page	: 1 of 8
Client	: **Cash Clients Canada**	Laboratory	: Waterloo - Environmental
Contact	: Scott Stovel	Account Manager	: Khairul Intiar
Address	: 60 Northland Rd. Unit 1 Waterloo ON Canada N2V 2B8	Address	: 60 Northland Road, Unit 1 Waterloo, Ontario Canada N2V 2B8
Telephone	: ----	Telephone	: +1 519 886 6910
Project	: Arkell Property	Date Samples Received	: 26-Nov-2022 12:30
PO	: ----	Issue Date	: 06-Dec-2022 10:30
C-O-C number	: ----		
Sampler	: ----		
Site	: ----		
Quote number	: Waterloo Hub Cash Clients - Khai		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number: Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO: Data Quality Objective.
LOR: Limit of Reporting (detection limit).
RPD: Relative Percent Difference.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Laboratory Control Sample (LCS) outliers occur
- No Matrix Spike outliers occur.
- Duplicate outliers occur - please see following pages for full details.
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **Water**

Analyte Group	Laboratory sample ID	Client/Ref Sample ID	Analyte	CAS Number	Method	Result	Limits	Comment
Duplicate (DUP) RPDs								
Microbiological Tests	WT2223236-003	tw3-end	heterotrophic plate count [HPC]	----	E012.HPC	114 %	65%	Duplicate RPD does not meet the DQO for this test.

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 00:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 00:00 is used for calculation purposes.

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Aggregate Organics : Biochemical Oxygen Demand - 5 day										
HDPE [BOD HT-4d]										
tw3-mid	E550	25-Nov-2022	----	----	----		28-Nov-2022	4 days	2 days	✓
Aggregate Organics : Biochemical Oxygen Demand (Carbonaceous) - 5 day										
HDPE [BOD HT-4d]										
tw3-mid	E555	25-Nov-2022	----	----	----		28-Nov-2022	4 days	2 days	✓
Anions and Nutrients : Nitrate in Water by IC										
HDPE [ON MECP]										
tw3	E235.NO3	25-Nov-2022	30-Nov-2022	----	----		02-Dec-2022	7 days	7 days	✓
Anions and Nutrients : Nitrate in Water by IC										
HDPE [ON MECP]										
tw3-end	E235.NO3	25-Nov-2022	30-Nov-2022	----	----		02-Dec-2022	7 days	7 days	✓
Anions and Nutrients : Nitrite in Water by IC										
HDPE [ON MECP]										
tw3	E235.NO2	25-Nov-2022	30-Nov-2022	----	----		02-Dec-2022	7 days	7 days	✓
Anions and Nutrients : Nitrite in Water by IC										
HDPE [ON MECP]										
tw3-end	E235.NO2	25-Nov-2022	30-Nov-2022	----	----		02-Dec-2022	7 days	7 days	✓
Microbiological Tests : Heterotrophic Plate Count by MF (MF-mHPC)										
Sterile HDPE (Sodium thiosulphate) [ON MECP]										
tw3-end	E012.HPC	25-Nov-2022	----	----	----		26-Nov-2022	48 hrs	21 hrs	✓

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Microbiological Tests : Heterotrophic Plate Count by MF (MF-mHPC)										
Sterile HDPE (Sodium thiosulphate) [ON MECP]										
tw3	E012.HPC	25-Nov-2022	----	----	----		26-Nov-2022	48 hrs	24 hrs	✓
Microbiological Tests : Total Coliforms and E. coli (Enzyme Substrate)										
Sterile HDPE (Sodium thiosulphate) [ON MECP]										
tw3-end	E010	25-Nov-2022	----	----	----		26-Nov-2022	48 hrs	21 hrs	✓
Microbiological Tests : Total Coliforms and E. coli (Enzyme Substrate)										
Sterile HDPE (Sodium thiosulphate) [ON MECP]										
tw3	E010	25-Nov-2022	----	----	----		26-Nov-2022	48 hrs	24 hrs	✓
Total Metals : Total Mercury in Water by CVAAS										
Glass vial total (hydrochloric acid)										
tw3-mid	E508	25-Nov-2022	28-Nov-2022	----	----		28-Nov-2022	28 days	3 days	✓
Total Metals : Total metals in Water by CRC ICPMS										
HDPE total (nitric acid)										
tw3	E420	25-Nov-2022	28-Nov-2022	----	----		28-Nov-2022	180 days	3 days	✓
Total Metals : Total metals in Water by CRC ICPMS										
HDPE total (nitric acid)										
tw3-end	E420	25-Nov-2022	28-Nov-2022	----	----		28-Nov-2022	180 days	3 days	✓

Legend & Qualifier Definitions

Rec. HT: ALS recommended hold time (see units).

Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Water**

Evaluation: × = *QC frequency outside specification*; ✓ = *QC frequency within specification.*

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	*Method*	*QC Lot #*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*
Laboratory Duplicates (DUP)							
Biochemical Oxygen Demand - 5 day	E550	759939	1	14	7.1	5.0	✓
Biochemical Oxygen Demand (Carbonaceous) - 5 day	E555	759940	1	17	5.8	5.0	✓
Heterotrophic Plate Count by MF (MF-mHPC)	E012.HPC	759017	1	2	50.0	5.0	✓
Nitrate in Water by IC	E235.NO3	762873	1	19	5.2	5.0	✓
Nitrite in Water by IC	E235.NO2	762874	1	14	7.1	5.0	✓
Total Coliforms and E. coli (Enzyme Substrate)	E010	758969	1	2	50.0	5.0	✓
Total Mercury in Water by CVAAS	E508	759827	1	4	25.0	5.0	✓
Total metals in Water by CRC ICPMS	E420	759643	1	5	20.0	5.0	✓
Laboratory Control Samples (LCS)							
Biochemical Oxygen Demand - 5 day	E550	759939	1	14	7.1	5.0	✓
Biochemical Oxygen Demand (Carbonaceous) - 5 day	E555	759940	1	17	5.8	5.0	✓
Nitrate in Water by IC	E235.NO3	762873	1	19	5.2	5.0	✓
Nitrite in Water by IC	E235.NO2	762874	1	14	7.1	5.0	✓
Total Mercury in Water by CVAAS	E508	759827	1	4	25.0	5.0	✓
Total metals in Water by CRC ICPMS	E420	759643	1	5	20.0	5.0	✓
Method Blanks (MB)							
Biochemical Oxygen Demand - 5 day	E550	759939	1	14	7.1	5.0	✓
Biochemical Oxygen Demand (Carbonaceous) - 5 day	E555	759940	1	17	5.8	5.0	✓
Heterotrophic Plate Count by MF (MF-mHPC)	E012.HPC	759017	1	2	50.0	5.0	✓
Nitrate in Water by IC	E235.NO3	762873	1	19	5.2	5.0	✓
Nitrite in Water by IC	E235.NO2	762874	1	14	7.1	5.0	✓
Total Coliforms and E. coli (Enzyme Substrate)	E010	758969	1	2	50.0	5.0	✓
Total Mercury in Water by CVAAS	E508	759827	1	4	25.0	5.0	✓
Total metals in Water by CRC ICPMS	E420	759643	1	5	20.0	5.0	✓
Matrix Spikes (MS)							
Nitrate in Water by IC	E235.NO3	762873	1	19	5.2	5.0	✓
Nitrite in Water by IC	E235.NO2	762874	1	14	7.1	5.0	✓
Total Mercury in Water by CVAAS	E508	759827	1	4	25.0	5.0	✓
Total metals in Water by CRC ICPMS	E420	759643	1	5	20.0	5.0	✓

Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by "mod").

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Total Coliforms and E. coli (Enzyme Substrate)	E010 Waterloo - Environmental	Water	APHA 9223 (mod)	The enzyme substrate test simultaneously detects Total Coliforms and E. coli in a 100 mL sample after incubation at 35.0 ±0.5°C for either 18 or 24 hours (dependent on reagent used).
Heterotrophic Plate Count by MF (MF-mHPC)	E012.HPC Waterloo - Environmental	Water	SM 9215D	Following filtration (0.45 µm), and incubation at 35.0 ±0.5°C for 48 hours, the observed colonies are enumerated.
Nitrite in Water by IC	E235.NO2 Waterloo - Environmental	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Nitrate in Water by IC	E235.NO3 Waterloo - Environmental	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Total metals in Water by CRC ICPMS	E420 Waterloo - Environmental	Water	EPA 200.2/6020B (mod)	Water samples are digested with nitric and hydrochloric acids, and analyzed by Collision/Reaction Cell ICPMS. Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.
Total Mercury in Water by CVAAS	E508 Waterloo - Environmental	Water	EPA 1631E (mod)	Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS
Biochemical Oxygen Demand - 5 day	E550 Waterloo - Environmental	Water	APHA 5210 B (mod)	Samples are diluted and incubated for a specified time period, after which the oxygen depletion is measured using a dissolved oxygen meter. Free chlorine is a negative interference in the BOD method; please advise ALS when free chlorine is present in samples.
Biochemical Oxygen Demand (Carbonaceous) - 5 day	E555 Waterloo - Environmental	Water	APHA 5210 B (mod)	Samples are diluted and incubated for a specified time period, after which the oxygen depletion is measured using a dissolved oxygen meter. Nitrification inhibitor is added to samples to prevent nitrogenous compounds from consuming oxygen resulting in only carbonaceous oxygen demand being reported by this method. Free chlorine is a negative interference in the BOD method; please advise ALS when free chlorine is present in samples.

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Nitrate and Nitrite (as N) (Calculation)	EC235.N+N Waterloo - Environmental	Water	EPA 300.0	Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Canada Ltd.

QUALITY CONTROL REPORT

Work Order	: **WT2223236**	Page	: 1 of 10
Client	: Cash Clients Canada	Laboratory	: Waterloo - Environmental
Contact	: Scott Stovel	Account Manager	: Khairul Intiar
Address	: 60 Northland Rd. Unit 1 Waterloo ON Canada N2V 2B8	Address	: 60 Northland Road, Unit 1 Waterloo, Ontario Canada N2V 2B8
Telephone	:	Telephone	: +1 519 886 6910
Project	: Arkell Property	Date Samples Received	: 26-Nov-2022 12:30
PO	: ----	Date Analysis Commenced	: 26-Nov-2022
C-O-C number	: ----	Issue Date	: 06-Dec-2022 10:30
Sampler	: ---- ----		
Site	: ----		
Quote number	: Waterloo Hub Cash Clients - Khai		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percent Difference (RPD) and Data Quality Objectives
- Matrix Spike (MS) Report; Recovery and Data Quality Objectives
- Method Blank (MB) Report; Recovery and Data Quality Objectives
- Laboratory Control Sample (LCS) Report; Recovery and Data Quality Objectives

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Amanda Ganouri-Lumsden	Department Manager - Microbiology and Prep	Waterloo Microbiology, Waterloo, Ontario
Jon Fisher	Department Manager - Inorganics	Waterloo Inorganics, Waterloo, Ontario
Jon Fisher	Department Manager - Inorganics	Waterloo Metals, Waterloo, Ontario
Ruby Sujeepan		Waterloo Microbiology, Waterloo, Ontario

General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number = Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO = Data Quality Objective.
LOR = Limit of Reporting (detection limit).
RPD = Relative Percent Difference
# = Indicates a QC result that did not meet the ALS DQO.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test-specific).

Sub-Matrix: **Water**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	LOR	Unit	Original Result	Duplicate Result	RPD(%) or Difference	Duplicate Limits	Qualifier
Anions and Nutrients (QC Lot: 762873)											
WT2223236-001	tw3	nitrate (as N)	14797-55-8	E235.NO3	0.020	mg/L	4.74	4.72	0.474%	20%	----
Anions and Nutrients (QC Lot: 762874)											
WT2223236-001	tw3	nitrite (as N)	14797-65-0	E235.NO2	0.010	mg/L	<0.010	<0.010	0	Diff <2x LOR	----
Microbiological Tests (QC Lot: 758969)											
WT2223236-001	tw3	coliforms, Escherichia coli [E. coli]	----	E010	1	MPN/100mL	<1	<1	0	Diff <2x LOR	----
		coliforms, total	----	E010	1	MPN/100mL	<1	<1	0	Diff <2x LOR	----
Microbiological Tests (QC Lot: 759017)											
WT2223236-003	tw3-end	heterotrophic plate count [HPC]	----	E012.HPC	1	CFU/mL	11	3	114%	65%	----
Total Metals (QC Lot: 759643)											
WT2222908-001	Anonymous	aluminum, total	7429-90-5	E420	0.0030	mg/L	0.0188	0.0182	0.0006	Diff <2x LOR	----
		antimony, total	7440-36-0	E420	0.00010	mg/L	<0.00010	<0.00010	0	Diff <2x LOR	----
		arsenic, total	7440-38-2	E420	0.00010	mg/L	0.00028	0.00029	0.00001	Diff <2x LOR	----
		barium, total	7440-39-3	E420	0.00010	mg/L	0.0953	0.0966	1.43%	20%	----
		beryllium, total	7440-41-7	E420	0.000020	mg/L	<0.000020	<0.000020	0	Diff <2x LOR	----
		bismuth, total	7440-69-9	E420	0.000050	mg/L	<0.000050	<0.000050	0	Diff <2x LOR	----
		boron, total	7440-42-8	E420	0.010	mg/L	0.021	0.021	0.000003	Diff <2x LOR	----
		cadmium, total	7440-43-9	E420	0.0000050	mg/L	0.0000086	0.0000080	0.0000006	Diff <2x LOR	----
		calcium, total	7440-70-2	E420	0.050	mg/L	98.1	98.0	0.136%	20%	----
		cesium, total	7440-46-2	E420	0.000010	mg/L	<0.000010	<0.000010	0	Diff <2x LOR	----
		chromium, total	7440-47-3	E420	0.00050	mg/L	<0.00050	<0.00050	0	Diff <2x LOR	----
		cobalt, total	7440-48-4	E420	0.00010	mg/L	<0.00010	<0.00010	0	Diff <2x LOR	----
		copper, total	7440-50-8	E420	0.00050	mg/L	0.402	0.405	0.675%	20%	----
		iron, total	7439-89-6	E420	0.010	mg/L	0.059	0.060	0.0009	Diff <2x LOR	----
		lead, total	7439-92-1	E420	0.000050	mg/L	0.000182	0.000183	0.000001	Diff <2x LOR	----
		lithium, total	7439-93-2	E420	0.0010	mg/L	0.0053	0.0052	0.0001	Diff <2x LOR	----
		magnesium, total	7439-95-4	E420	0.0050	mg/L	33.6	34.0	1.22%	20%	----
		manganese, total	7439-96-5	E420	0.00010	mg/L	0.00673	0.00700	3.91%	20%	----
		molybdenum, total	7439-98-7	E420	0.000050	mg/L	0.000962	0.000995	3.33%	20%	----
		nickel, total	7440-02-0	E420	0.00050	mg/L	0.00075	0.00078	0.00003	Diff <2x LOR	----
		phosphorus, total	7723-14-0	E420	0.050	mg/L	<0.050	<0.050	0	Diff <2x LOR	----

Sub-Matrix: **Water**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	*Client sample ID*	*Analyte*	*CAS Number*	*Method*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD(%) or Difference*	*Duplicate Limits*	*Qualifier*
Total Metals (QC Lot: 759643) - continued											
WT2222908-001	Anonymous	potassium, total	7440-09-7	E420	0.050	mg/L	3.03	3.04	0.237%	20%	----
		rubidium, total	7440-17-7	E420	0.00020	mg/L	0.00127	0.00128	0.000005	Diff <2x LOR	----
		selenium, total	7782-49-2	E420	0.000050	mg/L	0.000131	0.000107	0.000023	Diff <2x LOR	----
		silicon, total	7440-21-3	E420	0.10	mg/L	5.14	5.21	1.34%	20%	----
		silver, total	7440-22-4	E420	0.000010	mg/L	<0.000010	<0.000010	0	Diff <2x LOR	----
		sodium, total	7440-23-5	E420	0.050	mg/L	73.2	73.8	0.933%	20%	----
		strontium, total	7440-24-6	E420	0.00020	mg/L	0.331	0.332	0.507%	20%	----
		sulfur, total	7704-34-9	E420	0.50	mg/L	23.2	23.5	1.28%	20%	----
		tellurium, total	13494-80-9	E420	0.00020	mg/L	<0.00020	<0.00020	0	Diff <2x LOR	----
		thallium, total	7440-28-0	E420	0.000010	mg/L	<0.000010	<0.000010	0	Diff <2x LOR	----
		thorium, total	7440-29-1	E420	0.00010	mg/L	<0.00010	<0.00010	0	Diff <2x LOR	----
		tin, total	7440-31-5	E420	0.00010	mg/L	<0.00010	<0.00010	0	Diff <2x LOR	----
		titanium, total	7440-32-6	E420	0.00030	mg/L	<0.00030	<0.00030	0	Diff <2x LOR	----
		tungsten, total	7440-33-7	E420	0.00010	mg/L	<0.00010	<0.00010	0	Diff <2x LOR	----
		uranium, total	7440-61-1	E420	0.000010	mg/L	0.00103	0.00101	1.71%	20%	----
		vanadium, total	7440-62-2	E420	0.00050	mg/L	<0.00050	<0.00050	0	Diff <2x LOR	----
		zinc, total	7440-66-6	E420	0.0030	mg/L	0.130	0.131	0.704%	20%	----
		zirconium, total	7440-67-7	E420	0.00020	mg/L	<0.00020	<0.00020	0	Diff <2x LOR	----
Total Metals (QC Lot: 759827)											
WT2222908-001	Anonymous	mercury, total	7439-97-6	E508	0.0000050	mg/L	<0.0000050	<0.0000050	0	Diff <2x LOR	----
Aggregate Organics (QC Lot: 759939)											
WT2223152-003	Anonymous	biochemical oxygen demand [BOD]	----	E550	2.0	mg/L	6.1	6.1	0.0%	30%	----
Aggregate Organics (QC Lot: 759940)											
WT2223164-001	Anonymous	carbonaceous biochemical oxygen demand [CBOD]	----	E555	3.0	mg/L	<3.0	<3.0	0.0%	30%	----

Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Anions and Nutrients (QCLot: 762873)						
nitrate (as N)	14797-55-8	E235.NO3	0.02	mg/L	<0.020	----
Anions and Nutrients (QCLot: 762874)						
nitrite (as N)	14797-65-0	E235.NO2	0.01	mg/L	<0.010	----
Microbiological Tests (QCLot: 758969)						
coliforms, Escherichia coli [E. coli]	----	E010	1	MPN/100mL	<1	----
coliforms, total	----	E010	1	MPN/100mL	<1	----
Microbiological Tests (QCLot: 759017)						
heterotrophic plate count [HPC]	----	E012.HPC	1	CFU/mL	<1	----
Total Metals (QCLot: 759643)						
aluminum, total	7429-90-5	E420	0.003	mg/L	<0.0030	----
antimony, total	7440-36-0	E420	0.0001	mg/L	<0.00010	----
arsenic, total	7440-38-2	E420	0.0001	mg/L	<0.00010	----
barium, total	7440-39-3	E420	0.0001	mg/L	<0.00010	----
beryllium, total	7440-41-7	E420	0.00002	mg/L	<0.000020	----
bismuth, total	7440-69-9	E420	0.00005	mg/L	<0.000050	----
boron, total	7440-42-8	E420	0.01	mg/L	<0.010	----
cadmium, total	7440-43-9	E420	0.000005	mg/L	<0.0000050	----
calcium, total	7440-70-2	E420	0.05	mg/L	<0.050	----
cesium, total	7440-46-2	E420	0.00001	mg/L	<0.000010	----
chromium, total	7440-47-3	E420	0.0005	mg/L	<0.00050	----
cobalt, total	7440-48-4	E420	0.0001	mg/L	<0.00010	----
copper, total	7440-50-8	E420	0.0005	mg/L	<0.00050	----
iron, total	7439-89-6	E420	0.01	mg/L	<0.010	----
lead, total	7439-92-1	E420	0.00005	mg/L	<0.000050	----
lithium, total	7439-93-2	E420	0.001	mg/L	<0.0010	----
magnesium, total	7439-95-4	E420	0.005	mg/L	<0.0050	----
manganese, total	7439-96-5	E420	0.0001	mg/L	<0.00010	----
molybdenum, total	7439-98-7	E420	0.00005	mg/L	<0.000050	----
nickel, total	7440-02-0	E420	0.0005	mg/L	<0.00050	----
phosphorus, total	7723-14-0	E420	0.05	mg/L	<0.050	----
potassium, total	7440-09-7	E420	0.05	mg/L	<0.050	----
rubidium, total	7440-17-7	E420	0.0002	mg/L	<0.00020	----

Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Total Metals (QCLot: 759643) - continued						
selenium, total	7782-49-2	E420	0.00005	mg/L	<0.000050	----
silicon, total	7440-21-3	E420	0.1	mg/L	<0.10	----
silver, total	7440-22-4	E420	0.00001	mg/L	<0.000010	----
sodium, total	7440-23-5	E420	0.05	mg/L	<0.050	----
strontium, total	7440-24-6	E420	0.0002	mg/L	<0.00020	----
sulfur, total	7704-34-9	E420	0.5	mg/L	<0.50	----
tellurium, total	13494-80-9	E420	0.0002	mg/L	<0.00020	----
thallium, total	7440-28-0	E420	0.00001	mg/L	<0.000010	----
thorium, total	7440-29-1	E420	0.0001	mg/L	<0.00010	----
tin, total	7440-31-5	E420	0.0001	mg/L	<0.00010	----
titanium, total	7440-32-6	E420	0.0003	mg/L	<0.00030	----
tungsten, total	7440-33-7	E420	0.0001	mg/L	<0.00010	----
uranium, total	7440-61-1	E420	0.00001	mg/L	<0.000010	----
vanadium, total	7440-62-2	E420	0.0005	mg/L	<0.00050	----
zinc, total	7440-66-6	E420	0.003	mg/L	<0.0030	----
zirconium, total	7440-67-7	E420	0.0002	mg/L	<0.00020	----
Total Metals (QCLot: 759827)						
mercury, total	7439-97-6	E508	0.000005	mg/L	<0.0000050	----
Aggregate Organics (QCLot: 759939)						
biochemical oxygen demand [BOD]	----	E550	2	mg/L	<2.0	----
Aggregate Organics (QCLot: 759940)						
carbonaceous biochemical oxygen demand [CBOD]	----	E555	2	mg/L	<2.0	----

Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: **Water**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Anions and Nutrients (QCLot: 762873)									
nitrate (as N)	14797-55-8	E235.NO3	0.02	mg/L	2.5 mg/L	99.9	90.0	110	----
Anions and Nutrients (QCLot: 762874)									
nitrite (as N)	14797-65-0	E235.NO2	0.01	mg/L	0.5 mg/L	98.9	90.0	110	----
Total Metals (QCLot: 759643)									
aluminum, total	7429-90-5	E420	0.003	mg/L	0.1 mg/L	104	80.0	120	----
antimony, total	7440-36-0	E420	0.0001	mg/L	0.05 mg/L	105	80.0	120	----
arsenic, total	7440-38-2	E420	0.0001	mg/L	0.05 mg/L	105	80.0	120	----
barium, total	7440-39-3	E420	0.0001	mg/L	0.0125 mg/L	99.6	80.0	120	----
beryllium, total	7440-41-7	E420	0.00002	mg/L	0.005 mg/L	97.7	80.0	120	----
bismuth, total	7440-69-9	E420	0.00005	mg/L	0.05 mg/L	102	80.0	120	----
boron, total	7440-42-8	E420	0.01	mg/L	0.05 mg/L	93.8	80.0	120	----
cadmium, total	7440-43-9	E420	0.000005	mg/L	0.005 mg/L	101	80.0	120	----
calcium, total	7440-70-2	E420	0.05	mg/L	2.5 mg/L	98.3	80.0	120	----
cesium, total	7440-46-2	E420	0.00001	mg/L	0.0025 mg/L	105	80.0	120	----
chromium, total	7440-47-3	E420	0.0005	mg/L	0.0125 mg/L	99.8	80.0	120	----
cobalt, total	7440-48-4	E420	0.0001	mg/L	0.0125 mg/L	101	80.0	120	----
copper, total	7440-50-8	E420	0.0005	mg/L	0.0125 mg/L	100	80.0	120	----
iron, total	7439-89-6	E420	0.01	mg/L	0.05 mg/L	102	80.0	120	----
lead, total	7439-92-1	E420	0.00005	mg/L	0.025 mg/L	103	80.0	120	----
lithium, total	7439-93-2	E420	0.001	mg/L	0.0125 mg/L	102	80.0	120	----
magnesium, total	7439-95-4	E420	0.005	mg/L	2.5 mg/L	108	80.0	120	----
manganese, total	7439-96-5	E420	0.0001	mg/L	0.0125 mg/L	102	80.0	120	----
molybdenum, total	7439-98-7	E420	0.00005	mg/L	0.0125 mg/L	102	80.0	120	----
nickel, total	7440-02-0	E420	0.0005	mg/L	0.025 mg/L	101	80.0	120	----
phosphorus, total	7723-14-0	E420	0.05	mg/L	0.5 mg/L	110	80.0	120	----
potassium, total	7440-09-7	E420	0.05	mg/L	2.5 mg/L	105	80.0	120	----
rubidium, total	7440-17-7	E420	0.0002	mg/L	0.005 mg/L	105	80.0	120	----
selenium, total	7782-49-2	E420	0.00005	mg/L	0.05 mg/L	105	80.0	120	----
silicon, total	7440-21-3	E420	0.1	mg/L	0.5 mg/L	106	80.0	120	----
silver, total	7440-22-4	E420	0.00001	mg/L	0.005 mg/L	96.5	80.0	120	----
sodium, total	7440-23-5	E420	0.05	mg/L	2.5 mg/L	105	80.0	120	----
strontium, total	7440-24-6	E420	0.0002	mg/L	0.0125 mg/L	103	80.0	120	----

Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
					Concentration	LCS	Low	High	Qualifier
Total Metals (QCLot: 759643) - continued									
sulfur, total	7704-34-9	E420	0.5	mg/L	2.5 mg/L	95.3	80.0	120	----
tellurium, total	13494-80-9	E420	0.0002	mg/L	0.005 mg/L	99.8	80.0	120	----
thallium, total	7440-28-0	E420	0.00001	mg/L	0.05 mg/L	103	80.0	120	----
thorium, total	7440-29-1	E420	0.0001	mg/L	0.005 mg/L	93.4	80.0	120	----
tin, total	7440-31-5	E420	0.0001	mg/L	0.025 mg/L	99.3	80.0	120	----
titanium, total	7440-32-6	E420	0.0003	mg/L	0.0125 mg/L	98.8	80.0	120	----
tungsten, total	7440-33-7	E420	0.0001	mg/L	0.005 mg/L	103	80.0	120	----
uranium, total	7440-61-1	E420	0.00001	mg/L	0.00025 mg/L	106	80.0	120	----
vanadium, total	7440-62-2	E420	0.0005	mg/L	0.025 mg/L	103	80.0	120	----
zinc, total	7440-66-6	E420	0.003	mg/L	0.025 mg/L	102	80.0	120	----
zirconium, total	7440-67-7	E420	0.0002	mg/L	0.005 mg/L	99.5	80.0	120	----
Total Metals (QCLot: 759827)									
mercury, total	7439-97-6	E508	0.000005	mg/L	0.0001 mg/L	108	80.0	120	----
Aggregate Organics (QCLot: 759939)									
biochemical oxygen demand [BOD]	----	E550	2	mg/L	198 mg/L	104	85.0	115	----
Aggregate Organics (QCLot: 759940)									
carbonaceous biochemical oxygen demand [CBOD]	----	E555	2	mg/L	198 mg/L	103	85.0	115	----

Matrix Spike (MS) Report

A Matrix Spike (MS) is a randomly selected intra-laboratory replicate sample that has been fortified (spiked) with test analytes at known concentration, and processed in an identical manner to test samples. Matrix Spikes provide information regarding analyte recovery and potential matrix effects. MS DQO exceedances due to sample matrix may sometimes be unavoidable; in such cases, test results for the associated sample (or similar samples) may be subject to bias. ND – Recovery not determined, background level >= 1x spike level.

Sub-Matrix: **Water**

					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	Concentration	Target	MS	Low	High	Qualifier
Anions and Nutrients (QCLot: 762873)										
WT2223236-001	tw3	nitrate (as N)	14797-55-8	E235.NO3	ND mg/L	2.5 mg/L	ND	75.0	125	----
Anions and Nutrients (QCLot: 762874)										
WT2223236-001	tw3	nitrite (as N)	14797-65-0	E235.NO2	0.498 mg/L	0.5 mg/L	99.6	75.0	125	----
Total Metals (QCLot: 759643)										
WT2223166-001	Anonymous	aluminum, total	7429-90-5	E420	0.100 mg/L	0.1 mg/L	100	70.0	130	----
		antimony, total	7440-36-0	E420	0.0520 mg/L	0.05 mg/L	104	70.0	130	----
		arsenic, total	7440-38-2	E420	0.0528 mg/L	0.05 mg/L	106	70.0	130	----
		barium, total	7440-39-3	E420	ND mg/L	0.0125 mg/L	ND	70.0	130	----
		beryllium, total	7440-41-7	E420	0.00474 mg/L	0.005 mg/L	94.8	70.0	130	----
		bismuth, total	7440-69-9	E420	0.0473 mg/L	0.05 mg/L	94.6	70.0	130	----
		boron, total	7440-42-8	E420	0.044 mg/L	0.05 mg/L	89.0	70.0	130	----
		cadmium, total	7440-43-9	E420	0.00498 mg/L	0.005 mg/L	99.5	70.0	130	----
		calcium, total	7440-70-2	E420	ND mg/L	2.5 mg/L	ND	70.0	130	----
		cesium, total	7440-46-2	E420	0.00262 mg/L	0.0025 mg/L	105	70.0	130	----
		chromium, total	7440-47-3	E420	0.0129 mg/L	0.0125 mg/L	103	70.0	130	----
		cobalt, total	7440-48-4	E420	0.0126 mg/L	0.0125 mg/L	101	70.0	130	----
		copper, total	7440-50-8	E420	0.0117 mg/L	0.0125 mg/L	93.8	70.0	130	----
		iron, total	7439-89-6	E420	0.048 mg/L	0.05 mg/L	97.1	70.0	130	----
		lead, total	7439-92-1	E420	0.0242 mg/L	0.025 mg/L	96.6	70.0	130	----
		lithium, total	7439-93-2	E420	0.0119 mg/L	0.0125 mg/L	94.9	70.0	130	----
		magnesium, total	7439-95-4	E420	ND mg/L	2.5 mg/L	ND	70.0	130	----
		manganese, total	7439-96-5	E420	0.0124 mg/L	0.0125 mg/L	99.6	70.0	130	----
		molybdenum, total	7439-98-7	E420	0.0127 mg/L	0.0125 mg/L	102	70.0	130	----
		nickel, total	7440-02-0	E420	0.0244 mg/L	0.025 mg/L	97.7	70.0	130	----
		phosphorus, total	7723-14-0	E420	0.513 mg/L	0.5 mg/L	102	70.0	130	----
		potassium, total	7440-09-7	E420	2.58 mg/L	2.5 mg/L	103	70.0	130	----
		rubidium, total	7440-17-7	E420	0.00528 mg/L	0.005 mg/L	106	70.0	130	----
		selenium, total	7782-49-2	E420	0.0513 mg/L	0.05 mg/L	103	70.0	130	----
		silicon, total	7440-21-3	E420	ND mg/L	0.5 mg/L	ND	70.0	130	----
		silver, total	7440-22-4	E420	0.00457 mg/L	0.005 mg/L	91.5	70.0	130	----
		sodium, total	7440-23-5	E420	ND mg/L	2.5 mg/L	ND	70.0	130	----

Sub-Matrix: **Water**

					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	Concentration	Target	MS	Low	High	Qualifier
Total Metals (QCLot: 759643) - continued										
WT2223166-001	Anonymous	strontium, total	7440-24-6	E420	ND mg/L	0.0125 mg/L	ND	70.0	130	----
		sulfur, total	7704-34-9	E420	ND mg/L	2.5 mg/L	ND	70.0	130	----
		tellurium, total	13494-80-9	E420	0.00469 mg/L	0.005 mg/L	93.7	70.0	130	----
		thallium, total	7440-28-0	E420	0.0491 mg/L	0.05 mg/L	98.2	70.0	130	----
		thorium, total	7440-29-1	E420	0.00474 mg/L	0.005 mg/L	94.8	70.0	130	----
		tin, total	7440-31-5	E420	0.0252 mg/L	0.025 mg/L	101	70.0	130	----
		titanium, total	7440-32-6	E420	0.0126 mg/L	0.0125 mg/L	101	70.0	130	----
		tungsten, total	7440-33-7	E420	0.00511 mg/L	0.005 mg/L	102	70.0	130	----
		uranium, total	7440-61-1	E420	ND mg/L	0.00025 mg/L	ND	70.0	130	----
		vanadium, total	7440-62-2	E420	0.0262 mg/L	0.025 mg/L	105	70.0	130	----
		zinc, total	7440-66-6	E420	ND mg/L	0.025 mg/L	ND	70.0	130	----
		zirconium, total	7440-67-7	E420	0.00504 mg/L	0.005 mg/L	101	70.0	130	----
Total Metals (QCLot: 759827)										
WT2223146-001	Anonymous	mercury, total	7439-97-6	E508	0.000100 mg/L	0.0001 mg/L	100	70.0	130	----

Chain of Custody (COC) / Analytical Request Form

COC Number: 20 - 1002809

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Environmental Division
Waterloo
Work Order Reference
WT2223236

Telephone : +1 519 886 6910

Report To	Contact and company name below will appear on the final report	Reports / Recipients	Turnaround Time (TAT) Requested
Company:	Stovel and Associates INC.	Select Report Format: ☒ PDF ☒ EXCEL ☐ EDD (DIGITAL)	☐ Routine [R] if received by 3pm M-F - no surcharges apply
Contact:	Scott Stovel	Merge QC/QCI Reports with COA ☐ YES ☐ NO ☐ N/A	☐ 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimu
Phone:	226-820-0343	☐ Compare Results to Criteria on Report - provide details below if box checked	☐ 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimu
	Company address below will appear on the final report	Select Distribution: ☐ EMAIL ☐ MAIL ☐ FAX	☐ 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimu
Street:	451 Wilmot-Mt. Elgin Road	Email 1 or Fax: Stovel.associates@outlook.com	☐ 1 day [E] if received by 3pm M-F - 100% rush surcharge minimu
City/Province:	Fergus, ON	Email 2: Rob.Stovel.jr@outlook.com	☐ Same day [E2] if received by 10am M-S - 200% rush surcharge. Add
Postal Code:	N1M 1T9	Email 3: Scott.Stovel@gmail.com	may apply to rush requests on weekends, statutory holidays and non-
Invoice To	Same as Report To ☐ YES ☐ NO	Invoice Recipients	Date and Time Required for all E&P TATs:
	Copy of Invoice with Report ☐ YES ☐ NO	Select Invoice Distribution: ☒ EMAIL ☐ MAIL ☐ FAX	For all tests with rush TATs requested, please
Company:		Email 1 or Fax	Analysis Re
Contact:		Email 2	

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:		AFE/Cost Center:	PO#:
Job #:	ARKell Property	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (ALS use only):	WT2223236 AH	ALS Contact:	Sampler: [redacted]

ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	TC, EC, HPC	NO2 / NO3	Metals	BOD, CBOD	Total Mercury	SAMPLES ON HOLD	EXTENDED STORAGE REQUIRE	SUSPECTED HAZARD (see note
	TW3	25-11-2022	14:15	Water		✓	✓	✓					
	TW3-Mid	25-11-2022	17:05	Water					✓	✓			
	TW3-End	25-11-2022	17:05	Water		✓	✓	✓					

Indicate Filtered (F), Preserved (P) or Filtered and

Drinking Water (DW) Samples[1] (client use)	Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)
Are samples taken from a Regulated DW System? ☐ YES ☒ NO	
Are samples for human consumption/ use? ☒ YES ☐ NO	

SAMPLE RECEIPT DETAILS (ALS use only)

Cooling Method: ☐ NONE ☐ ICE ☒ ICE PACKS ☐ FROZEN ☐ COOLING INITIATED

Submission Comments identified on Sample Receipt Notification: ☐ YES ☐ NO

Cooler Custody Seals Intact: ☐ YES ☐ N/A Sample Custody Seals Intact: ☐ YES ☐ N/A

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
				4.9			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (ALS use only)			FINAL SHIPMENT RECEPTION (ALS use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by: AH	Date: 2022-11-26	Time: 12:30 PM

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

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ALS 466 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

MA B-311 ; GC-146 , MM-460

ALS Canada Ltd.

CERTIFICATE OF ANALYSIS

Work Order	: **WT2223354**	Page	: 1 of 4
Client	: **Cash Clients Canada**	Laboratory	: Waterloo - Environmental
Contact	: Scott Stovel	Account Manager	: Candice Hunter
Address	: 651 Orangeville Road Fergus ON Canada N1M 1T9	Address	: 60 Northland Road, Unit 1 Waterloo ON Canada N2V 2B8
Telephone	: ----	Telephone	: +1 519 886 6910
Project	: Arkell Property	Date Samples Received	: 28-Nov-2022 17:00
PO	: ----	Date Analysis Commenced	: 29-Nov-2022
C-O-C number	: 20-1002857	Issue Date	: 09-Dec-2022 11:36
Sampler	: Scott Stovel		
Site	: ----		
Quote number	: Stovel and Associates Inc.		
No. of samples received	: 1		
No. of samples analysed	: 1		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Amanda Ganouri-Lumsden	Department Manager - Microbiology and Prep	Microbiology, Waterloo, Ontario
Jon Fisher	Department Manager - Inorganics	Inorganics, Waterloo, Ontario
Jon Fisher	Department Manager - Inorganics	Metals, Waterloo, Ontario

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances

LOR: Limit of Reporting (detection limit).

Unit	*Description*
µg/L	micrograms per litre
CFU/mL	colony forming units per millilitre
mg/L	milligrams per litre
MPN/100mL	most probable number per hundred millilitres

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Qualifiers

Qualifier	*Description*
BODL	*Limit of Reporting for BOD was increased to account for the largest volume of sample tested.*
TNTC	*Too numerous to count (microbiology test). Overcrowded, confluent &/or non-identifiable microbial growth prevented identification & measurement of target bacterial colonies.*

Analytical Results

Sub-Matrix: Drinking Water (Matrix: Water)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID: TW3	----	----	----	----
					Client sampling date / time: 28-Nov-2022 15:30	----	----	----	----
					WT2223354-001	--------	--------	--------	--------
					Result	---	---	---	---
Anions and Nutrients									
nitrate (as N)	14797-55-8	E235.NO3	0.020	mg/L	4.97	----	----	----	----
nitrite (as N)	14797-65-0	E235.NO2	0.010	mg/L	<0.010	----	----	----	----
Microbiological Tests									
coliforms, Escherichia coli [E. coli]	----	E010	1	MPN/100mL	Not Detected	----	----	----	----
coliforms, total	----	E010	1	MPN/100mL	Not Detected	----	----	----	----
heterotrophic plate count [HPC]	----	E012.HPC	1	CFU/mL	>200 TNTC	----	----	----	----
Total Metals									
aluminum, total	7429-90-5	E432	10	µg/L	12	----	----	----	----
antimony, total	7440-36-0	E432	0.60	µg/L	<0.60	----	----	----	----
arsenic, total	7440-38-2	E432	1.0	µg/L	<1.0	----	----	----	----
barium, total	7440-39-3	E432	10	µg/L	59	----	----	----	----
beryllium, total	7440-41-7	E432	1.0	µg/L	<1.0	----	----	----	----
bismuth, total	7440-69-9	E432	1.0	µg/L	<1.0	----	----	----	----
boron, total	7440-42-8	E432	50	µg/L	<50	----	----	----	----
cadmium, total	7440-43-9	E432	0.10	µg/L	<0.10	----	----	----	----
calcium, total	7440-70-2	E432	0.50	mg/L	84.8	----	----	----	----
cesium, total	7440-46-2	E432	0.10	µg/L	<0.10	----	----	----	----
chromium, total	7440-47-3	E432	1.0	µg/L	<1.0	----	----	----	----
cobalt, total	7440-48-4	E432	0.50	µg/L	<0.50	----	----	----	----
copper, total	7440-50-8	E432	1.0	µg/L	<1.0	----	----	----	----
iron, total	7439-89-6	E432	50	µg/L	671	----	----	----	----
lead, total	7439-92-1	E432	1.0	µg/L	5.2	----	----	----	----
lithium, total	7439-93-2	E432	100	µg/L	<100	----	----	----	----
magnesium, total	7439-95-4	E432	0.50	mg/L	33.1	----	----	----	----
manganese, total	7439-96-5	E432	1.0	µg/L	14.5	----	----	----	----
mercury, total	7439-97-6	E508	0.100	µg/L	<0.100	----	----	----	----
molybdenum, total	7439-98-7	E432	1.0	µg/L	<1.0	----	----	----	----
nickel, total	7440-02-0	E432	2.0	µg/L	<2.0	----	----	----	----
phosphorus, total	7723-14-0	E432	0.050	mg/L	<0.050	----	----	----	----

Analytical Results

Sub-Matrix: Drinking Water (Matrix: Water)					Client sample ID	TW3	----	----	----	----
					Client sampling date / time	28-Nov-2022 15:30	----	----	----	----
Analyte	CAS Number	Method	LOR	Unit		WT2223354-001	--------	--------	--------	--------
						Result	----	----	----	----
Total Metals										
potassium, total	7440-09-7	E432	1.0	mg/L		1.6	----	----	----	----
rubidium, total	7440-17-7	E432	2	µg/L		<2	----	----	----	----
selenium, total	7782-49-2	E432	1.0	µg/L		<1.0	----	----	----	----
silicon, total	7440-21-3	E432	1000	µg/L		6300	----	----	----	----
silver, total	7440-22-4	E432	0.10	µg/L		<0.10	----	----	----	----
sodium, total	7440-23-5	E432	0.50	mg/L		82.0	----	----	----	----
strontium, total	7440-24-6	E432	1.0	µg/L		130	----	----	----	----
sulfur, total	7704-34-9	E432	500	µg/L		7490	----	----	----	----
tellurium, total	13494-80-9	E432	1.0	µg/L		<1.0	----	----	----	----
thallium, total	7440-28-0	E432	0.30	µg/L		<0.30	----	----	----	----
thorium, total	7440-29-1	E432	1.0	µg/L		<1.0	----	----	----	----
tin, total	7440-31-5	E432	1.0	µg/L		<1.0	----	----	----	----
titanium, total	7440-32-6	E432	2.0	µg/L		<2.0	----	----	----	----
tungsten, total	7440-33-7	E432	10	µg/L		<10	----	----	----	----
uranium, total	7440-61-1	E432	2.0	µg/L		<2.0	----	----	----	----
vanadium, total	7440-62-2	E432	1.0	µg/L		<1.0	----	----	----	----
zinc, total	7440-66-6	E432	3.0	µg/L		50.4	----	----	----	----
zirconium, total	7440-67-7	E432	4.0	µg/L		<4.0	----	----	----	----
Aggregate Organics										
biochemical oxygen demand [BOD]	----	E550	2.0	mg/L		<3.0 BODL	----	----	----	----
carbonaceous biochemical oxygen demand [CBOD]	----	E555	2.0	mg/L		<3.0 BODL	----	----	----	----

Please refer to the General Comments section for an explanation of any qualifiers detected.

Chain of Custody (COC) / Analytical Request Form

COC Number: 20

Page

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Canada Toll Free: 1 800 668 9878

Environmental Division Waterloo

Work Order Reference WT2223354

Telephone : +1 519 886 6910

Report To	Contact and company name below will appear on the final report
Company:	Stovel and Associates INC.
Contact:	Scott Stovel
Phone:	226-820-0343
	Company address below will appear on the final report
Street:	651 Orangeville Road
City/Province:	Fergus, ON
Postal Code:	N1M 1T9
Invoice To	Same as Report To ☐ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	

Reports / Recipients

Select Report Format: ☒ PDF ☒ EXCEL ☐ EDD (DIGITAL)

Merge QC/QCI Reports with COA ☐ YES ☐ NO ☐ N/A

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☐ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: Stovel.associates@outlook.com

Email 2: Rob Stovel@rogers.com

Email 3: Scott.Stovel@gmail.com

Invoice Recipients

Select Invoice Distribution: ☒ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax:

Email 2:

Turnaround Time (TAT) Requested

☐ Routine [R] if received by 3pm M-F - no surcharges apply

☐ 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimum

☐ 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimum

☐ 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimum

☐ 1 day [E] if received by 3pm M-F - 100% rush surcharge minimum

☐ Same day [E2] if received by 10am M-S - 200% rush surcharge. Additional may apply to rush requests on weekends, statutory holidays and non-routine

Date and Time Required for all E&P TATs:

For all tests with rush TATs requested, please contact your AM to confirm availability.

Project Information

ALS Account # / Quote #:

Job #: Arkell Property

PO / AFE:

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (ALS use only): WT2223354

ALS Contact:

Sampler: [redacted]

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	TKN, EC, HPC	NO2/NO3	Metals	BOD, CBOD	Mercury (total)	SAMPLES ON HOLD	EXTENDED STORAGE REQUIRED	SUSPECTED HAZARD (see notes)
	TW3	28-11-2022	15:30	Water		✓	✓	✓	✓	✓			

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☒ NO

Are samples for human consumption/ use? ☒ YES ☐ NO

Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)

SAMPLE RECEIPT DETAILS (ALS use only)

Cooling Method: ☐ NONE ☐ ICE ☒ ICE PACKS ☐ FROZEN ☐ COOLING INITIATED

Submission Comments identified on Sample Receipt Notification: ☐ YES ☐ NO

Cooler Custody Seals Intact: ☐ YES ☐ N/A Sample Custody Seals Intact: ☐ YES ☐ N/A

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
				0.9			

SHIPMENT RELEASE (client use)

Released by:	Date:	Time:

INITIAL SHIPMENT RECEPTION (ALS use only)

Received by:	Date:	Time:

FINAL SHIPMENT RECEPTION (ALS use only)

Received by:	Date:	Time:
[redacted]	Nov 28, 22	17

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

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Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

B-313; GC-149; MM-465

GROUNDWATER SUPPLY ASSESSMENT

PROPOSED RESIDENTIAL DEVELOPMENT

ARKELL, ONTARIO
(TOWNSHIP OF PUSLINCH)

Prepared for:

Stovel and Associates Inc.
Timberworx Custom Homes Inc.

March 2023

Prepared by:

ARL Groundwater Resources Ltd.

LIST OF TABLES

1 Summary of Borehole Log Information (from R.J. Burnside & Associates Limited 2006)

2 Existing Water Well Record Information (Arkell)

LIST OF FIGURES

1 Site Location

2 Borehole and Existing Water Well Locations

3 Test Well Locations (2022)

4 Graph of TW1/2022 Pumping Test (Arithmetic Scale)

5 Graph of TW2/2022 Pumping Test (Arithmetic Scale)

6 Graph of TW3/2022 Pumping Test (Arithmetic Scale)

APPENDICES

A - Water Well Records for the Test Wells (2022)

B - Additional Graphs of Pumping Test Results for the Test Wells (2022)

C - Lab Reports for Water Quality Analyses

1.0 INTRODUCTION

ARL Groundwater Resources Ltd. was retained by Timberworx Inc. and Stovel & Associates Inc. to undertake to undertake a groundwater supply assessment for a proposed multi-lot residential development in and adjacent to the Hamlet of Arkell located in the Township of Puslinch. The development property is understood to be within Part Lots 7, 8 & 9, Concession 10, Township of Puslinch, County of Wellington (**FIGURE 1**).

The proposed residential development is to be serviced by individual private wells and wastewater disposal systems. In general, the groundwater supply assessment presented in this report addresses the requirements of the guideline D-5-5 (Private Wells: Water Supply Assessment), published by the Ontario Ministry of the Environment, Conservation and Parks (MECP). The most recent revision to Guideline D-5-5 is understood to have been made in August 1996, and the MECP has continued to publish the guideline in its current form up until at least December 2018.

2.0 BACKGROUND INFORMATION ON THE SITE HYDROGEOLOGY

The property was previously considered for development in about 2005-2006. At that time R.J. Burnside & Associates Limited (RJB 2006) completed a hydrogeological review and predictive nitrate assessment for a proposed 38 single family residential lot development at the site. The land size for the development was reported to be 21.68 ha.

Some of the information presented in the following discussion is based in part on the results of the RBJ (2006) report.

2.1 QUATERNARY (SURFICIAL) GEOLOGY

Quaternary geological mapping by P.F. Karrow in the 1960s (Map 2153, Geological Report 61, Ontario Department of Mines, 1968) indicates that the surficial sediments on the property are described as outwash gravel. Wentworth Till occurs to the east and north of the property where it occurs as a surface expression of the Paris Moraine. Karrow (1968) describes the Wentworth Till as predominantly a sand till (typically 49% sand, 33% silt, 18% clay). RBJ (2006) reports that the Port Stanley Till (sandy silt till) is present in the general area, but this is not evident from the mapping by Karrow. Kame and esker deposits (consisting of sand and gravel) are mapped directly beneath the centre of the Hamlet of Arkell and to the north of the Hamlet where Arkell Road rises in elevation towards an intersection with the Paris Moraine.

RBJ (2006; Figure 5, Cross-Section A-A') indicates that overburden sediment thickness beneath the proposed development property is approximately 15 - 20 m. Sediment types are shown to consist of sand, gravel and stones to silty sand, clay, and stones. In general,

the overburden materials appear to be mostly coarse-grained materials.

2.2 BEDROCK GEOLOGY

Geological mapping of the Toronto to Windsor corridor by Sanford (Geological Survey of Canada, 1969) includes the study area. The mapping indicates that the Hamlet of Arkell and the proposed development property are underlain by the Eramosa Member of the Guelph Fm. The Eramosa Member is shown as occurring as a relatively narrow band in the area and is described as a dark brown to black bituminous dolomite and shale that intertongues with the basal Guelph Formation. The Eramosa Member is bordered to the west/southwest by the main Guelph Fm. unit, described by Sanford as a cream to brown, fine to medium crystalline dolomite containing numerous bioherm reefs. The Guelph Fm. sub-crop is shown to extend over a wide area to the west of Arkell, including the cities of Guelph, Cambridge, and a large part of Kitchener. The Eramosa Member is bordered on the east/northeast side by the Amabel Group, described as a grey and blue-grey medium crystalline dolomite containing numerous bioherm reefs. Stratigraphically, the Guelph Fm. overlies the Eramosa Member, which overlies the Amabel Group. The regional dip of the formations is to the southwest towards the Michigan Basin.

The bedrock nomenclature associated with the Guelph-Eramosa-Amabel stratigraphic sequence was revised by Brunton in about 2006. The corresponding revised stratigraphic sequence in descending order (Brunton 2006) is as follows: Guelph Fm., Eramosa Fm., Goat Island Fm., Gasport Fm., and Irondequoit Fm. In general, the former un-subdivided Amabel Fm. has now been subdivided into 3 separate formations (Goat Island, Gasport, Irondequoit).

2.3 BOREHOLE INFORMATION

R.J. Burnside and Associates Limited (RBJ 2006) provide the results of 10 boreholes drilled into the overburden sediments at the site using hollow stem auger drilling equipment. Two of the boreholes (BH1, BH10) were equipped as single monitoring wells for measuring groundwater levels in the overburden sediments. The borehole locations are shown in **FIGURE 2**. Based on the borehole logs as presented in the RBJ (2006) report, a summary of the borehole results is provided in **TABLE 1**.

TABLE 1
SUMMARY OF BOREHOLE LOG INFORMATION
(from RJB 2006)

Borehole Number	Total Depth	Sediment Description	Sediment Description	Bedrock Encountered
BH1 (MW1)	9.5 m (31.2 ft.)	Mostly sand & gravel to 7.7 m (25.2 ft.)	Silt, some clay, sand & gravel (7.7 - 9.5 m)	Yes
BH2	6.6 m (21.7 ft.)	Mostly sand & gravel to 6.6 m		No
BH3	6.6 m (21.7 ft.)	Mostly sand & gravel to 6.6 m		No
BH4	6.3 m (20.7 ft.)	Mostly sand & gravel to 6.3 m		No
BH5	6.6 m (21.7 ft.)	Mostly sand & gravel to 6.6 m		No
BH6	3.3 m (10.8 ft.)	Mostly sand & gravel to 3.3 m		No
BH7	7.3 m (24 ft.)	Mostly sand & gravel to 7.3 m		Uncertain
BH8	5.2 m (17.1 ft.)	Mostly sand & gravel to 5.2 m		No
BH9	6.2 m (20.3 ft.)	Mostly sand & gravel to 6.2 m		No
BH10 (MW2)	12.6 m (41.3 ft.)	Mostly sand & gravel to 6.9 m	Gravel-silt till to 10.1 m, interbedded sand, silt, till (10.1 - 12.6 m)	No

RBJ (2006) reported one round of water levels measurements recorded in the two monitoring wells approximately 2 weeks after the borehole drilling and well installation program (January 26, 2006). The water level measurements indicated that there was approximately 2 m of standing water in the two wells.

The borehole logs indicate that sand and gravel are the predominant sediment types present at the site to depths of at least 6 - 8 m (20 - 26 ft.).

2.4 WATER WELL RECORD INFORMATION

Existing water well record locations in the vicinity of Arkell were obtained from the MECP water well record database and are shown in **FIGURE 2**. The locations in **FIGURE 2** are based on a combination of the well coordinates provided in the MECP database and a site inspection to confirm apparent well locations. The water well records provide useful information with respect to the hydrogeological conditions at the site. Summary information from the water well records is provided in **TABLE 2**.

TABLE 2
Existing Water Well Record Information (Arkell)

Water Well Record	Date	Depth to Bedrock (ft.)	Brown Limestone or Rock Thickness (ft.)	Dark Brown Limestone or Rock Thickness (ft.)	Grey Limestone or Rock Thickness (ft.)	Brown Limestone or Rock Thickness (ft.)	Total Well Depth (ft.)
7046276	Jun. 25, 2007	49	36	75	80	-	240
6715979	Oct. 3, 2006	50	40	70	60	20	240
6715668	Jan. 10, 2006	49	41	65	75	10	240
6715483	Aug. 31, 2005	50	50	-	-	-	100
7100299	Dec. 31, 2007	54	24	97	25	-	200
7046277	Jun. 21, 2007	51	24	95	50	-	220
6712507	May 1, 1998	39	66	60	36	-	201
6706077	Jun. 24, 1976	33	37	25	-	-	95
6712521	Apr. 14, 1998	29	81	10	-	-	120
6702775	Mar. 20, 1965	46	54	25	-	-	125
6702773	July 4, 1964	55	75	10	-	-	140
6710001	Sept. 11, 1989	39	41	-	-	-	80

The water well record information indicates that the overburden thickness at the site ranges from approximately 9 - 17 m (30 - 55 ft.). The sediments are described as clay, sand and gravel, and boulders. Most of the existing water well records describe clay and stones in the upper part of the overburden sequence and clay and sand-gravel in the lower part of the overburden sequence. When interpreting the water well record information, it is important to note that most of the wells were targeting the bedrock aquifer system. Accurate sampling and descriptions of the overburden sediments was not a priority during drilling of the wells.

The existing water well record descriptions indicate that the following stratigraphic sequence appears to occur at the site; the upper 7 - 25 m (24 - 81 ft.) of bedrock (including the bedrock subcrop) is part of the Guelph Fm. (brown dolostone). The Eramosa Fm. occurs below the Guelph Fm., and is described by Brunton (OGS 2011) as a dark brown to black dolostone unit; the darker colour is due to a higher shale/organic content in the rock compared to the dolostone of the overlying Guelph Fm. The existing water well records indicate that thickness of the Eramosa Fm. is approximately 18 - 39 m (60 - 100 ft.) at the site.

At least 15 - 24 m (50 - 80 ft.) of grey rock occurs below the Eramosa Fm. The grey rock is interpreted as the Goat Island/Gasport Fm. (formerly referred to as unsubdivided Amabel Fm.). For the purposes of this report, the lower grey rock unit will be referred to as the Gasport Fm.

The Guelph Fm. is interpreted as the upper bedrock aquifer at the site. The Gasport Fm. are interpreted as a lower bedrock aquifer at the site. The Guelph Fm. is interpreted to be an unconfined to semi-confined aquifer as there is limited evidence of a confining layer in the overburden sediments at the site. Recharge to the Guelph Fm. is inferred as being relatively high due to the absence or limited occurrence of low hydraulic conductivity materials (such as silt and clay till) in the overlying overburden sediments. The Gasport

Fm. is interpreted as a semi-confined to confined aquifer; in this case the overlying Eramosa Fm. has a high shale content that imparts some aquitard characteristics to the unit and impedes leakage across the Eramosa Fm. from the overlying Guelph Fm.

The earlier bedrock geological mapping by Sanford (1969) showing the Eramosa Fm. as the bedrock subcrop in Arkell appears to be out-of-date. Based on the water well record information and the 2022 test well information (described in the following section), the Guelph Fm. is interpreted as forming the bedrock subcrop at the site.

3.0 TEST WELL INVESTIGATION

2.1 GENERAL

It is understood that the proposed development could eventually consist of up to about 50 individual single family residential lots on the 22-ha property. However, the initial stage of development may consist of something less than 50 lots on only a portion of the property. Based on this consideration, a program of 3 test wells was undertaken at the site in November 2022.The test well locations are shown in **FIGURE 3**.

2.2 TEST WELL PROGRAM

A test well program was designed so that the 3 test wells would be constructed in the lower aquifer (Gasport Fm.) at the site. The well design was selected to provide additional protection from surface sources of contamination.

The well design included drilling and installation of 150 mm (6 inch) nominal steel outer casing through the overburden sediments and into the top of the bedrock. The annular space surrounding the outer well casing was sealed with a bentonite slurry. Drilling of the bedrock commenced inside of the outer casing and continued to the base of the Eramosa Fm. A nominal 130 mm (5 inch) inner steel casing equipped with packers was installed to the base of Eramosa Fm. The packers are intended to serve as an annular seal around the inner casing. Drilling of a nominal 127 mm (5 inch) open hole continued inside of the inner steel casing, eventually terminating in the Gasport Fm. Final well depths are as follows.

TW1/2022: 72.5 m (238 ft.)
TW2/2022: 73.5 m (241 ft.)
TW3/2022: 79.6 m (261 ft.).

All work was performed by a licensed water well contractor. Water well records for the three test wells are included as **APPENDIX A**.

2.3 TEST WELL PUMPING TEST RESULTS

Constant rate pumping tests were performed by the water well contractor at each of the three test wells. Pumping rates were the same for all 3 tests (45.5 L/min; 10 Igal./min) and the pumping tests lasted for 6 hours. Flow rate for each test was recorded with a calibrated flow meter. The test pumping rates exceed the peak demand attributed to a four-person household (4 x 3.75 L/min = 15 L/min or 1,800 L/day) as specified in MECP guideline D-5-5.

Manual water level measurements were recorded during each pumping test. Manual water level recovery measurements were also recorded for 40 - 90 minutes following shutdown of the pump in each of the 3 test wells.

The dates of each pumping test were as follows:

TW1/2022 - November 21, 2022
TW2/2022 - November 23, 2022
TW3/2022 - November 25, 2022.

The results of the pumping test at TW1/2022 with elapsed time at an arithmetic scale are shown in **FIGURE 4**. The graph shows that water levels decline at a consistent rate of drawdown from about 1 minute until pump shutdown at an elapsed time of 6 hours (360 minutes). Water levels recover sharply for the first minute following pump shutdown, mirroring the initial drawdown observed during the first minute of the test. Water levels then recover at about the same rate in reverse as the drawdown trend.

The results of the pumping test at TW2/2022 with elapsed time at an arithmetic scale are shown in **FIGURE 5**. The graph shows that water levels decline at a relatively steep rate for the first 10 minutes of pumping before levelling off and approaching steady- state for about the next 215 minutes (3.5 hours into the pumping test). At that point water levels drop sharply by approximately 11 m, followed by a steady drawdown trend for the next 2 hours, at which time the pump is shut-off. After pump shutdown, water levels follow a steady recovery to within 4 m of the pre-test level after 40 minutes. The sudden decline in water level observed at 3.5 hours into the pumping test is interpreted as a probable boundary condition affecting one or more of the fractures/producing zones in the well.

The results of the pumping test at TW3/2022 with elapsed time at an arithmetic scale are shown in **FIGURE 6**. Water levels at TW3/2022 decline at a relatively steep rate for the first 15 minutes of pumping before levelling off for the next 60 minutes, and then following a recovery trend for the remainder of the pumping portion of the test. Recovery to the pre-test level essentially occurs within 75 minutes of pump shutdown. The apparent recovery in water levels measured during the pumping portion of the test may reflect ongoing development of some of the fractures/producing zones during the pumping test.

The results from the 3 pumping tests indicate that the test wells can easily meet the water quantity requirements of a single-family residence. Additional wells at the site can be expected to yield similar performance with respect to water quantity.

Additional graphs showing pumping water level and drawdown versus a log time scale for the three pumping tests are included in **APPENDIX B**.

2.4 WATER QUALITY TEST RESULTS

Water samples were collected from the three test wells during the pumping tests for water quality analysis. The water samples were collected at the following intervals during each test:

TW1 - samples collected after an elapsed time of approximately two hours.
TW2 - samples collected at approximately 1.5, 2.5, 4 hours.
TW3 - samples collected at approximately 3 and 6 hours.
TW3 - repeat set of samples collected at 3 hours during a second test.

The water samples were submitted to a commercial analytical laboratory (ALS Environmental - Waterloo, Ontario) for testing of parameters related to drinking water quality. The lab reports are included as an **APPENDIX C**.

Results from TW1

The water samples collected from TW1 were analyzed by the lab for a comprehensive list of parameters, including:

- Hardness, Total Dissolved Solids (TDS)
- Anions (including chloride, fluoride, nitrate, nitrite, sulphate, sulphide)
- Cyanide
- Bacteria (E. coli, total coliforms)
- Metals (including antimony, arsenic, barium, boron, cadmium, chromium, selenium, uranium)
- Volatile Organic Compounds (VOC)
- Benzo(a)pyrene (a polycyclic aromatic hydrocarbon)
- Semi-volatile organics (including Aldrin + Dieldrin and NDMA)
- Organochlorine Pesticides
- Herbicides and Pesticides.

The list included many of the parameters with an Ontario Microbiological or Chemical Drinking Water Standard (both Standards are human health-based). Review of the lab report indicates all parameters tested that have a Microbiological or Chemical Standard

were measured at levels below the Standard.

Sulphide was reported at a concentration of 0.182 mg/L. This concentration exceeds the aesthetic-based Ontario Drinking Water Objective of 0.05 mg/L. The Ministry notes that aesthetic criteria do not affect the safety of a water supply but may cause objectionable effects or render water unsuitable for domestic use. In this case, the elevated sulphide may result in some unpleasant odour in the water but should not otherwise prevent the water from being used for domestic supply.

Hardness was reported at a concentration of 365 mg/L (as $CaCO_3$), which exceeds the Ontario Drinking Water Operational Guideline of 80 - 100 mg/L (as $CaCO_3$). The Ministry notes that operational guidelines are established for parameters that, if not controlled, may negatively affect efficient and effective treatment, disinfection, and distribution of the water. Elevated hardness is a common occurrence in both municipal and private well supplies in Ontario. For private well systems the solution is often a home-based water softener.

Results from TW2

The water samples collected from TW2 were analyzed by the lab for a reduced number of parameters compared with TW1. Two sets of samples collected from TW2 were tested for nitrate and nitrite, E. coli and total coliforms, and a list of approximately 40 parameters that are part of a total metals scan.

Nitrate and nitrite were below the laboratory detection limit in both samples. E. coli and total coliforms were not detected in either sample.

In the metals scan, lead was reported at a concentration of 0.0219 mg/L in the first sample and 0.00668 mg/L in the second sample. The Ontario Drinking Water Chemical Standard for lead is 0.01 mg/L. Iron was reported at a concentration of 1.11 mg/L in the first sample and 0.355 mg/L in the second sample. The aesthetic Ontario Drinking Water Objective for iron is 0.3 mg/L. Manganese was reported at concentrations of 0.0399 mg/L in the first sample and 0.0148 mg/L in the second sample. The aesthetic Ontario Drinking Water Objective for manganese is 0.05 mg/L. Iron and manganese concentrations above the aesthetic drinking water objectives are common occurrences in both municipal and private well supplies.

Results from TW3

The lab analyses performed on all three sets of samples collected at TW3 included nitrate, nitrite, E. coli, total coliforms, and a metals scan of approximately 40 parameters.

The two samples from the first day of testing had reported nitrate concentrations of 4.7 and 5.3 mg/L (N). The Ontario Drinking Water Chemical Standard for nitrate is 10 mg/L (N). E. coli and total coliforms were not detected. Arsenic was reported at concentrations of 0.0203 and 0.0502 mg/L. The Ontario Drinking Water Chemical Standard for arsenic is 0.01 mg/L. Lead was reported at concentrations of 0.123 mg/L and 0.332 mg/L. As noted previously, the Ontario Drinking Water Chemical Standard for lead is 0.01 mg/L. It was noted at the time of sampling that there was some turbidity in the pump discharge water.

The one set of samples collected on the second day of testing had a reported nitrate concentration of 5 mg/L (N). E. coli and total coliforms were not detected. Lead was reported at 0.0052 mg/L, now below the Ontario Drinking Water Standard of 0.01 mg/L. Arsenic was reported as below the detection limit (<0.001mg/L). Iron was reported at 0.671 mg/L and manganese was reported at 0.0145 mg/L. It was noted that the clarity of the water had improved at the time of sampling compared with what was observed on the first day of sampling.

Based on these results, it is possible that turbidity in the well water at the time of sample collection on the first day may have affected the measured lead and arsenic levels in that sample.

3.0 WATER SUPPLY REQUIREMENTS AND AQUIFER YIELD

The results from the 3 test wells indicate that on average individual wells can easily meet the needs of single-family homes at the site. However, it is important to consider the total number of homes in relation to the expected aquifer yield at the site.

The proposed residential development presently under consideration includes up to 50 single-family residential units. Using the MECP peak flow rate requirement of 15 L/min over a 2-hour period, a daily flow requirement per home can be estimated at 1,800 L/day. At maximum build out (50 homes), maximum water demand can be estimated at 90,000 L/day (62.5 L/min; 1 L/s). Adding a 50% safety factor to the maximum water demand brings the total up to 135,000 L/day (94 L/min; 1.5 L/s).

The pumping rates used for each of the 3 test well pumping tests were identical at 65,520 L/day (45.5 L/min; 0.76 L/s), which is approximately 70% of the estimated maximum demand for all 50 lots, and 49% of the estimated maximum demand with a 50% safety factor added. Review of the pumping test data in more detail is warranted to evaluate

whether additional well yield is available above that of the pumping rate used for the well tests. Graphs to facilitate this review are available in **APPENDIX B**.

The pumping test at TW1indicates that the well specific capacity after 6 hours of pumping at 45.5 L/min was approximately 8.6 L/min/m of drawdown. Projecting the drawdown trend out to a hypothetical time of 1 day of continuous pumping indicates that the well specific capacity would have been approximately 6.1 L/min/m of drawdown. The available drawdown to the base of the inner casing at TW1 is approximately 19 m, so the specific capacity information indicates that the one-day yield of TW1 alone (19 m x 6.1 L/min/m x 50% additional S.F. = 58 L/min or 83,450 L/day) can meet about 90% of the expected maximum demand for a 50-lot subdivision.

The pumping test at TW2 indicates that the well water level dropped below the inner well casing approximately 240 minutes into the pumping test, yet the well was still able to sustain the test flow rate for the remainder of the 6-hour test. The projected pumping water level at 1 day would have been approximately 52.1 m, which is about 20 m above the bottom of the test well. However, the test data indicates that the one-day yield of TW2 should not exceed the pumping test rate of 45.5 L/min (65,520 L/day).

The pumping test at TW3 indicates that the well water level declined by 13 m over the first 45 minutes and then recovered for the remainder of the test. As noted previously, the observed recovery during the pumping test may be related to ongoing development of the fractures as the well was being pumped. It could also possibly have reflected interference from another nearby private well in Arkell. The drawdown after 6 hours of pumping had recovered to 8.2 m, and the well water level had essentially reached full recovery to the pre-test condition 75 minutes after the pump shutdown. The specific capacity of TW3 prior to pump shutdown was approximately 5.6 L/min/m of drawdown and the pumping level was measured at 24.1 m. The base of the inner well casing is at a depth of approximately 48 m indicating that an additional drawdown of approximately 24 m was available at the end of the pumping test. Using only 50% of the apparent remaining available drawdown indicates that well capacity is over 110 L/min (158,400 L/day). The results indicate that the well capacity of TW3 can meet the maximum demand for a 50-lot subdivision.

4.0 SUMMARY AND CONCLUSIONS

A review of background information including existing water well record information indicates that a multi-aquifer system exists in the vicinity of the Hamlet of Arkell, including the proposed development property. The multi-aquifer system consists of the following geological units, in descending order:

Guelph Fm. - Upper Aquifer
Eramosa Fm. - Intermediate Aquitard/Aquifer
Gasport Fm. - Lower Aquifer.

It is evident from the water well record information that both the Guelph Fm. and Gasport Fm. aquifers have met the water quantity needs of residences and businesses in the Arkell area for many years.

Three test wells (TW1/2022 - TW3/2022) were constructed and tested as part of a groundwater supply assessment for the proposed development property. The wells were constructed in the lower aquifer (Gasport Fm.) to evaluate whether the lower aquifer alone could meet the water supply requirements of up to 50 new residential lots on the property. The upper aquifer (Guelph Fm.) was not considered in the test well program.

The results from 3 test wells indicate that the Gasport Fm. aquifer (lower aquifer) can meet the water quantity requirements of new individual lots on the proposed development property. Further, interpretation of the test well performance indicates that the aquifer can support the water quantity requirements associated with 50 new residential lots at the site.

Overall, the water quality test results indicate that groundwater produced from the 3 test wells is potable, as most of the parameters tested with an Ontario Drinking Water Standards Maximum Acceptable Concentration (MAC) were within the MAC. The marginally elevated arsenic concentrations reported at TW3, and the marginally elevated lead concentrations reported at TW2 and TW3 may be related to particulate in the water at the time of sampling. Additional well development, sampling and lab testing could be considered to further assess the levels of arsenic and lead in the well water.

Construction of new supply wells associated with a multi-lot residential development on the property has the potential for interference to occur among individual wells as the development is built out. This interference could come in the form of (a) turbidity interference resulting from the process of well drilling and development and (b) water level interference when the wells are operating. The turbidity interference is a temporary problem that should dissipate after the well drilling and development operations are complete. Notification of adjacent well owners and monitoring when each new well is constructed will help to mitigate potential turbidity interference. Measures to minimize the effects of water level interference include optimizing the pump settings to maximize

drawdown in each of the individual wells. Consideration could also be given to implementing an outdoor water use bylaw or similar instrument to manage water use during the warm weather months of the year when water demand is higher.

5.0 RECOMMENDATION

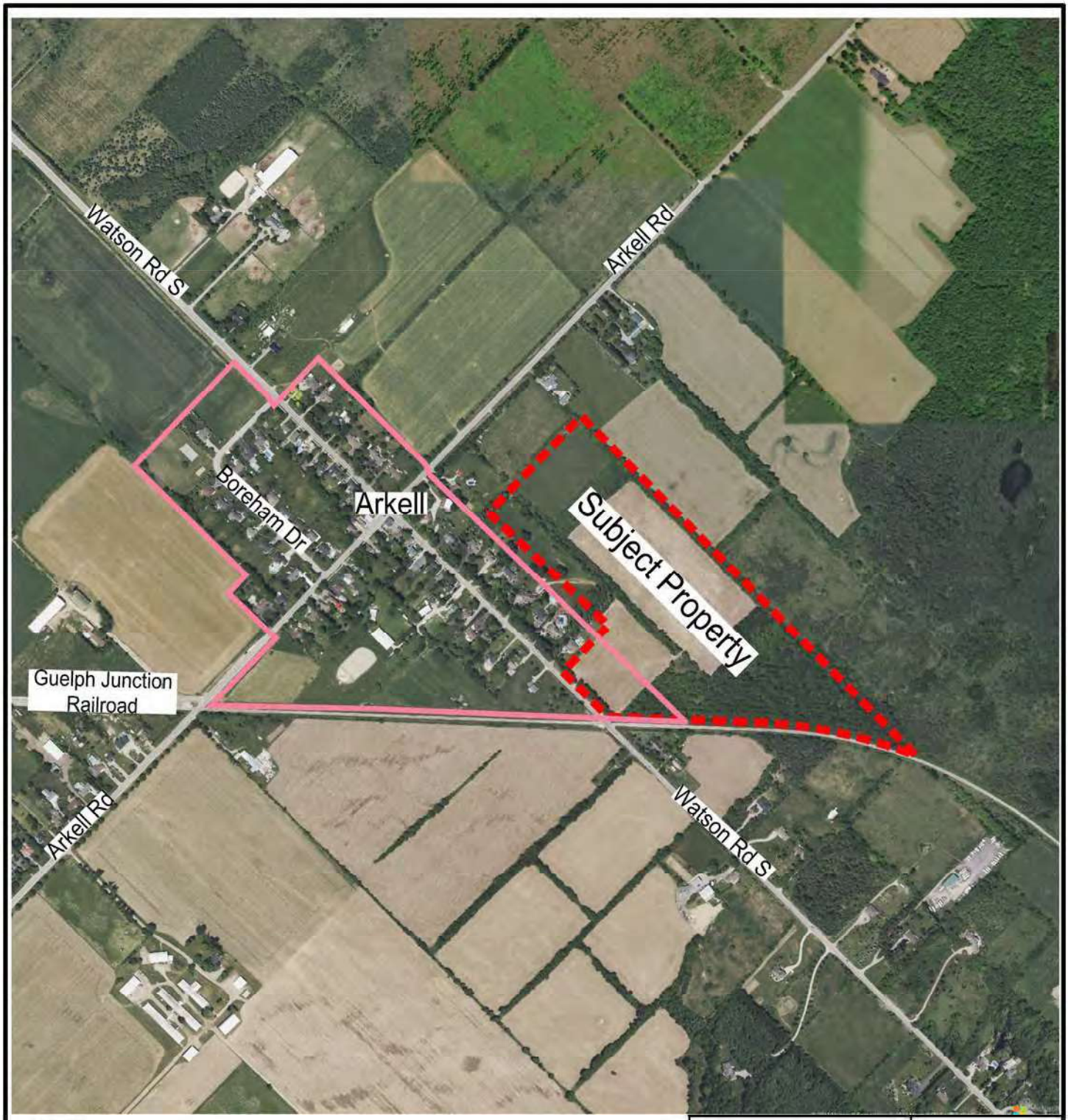
Consideration should be given to implementing a well water level monitoring program for new supply wells serving the proposed residential development. The program would require that each well be equipped with an access tube designed to facilitate measuring water levels.

Prepared by:

ARL GROUNDWATER RESOURCES LTD.



A.R. (Tony) Lotimer, M.Sc., P.Geo.
Principal Hydrogeologist



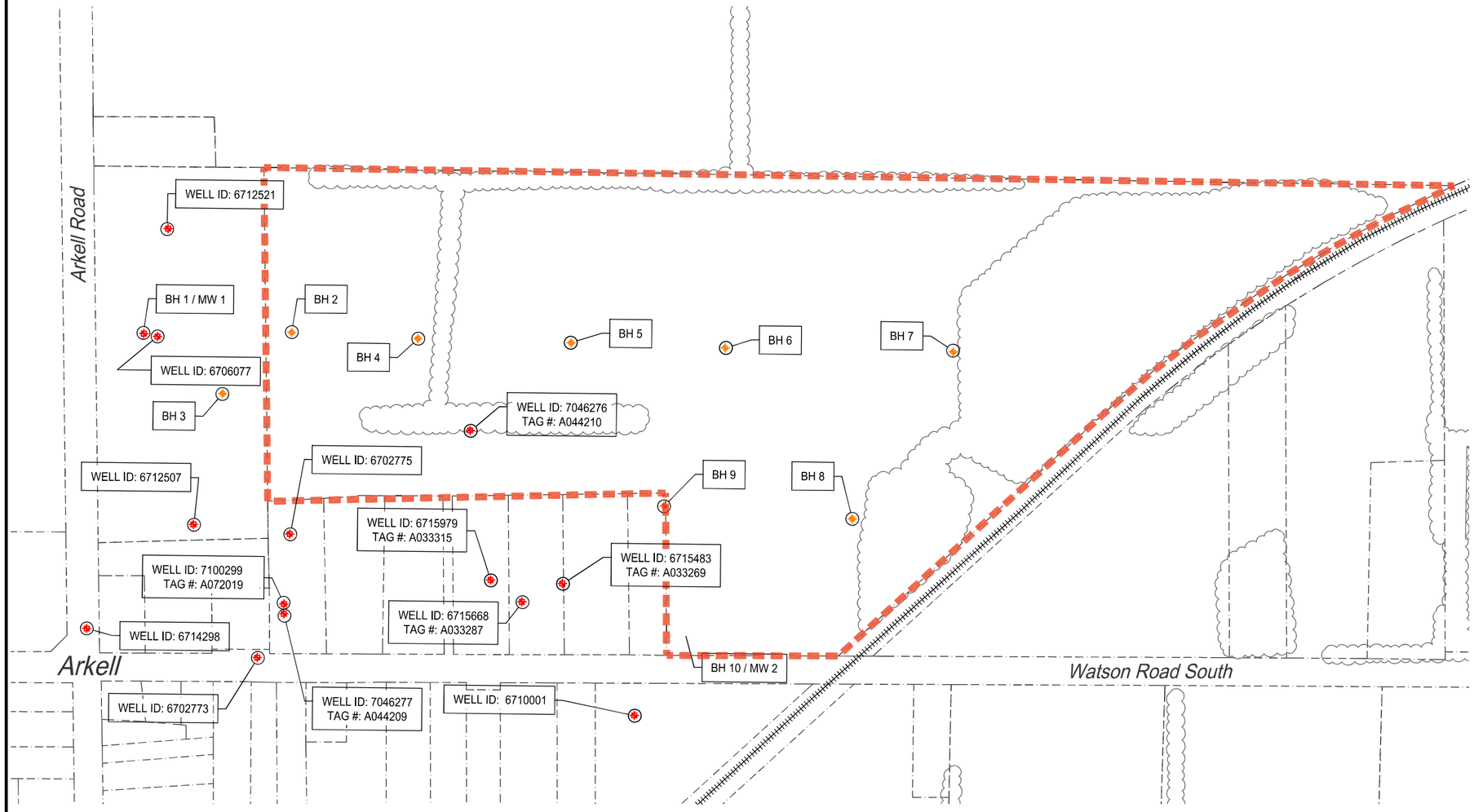
Legend

Existing Hamlet Boundary Limit (Official Plan)

Subject Lands

Location of Subject Property	Figure 1
Part of Lots 7, 8, & 9, Concession 10 Arkell Township of Puslinch, County of Wellington	
ARL Groundwater Resources Ltd.	
File Prepared By Stovel and Associates Inc.	Date: 02-17-2023
N W E S	Aprox. 1:10,000
Imagery Provided by Microsoft Corporation – MAXAR Distribution Airbus	

0 250 500 Meters



Existing Well Locations

Part of Lots 7,8 & 9 Concession 10
Township of Puslinch
County of Wellington

Notes

1. All Coordinates Were Determined Using NAD83 CSRS - Zone 17.
2. Exact Locations Of Objects Have Yet To Be Confirmed.
3. This Is Not a Plan Of Survey.
4. Existing Contours Shown Have Been Taken From The GRCA Web-GIS Application [Public].
5. Existing Well Locations Have Been Taken From Well Records - Ontario.

Legend

- Existing Railway
- Existing Wooded Area (G.R.C.A)
- Existing Well Location (Approx.)
- Borehole Location (Approx.)
- Subject Lands
- Existing Lot Line

WELL ID: 6715979 ← WELL ID
TAG #: A033315 ← WELL TAG #
N:4820656.0 ← NORTHING
E:567487.0 ← EASTING

Existing Well Data

Well ID	Tag #	Northing	Easting
6712521	-	4820993.0	567502.3
6706077	-	4820949.0	567439.3
6712507	-	4820833.0	567361.3
6714298	-	4820835.0	567255.6
6702773	-	4820734.0	567328.3
6702775	-	4820781.0	567407.3
6710001	-	4820514.0	567492.0
6715979	A033315	4820656.0	567487.0
6715668	A033287	4820629.0	567492.0
6715483	A033269	4820618.0	567522.0
7046277	A044209	4820743.0	567364.0
7100299	A072019	4820748.0	567369.0
7046276	A044210	4820743.0	567552.0

Figure prepared by Stovel and Associates Inc.

ARL Groundwater Resource Ltd.

N E W S

Figure 2

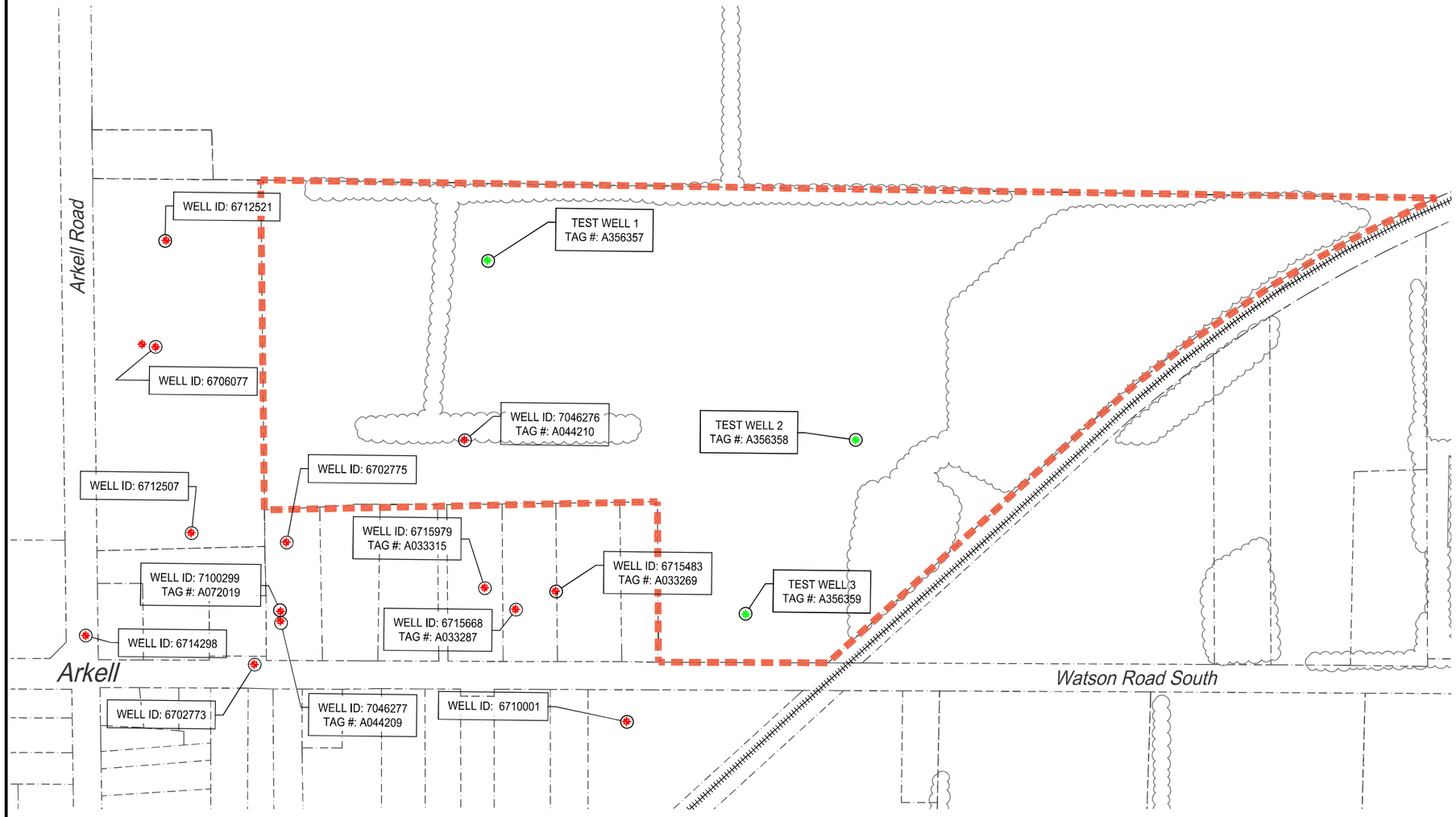
Date : 02/27/2023

0 100 200 Meters

Scale 1:3500

Existing & New (2022) Well Locations

Part of Lots 7,8 & 9 Concession 10
Township of Puslinch
County of Wellington



Notes

1. All Coordinates Were Determined Using NAD83 CSRS - Zone 17.
2. This Is Not a Plan Of Survey.
3. Existing Well Locations Have Been Taken From Well Records - Ontario.

Legend

- Existing Railway
- Existing Wooded Area (G.R.C.A)
- Existing Well Location (Approx.)
- Well Location (2022)
- Subject Lands
- Existing Lot Line

WELL ID: 6715979 ← WELL ID
TAG #: A033315 ← WELL TAG #
N:4820656.0 ← NORTHING
E:567487.0 ← EASTING

New Well Data

Well ID	Tag #	Northing	Easting	TOW Elevation
Test Well 1	A356357	4820824.4	567655.7	341.66m
Test Well 2	A356358	4820543.025	567755.014	344.23m
Test Well 3	A356359	4820508.752	567608.884	345.99m

Existing Well Data

Well ID	Tag #	Northing	Easting
6712521	-	4820993.0	567502.3
6706077	-	4820949.0	567439.3
6712507	-	4820833.0	567361.3
6714298	-	4820835.0	567255.6
6702773	-	4820734.0	567328.3
6702775	-	4820781.0	567407.3
6710001	-	4820514.0	567492.0
6715979	A033315	4820656.0	567487.0
6715668	A033287	4820629.0	567492.0
6715483	A033269	4820618.0	567522.0
7046277	A044209	4820743.0	567364.0
7100299	A072019	4820748.0	567369.0
7046276	A044210	4820743.0	567552.0

Figure prepared by Stovel and Associates Inc.

ARL Groundwater Resource Ltd.

N E W S

Figure 3

Date : 02/17/2023

0 100 200 Meters

Scale 1:3500

FIGURE 4: Arkell Test Well TW1
Pumping Water Level vs. Elapsed Time

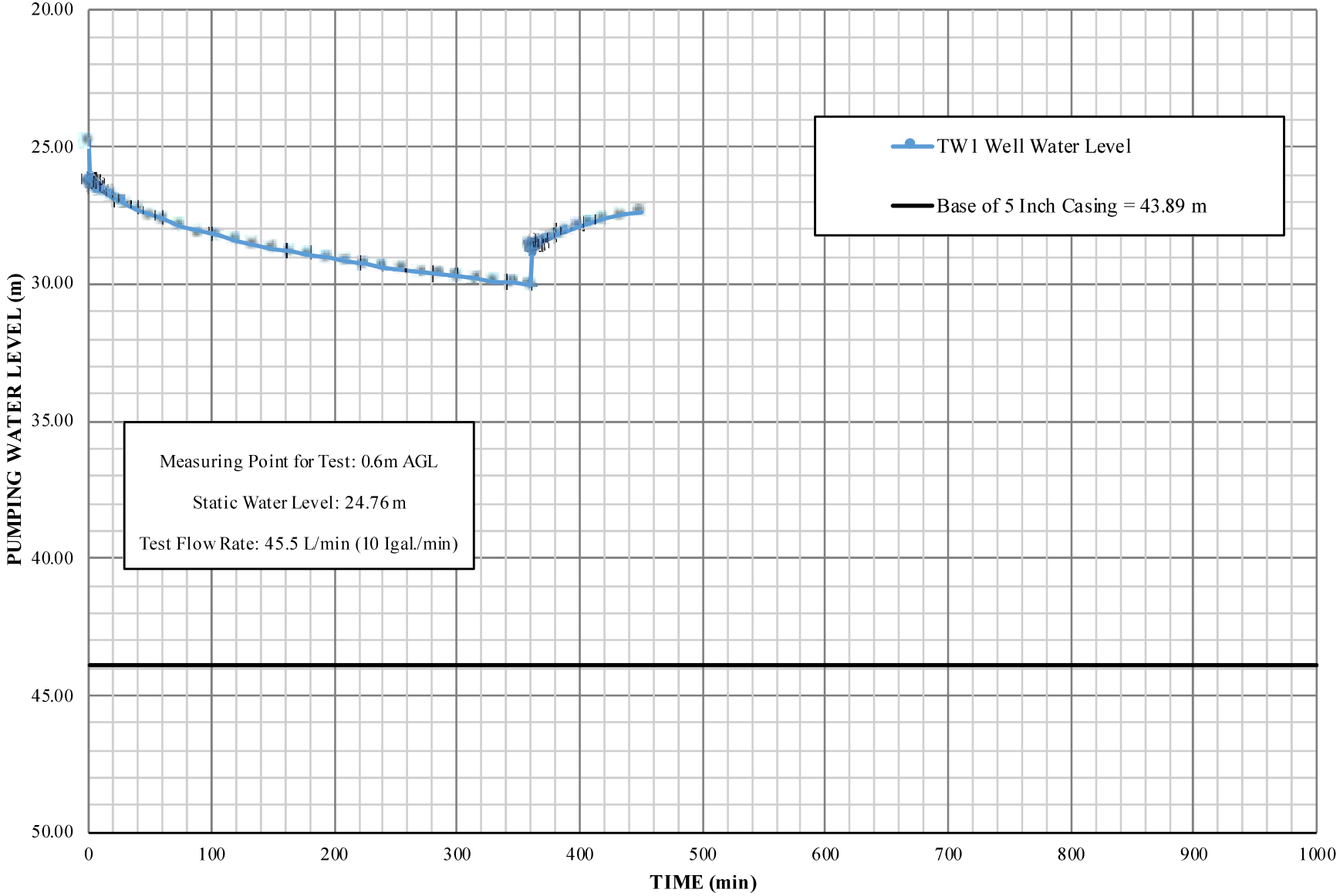


FIGURE 5: Arkell Test Well TW2
Pumping Water Level vs. Elapsed Time

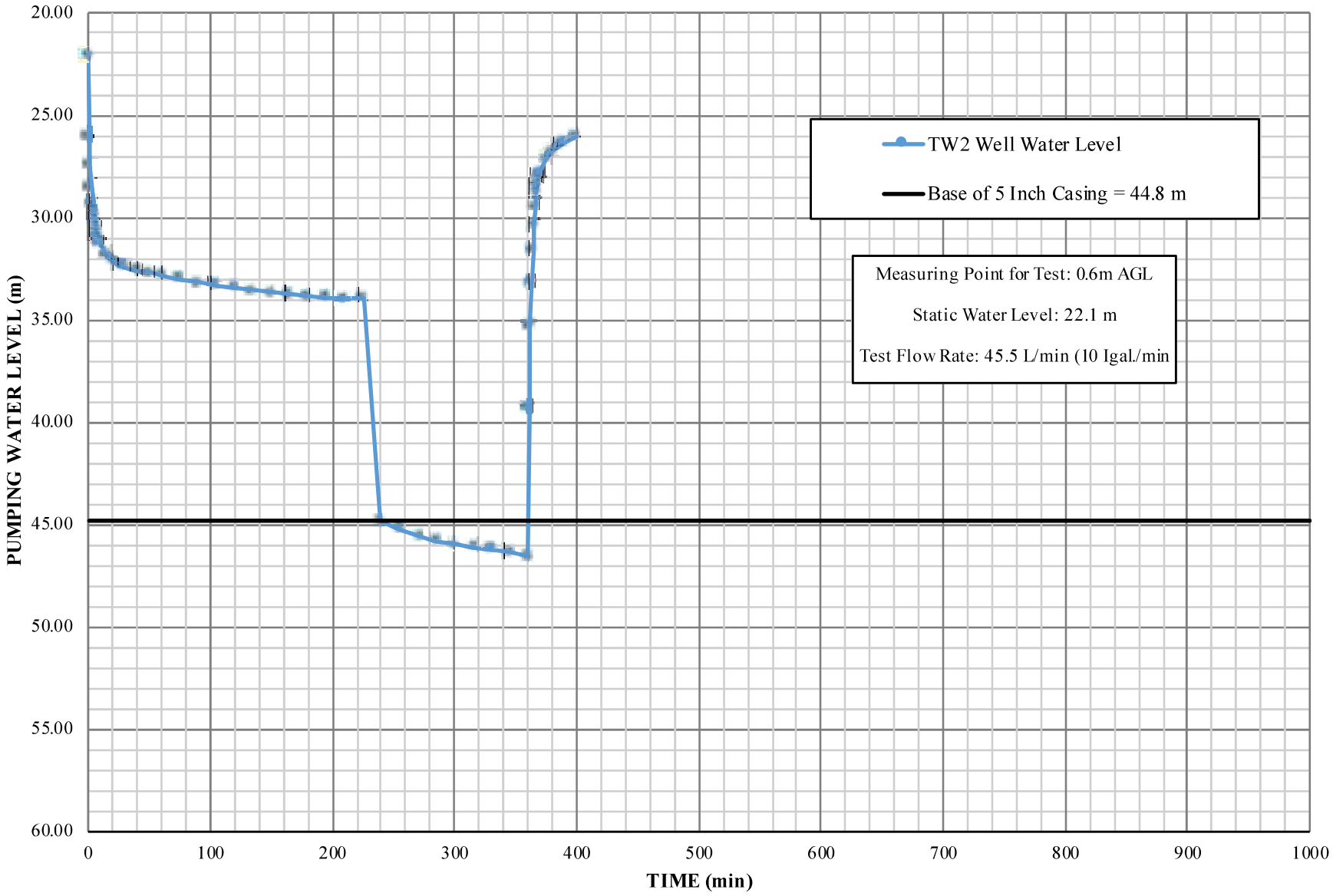
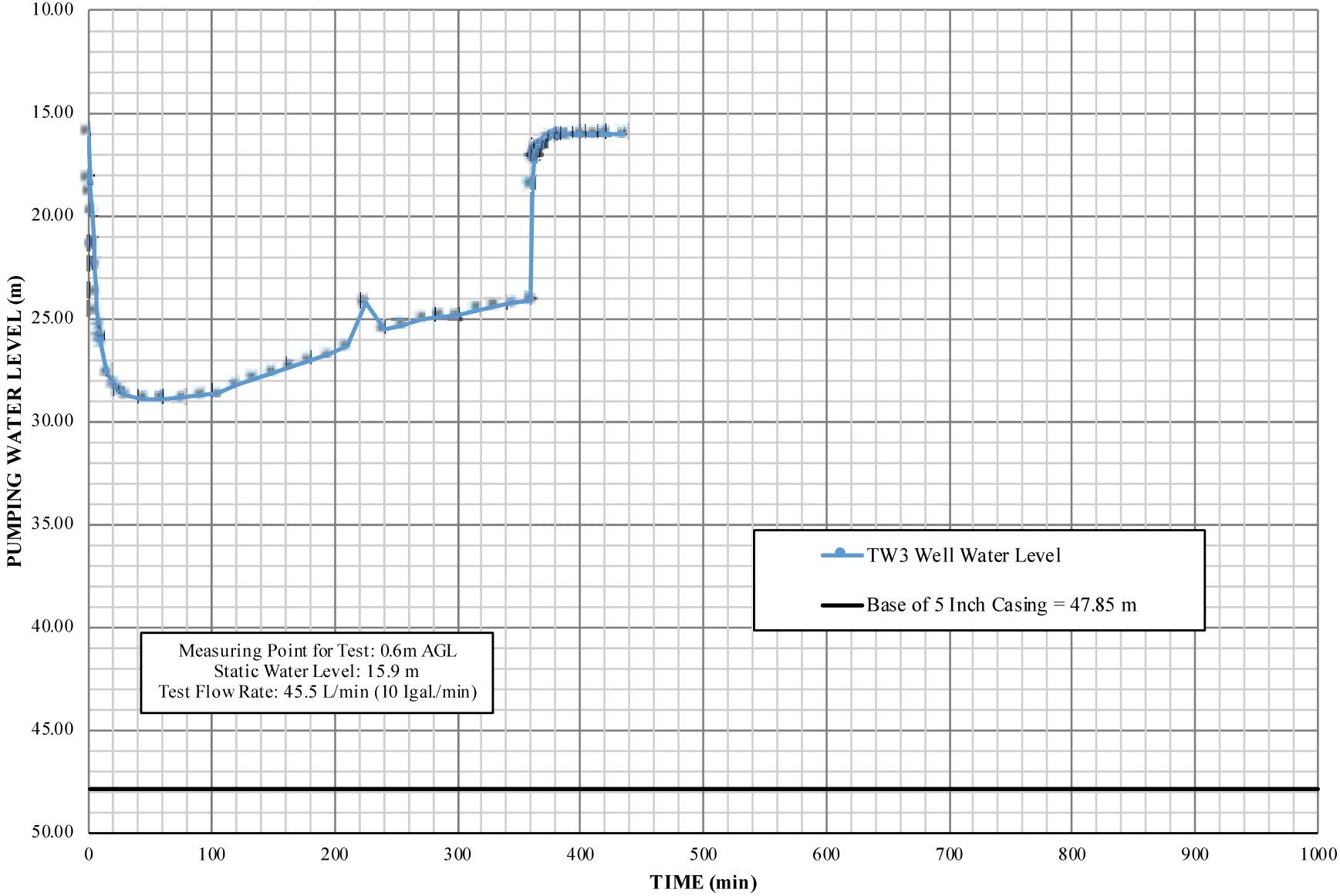


FIGURE 6: Arkell Test Well TW3
Pumping Water Level vs. Elapsed Time

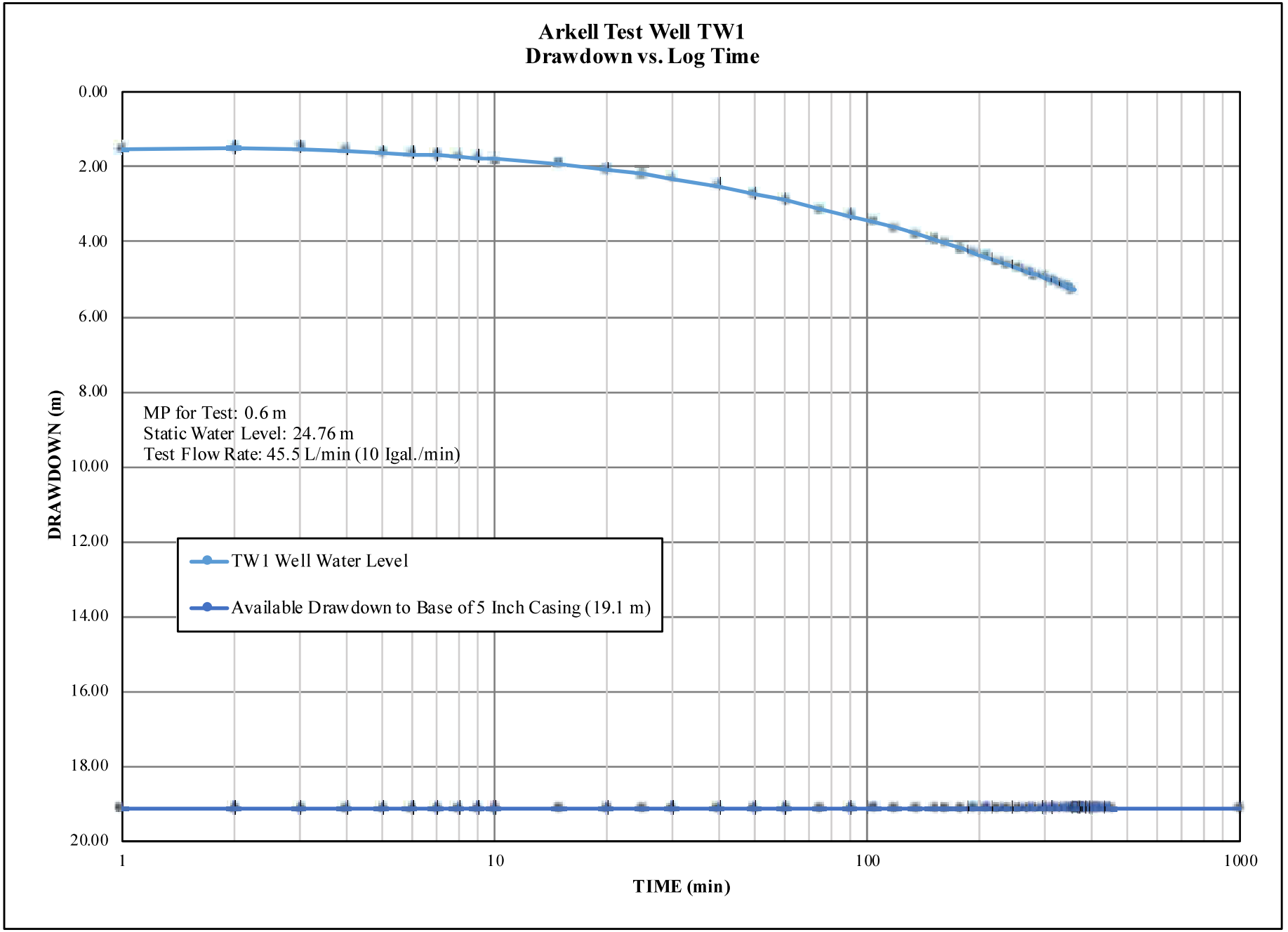


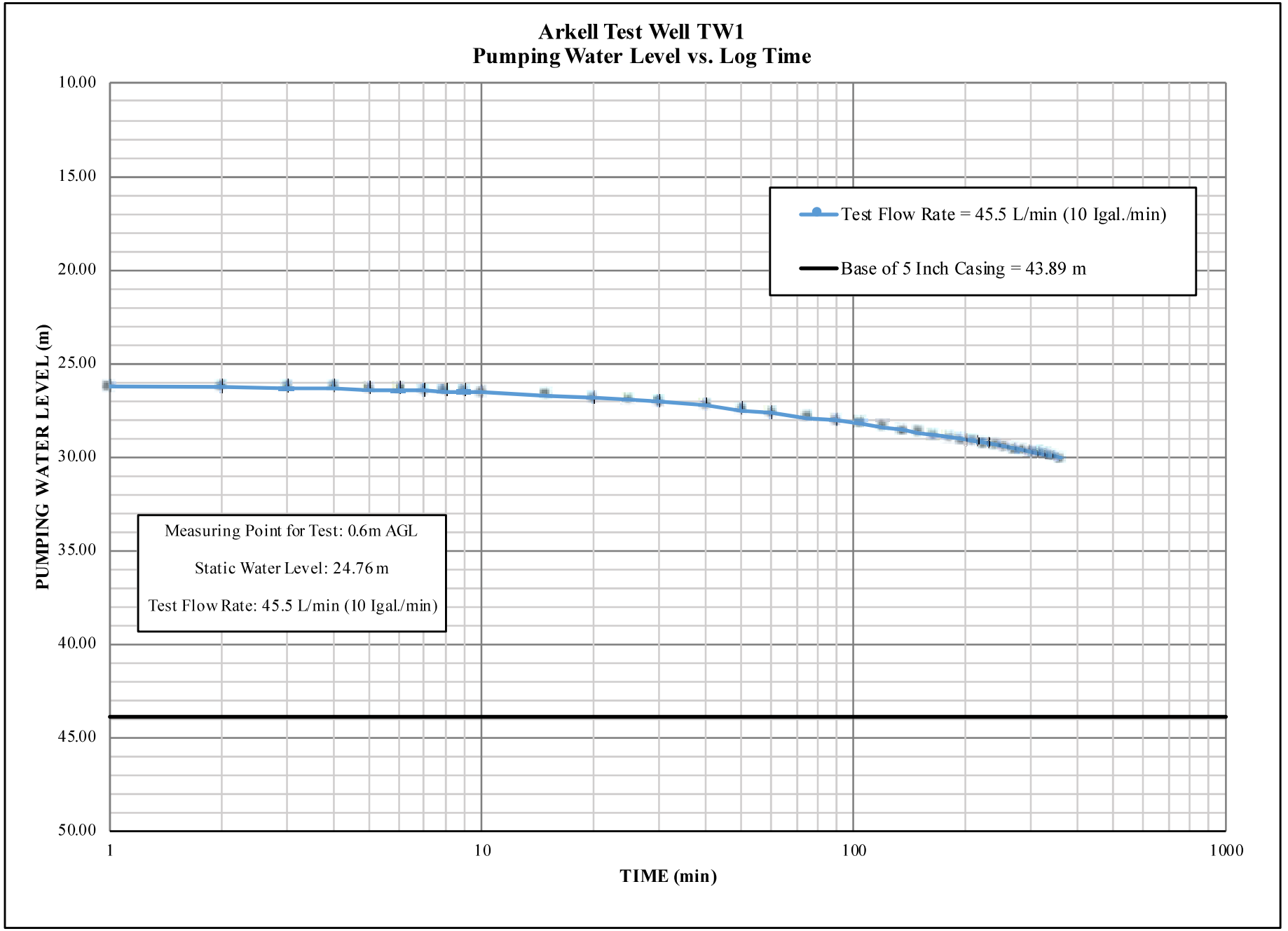
APPENDIX B

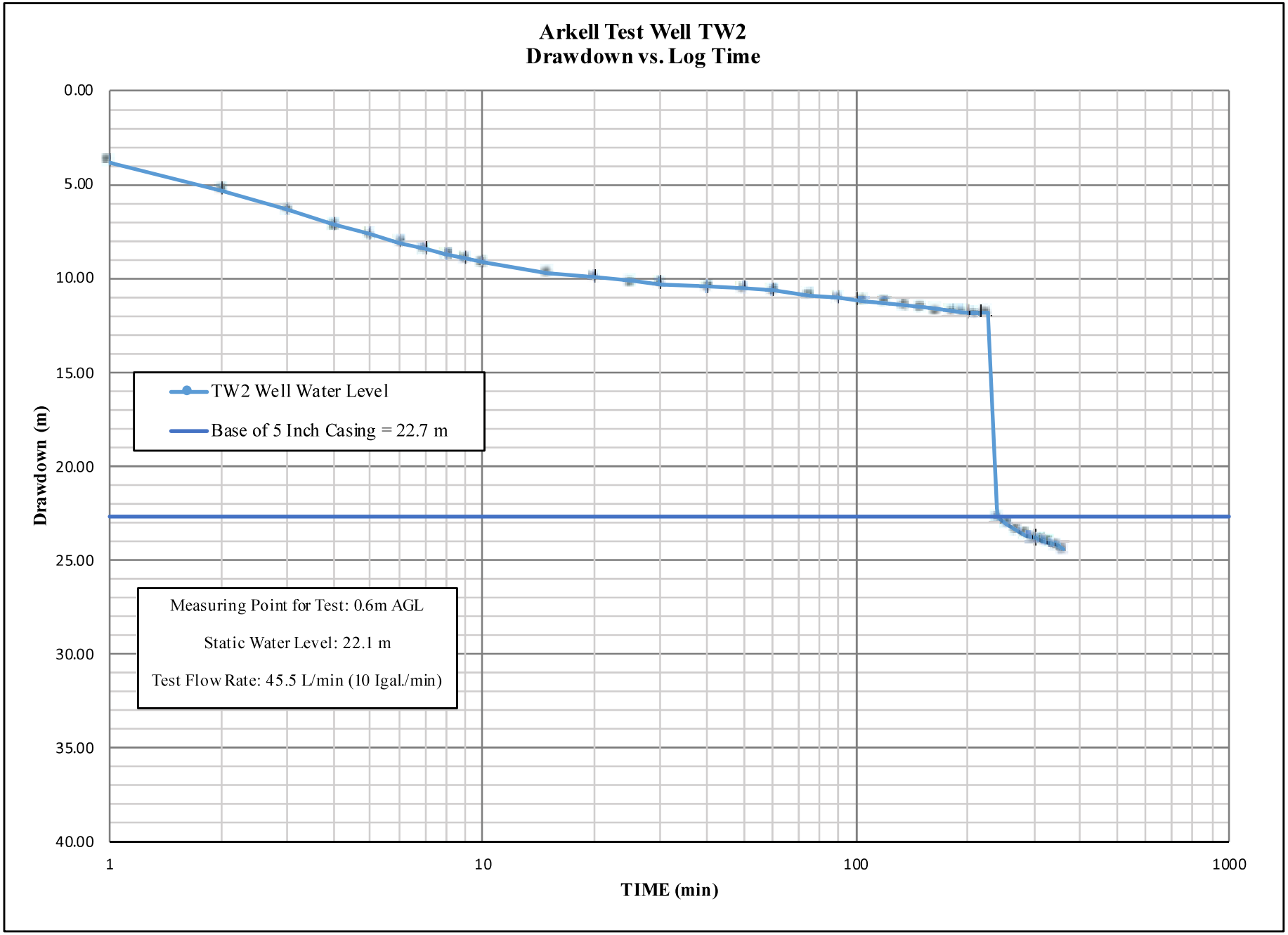
ADDITIONAL GRAPHS FROM THE PUMPING TESTS

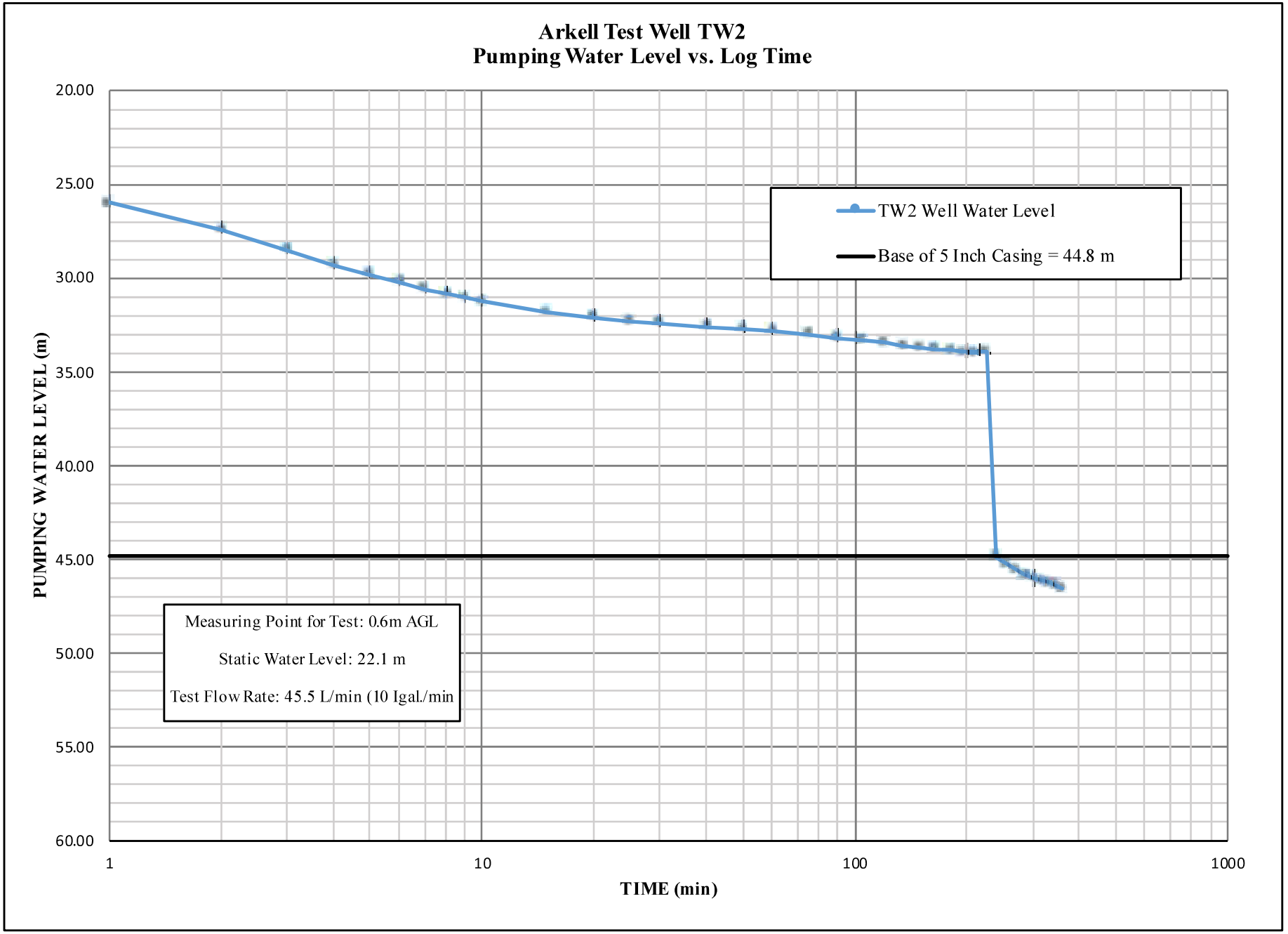
AT THE TEST WELLS

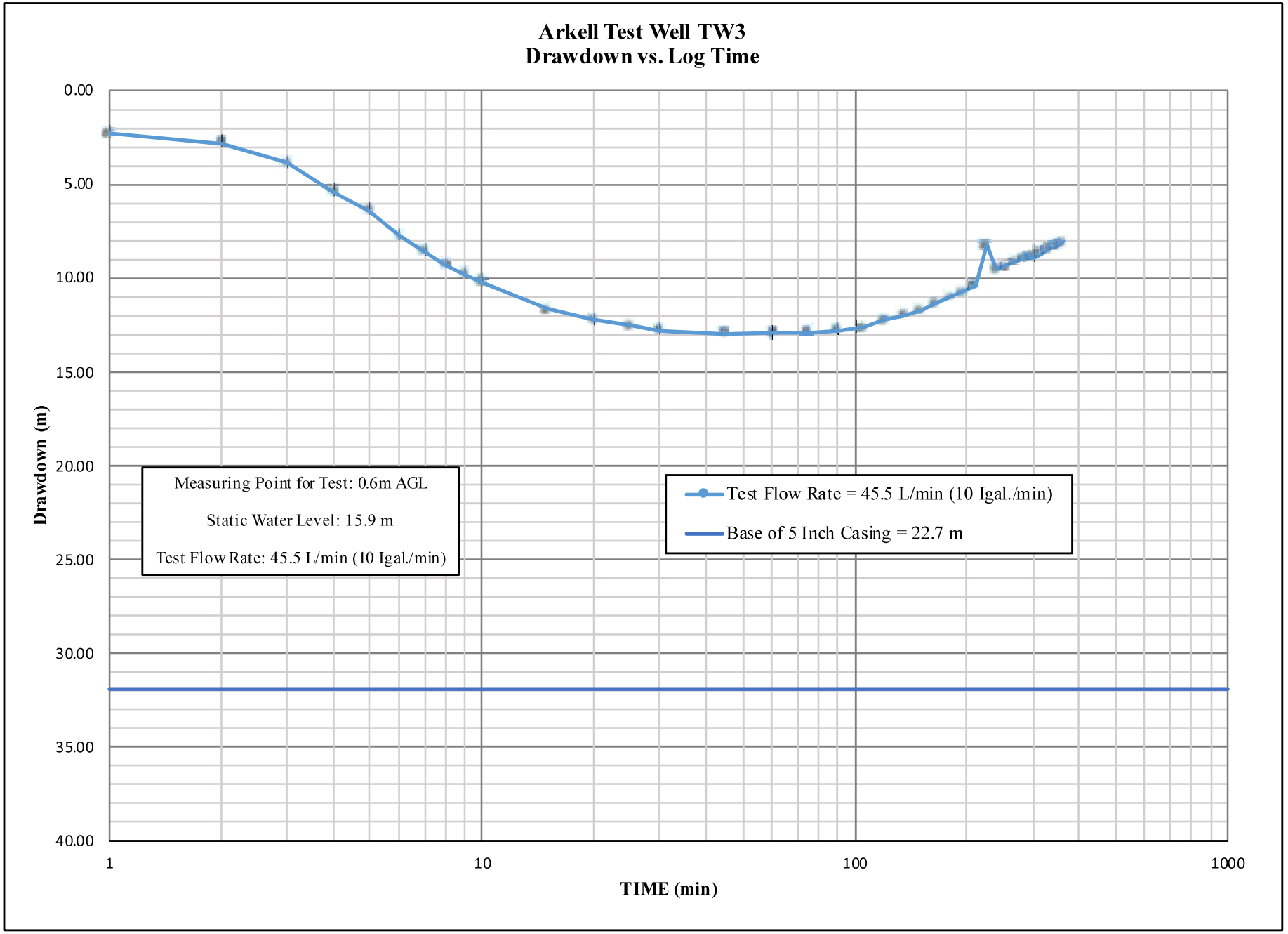
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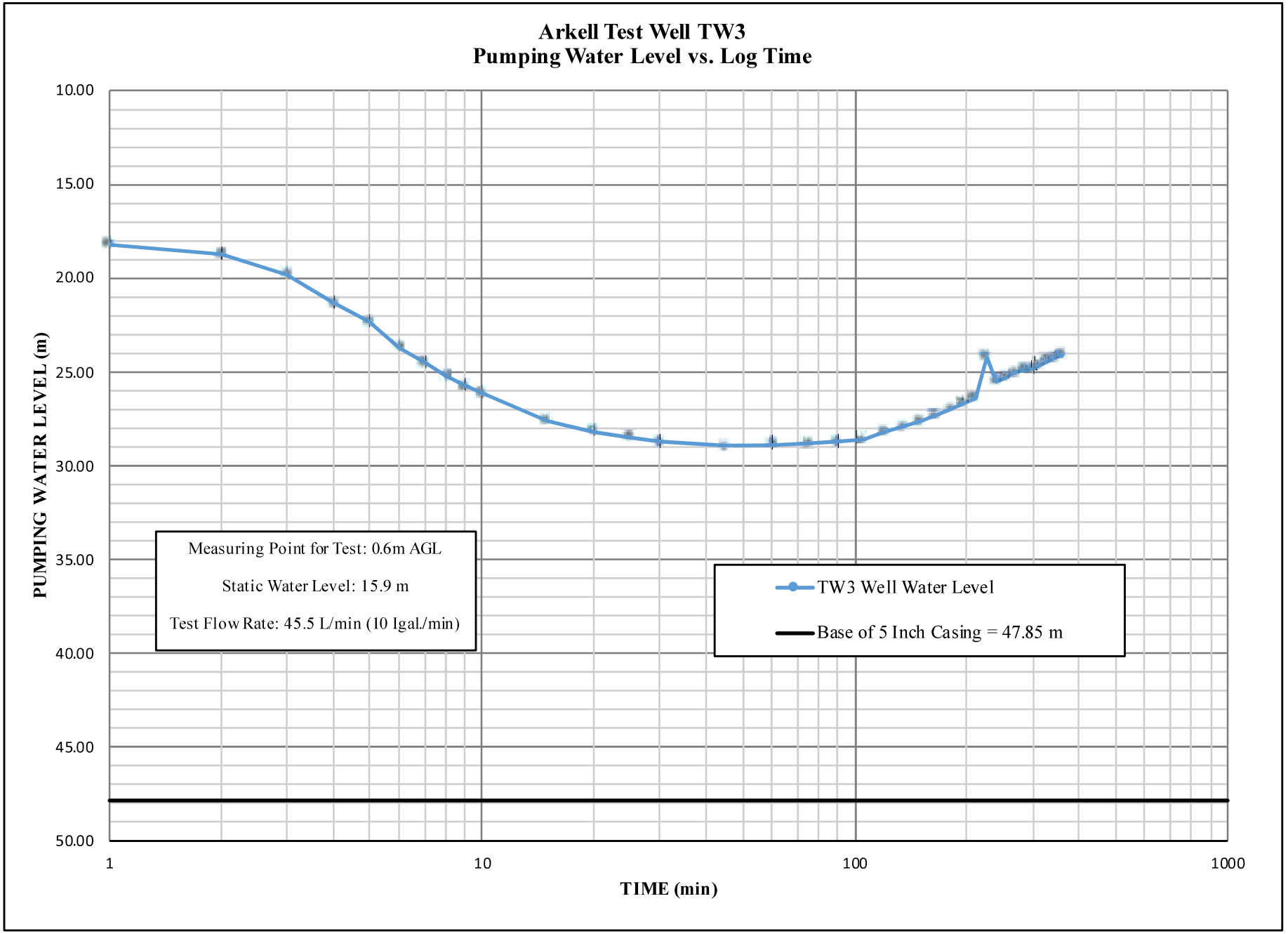

Arkell Test Well TW1
Drawdown vs. Log Time
DRAWDOWN (m)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
MP for Test: 0.6 m
Static Water Level: 24.76 m
Test Flow Rate: 45.5 L/min (10 Igal./min)
TW1 Well Water Level
Available Drawdown to Base of 5 Inch Casing (19.1 m)
1
10
100
1000
TIME (min)


Arkell Test Well TW1
Pumping Water Level vs. Log Time
PUMPING WATER LEVEL (m)
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
1
10
100
1000
TIME (min)
Test Flow Rate = 45.5 L/min (10 Igal./min)
Base of 5 Inch Casing = 43.89 m
Measuring Point for Test: 0.6m AGL
Static Water Level: 24.76 m
Test Flow Rate: 45.5 L/min (10 Igal./min)


Arkell Test Well TW2
Drawdown vs. Log Time
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
Drawdown (m)
TW2 Well Water Level
Base of 5 Inch Casing = 22.7 m
Measuring Point for Test: 0.6m AGL
Static Water Level: 22.1 m
Test Flow Rate: 45.5 L/min (10 Igal./min)
1
10
100
1000
TIME (min)


Arkell Test Well TW2
Pumping Water Level vs. Log Time
PUMPING WATER LEVEL (m)
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
1
10
100
1000
TIME (min)
TW2 Well Water Level
Base of 5 Inch Casing = 44.8 m
Measuring Point for Test: 0.6m AGL
Static Water Level: 22.1 m
Test Flow Rate: 45.5 L/min (10 Igal./min


Arkell Test Well TW3
Drawdown vs. Log Time
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
Drawdown (m)
1
10
100
1000
TIME (min)
Measuring Point for Test: 0.6m AGL
Static Water Level: 15.9 m
Test Flow Rate: 45.5 L/min (10 Igal./min)
Test Flow Rate = 45.5 L/min (10 Igal./min)
Base of 5 Inch Casing = 22.7 m


Arkell Test Well TW3
Pumping Water Level vs. Log Time
PUMPING WATER LEVEL (m)
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
1
10
100
1000
TIME (min)
Measuring Point for Test: 0.6m AGL
Static Water Level: 15.9 m
Test Flow Rate: 45.5 L/min (10 Igal./min)
TW3 Well Water Level
Base of 5 Inch Casing = 47.85 m

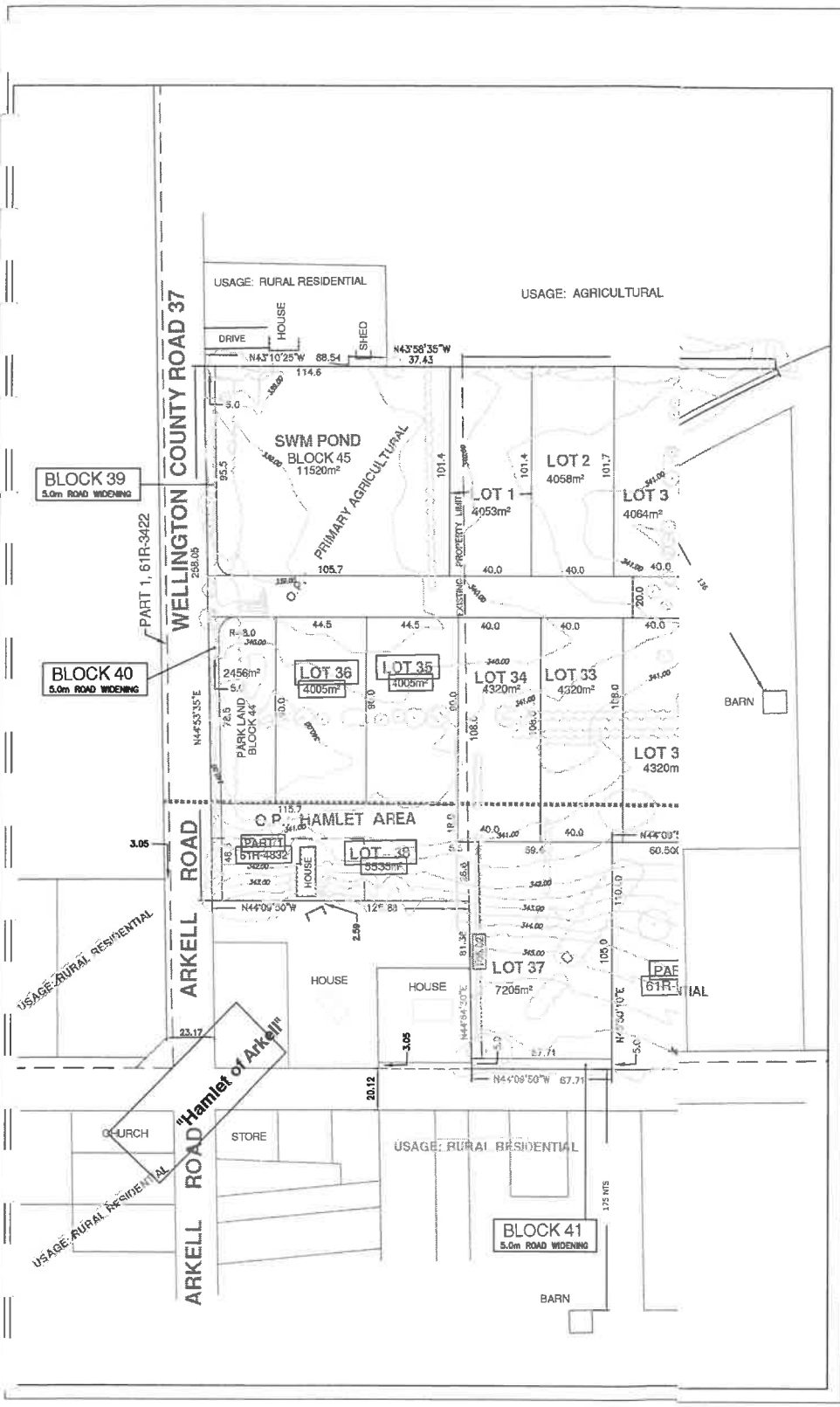
BURNSIDE

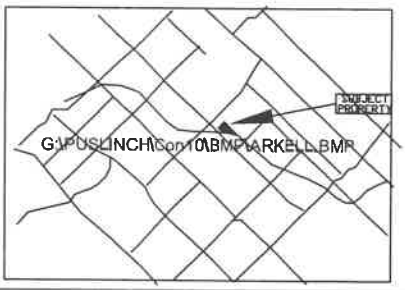
Appendix A
Draft Plan of Subdivision

DRAFT PLAN OF SUBDIVISION KUKOVICA

SCALE: 1 – 1500

0 25 50 75 metres





LEGAL DESCRIPTION

PART OF LOTS 7, 8 and 9, CONCESSION 10
TOWNSHIP OF PUSLINCH
COUNTY OF WELLINGTON

LAND USE SCHEDULE

DESCRIPTION	LOTS /BLOCKS	AREA (hectares)
SINGLE DETACHED RESIDENTIAL LOTS	1-38	18.07
STORMWATER MANAGEMENT AREA	BLOCK 45	1.15
ROAD WIDENING BLOCKS	BLOCK 39-43	0.23
ROADS		1.98
PARK LAND DESIGNATION	BLOCK 44	0.25
	TOTAL:	21.68

ADDITIONAL INFORMATION

(UNDER SECTION 51(17) OF THE PLANNING ACT)

a) the boundaries of the land proposed to be subdivided;(as shown)
b) the locations, widths and names of proposed highways within the proposed subdivision and of existing highways abutting proposed subdivision;(as shown)
c) key plan;(as shown)
d) purpose for which proposed lots are to be used;(as shown)
e) existing uses of all abutting lands;(as shown)
f) approximate dimensions and layout of proposed lots;(as shown)
g) natural and artificial features such as buildings, railways, watercourses, drainage ditches, wetlands and wooded areas within the land proposed to be subdivided;(as shown)
h) availability and nature of domestic water supplies; water to be supplied by wells
i) nature and porosity of soil; compact to dense sandy gravel or sand under topsoil; some dense silt and dense gravely silty sand known as Port StanleyTill
j) existing contours;(as shown)
k) municipal services available; none
l) nature and extent of any restrictions affecting land proposed to be subdivided; none

OWNER'S CERTIFICATE

I AUTHORIZE _____ TO PREPARE AND SUBMIT THIS DRAFT PLAN OF SUBDIVISION TO THE TOWNSHIP OF PUSLINCH.

TOM KUKOVICA — DATE

SURVEYOR'S CERTIFICATE

I CERTIFY THAT THE BOUNDARIES OF THE LAND TO BE SUBDIVIDED AND THEIR RELATIONSHIP TO THE ADJACENT LANDS ARE CORRECTLY SHOWN.

JEFFREY E. BUISMAN, O.L.S.
Van Harten Surveying Inc. — DATE

DATE	REVISIONS
MAY 18, 2006	FIRST SUBMISSION

Van Harten SURVEYING INC.
LAND SURVEYORS and ENGINEERS

423 WOOLWICH STREET
GUELPH – ONTARIO, N1H 3X3
PHONE: (519) 821 – 2763
FAX: 821 – 2770
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660 RIDDELL ROAD, UNIT 1
ORANGEVILLE – ONTARIO, L9W 5G5
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FAX: 519 – 940 – 4113
www.vanharten.com

DRAWN BY: M.A.M. | CHECKED BY: J.E.B. | PROJECT No. 15919-04

BURNSIDE

Appendix B
Water Well Records

MUNICIPALITY CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR:MN	WATER USE	SCREEN DEPTH FEET	SCREEN LENGTH FEET	OWNER DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
CONTINUING... PUSLINCH TOWNSHIP																	
CON	08	053	67-13525	999999~ 9999999		2000/10	2336	06	FR	0144	57	58	20	1 :	DO		VERDONE,A. BRWN CLAY STNS 0015 BRWN CLAY SAND GRVL 0055 BRWN GRVL SAND 0070 GREY CLAY SAND GRVL 0095 BRWN ROCK 0125 GREY ROCK 0144
CON	09	001	67-08591	564936 4821799	1033	1986/06	1906	05	FR	0096	10	20	110	:	DO		CITY OF GUELPH SHLE 0003 BLCK ROCK SOFT 0030 BLUE ROCK 0032 GREY ROCK 0046 LMSN SOFT 0062 GREY LMSN SOFT 0086 BRWN LMSN 0094 GREY LMSN 0140
CON	09	001	67-08651	564936 4821799	1036	1987/01	2336	12	FR	0104	7			:	MN		CITY OF GUELPH BRWN ROCK FCRD 0003 BRWN ROCK 0035 GREY ROCK 0080 BRWN ROCK 0088 GREY ROCK 0138 GREY ROCK 0150
CON	09	001	67-04579	565540 4821970	1060	1973/04	1906	05	FR	0043	13	21	9	6 :0	DO		CLARKE P BLDR GRVL CLAY 0040 GRVL 0043
CON	09	001	67-10988	565525 4822012	1049	1992/07	6624	05	FR	0185	27	85	15	1 :	DO AC		SPIRA, KEN STNS GRVL SAND 0022 BRWN FSND GRVL CLAY 0038 GREY HPAN CLAY 0050 BRWN ROCK 0058 BLCK ROCK 0070 BRWN ROCK 0118 GREY ROCK 0128 GREY ROCK 0188
CON	09	001	67-07126	564800 4821550	980	1979/11	2336	05	SU	0086	26	48	12	1 :0	DO		GAMSBY D BRWN CLAY SAND GRVL 0022 BRWN STNS 0050 BLCK STNS 0087
CON	09	001	67-08858	565228 4821448	1033	1987/06	4005	06	FR	0039	6	37	15	1 :	DO		CRASHLY, BOB BRWN BLDR SAND CLAY 0018 BRWN GRVL SAND LOOS 0021 GREY LMSN SAND LYRD 0023 GREY LMSN HARD 0042
CON	09	001	67-08640	565745 4822009	1043	1986/12	4005	06	FR	0035	10	18	20	3 :0	DO		SLOOT, JOHN BRWN CLAY SNDY BLDR 0008 BRWN GRVL CLAY BLDR 0030 GREY SAND CGVL LOOS 0033 GREY FGVL SAND LOOS 0035
CON	09	001	67-02686	565550 4822145	1120	1962/08	2521	04	FR	0036	5	30	10	2 :0	DO		ESTATE HOMES CLAY BLDR 0005 GRVL 0010 BLCK ROCK 0036
CON	09	001	67-06265	565360 4822180	1050	1976/01	4208	06	FR	0035	4	40	12	1 :0	DO		BURFORD JAMES BRWN STNS GRVL 0010 BRWN CLAY SNDY 0014 GREY LMSN 0047
CON	09	001	67-02688	564250 4820845	1125	1962/11	2406		FR	0055	32	35	10	1 :0	ST DO		LEHMAN H PRDG 0018 BRWN CLAY CSND 0032 BRWN ROCK 0055
CON	09	001	67-02690	565720 4822000	1075	1965/12	2406	05	FR	0048	7	15	10	3 :0	DO		OSKAM T PRDG 0005 BRWN STNS 0015 BRWN ROCK 0048
CON	09	001	67-02691	565550 4822160	1150	1965/10	1906	04	FR	0040	7	20	10	2 :0	DO		LIVINGSTONE L CLAY STNS 0012 BRWN ROCK 0040
CON	09	001	67-02692	564940 4821535	1075	1964/06	2406	05	FR	0035	5	20	15	4 :0	DO		SCHENK C GRVL BLDR 0014 BRWN LMSN 0026 BLCK ROCK 0039
CON	09	001	67-02693	565490 4822050	1075	1967/10	1906	04	FR	0048	12	15	8	5 :0	DO		ZIEGLER C BLDR CLAY GRVL 0023 GRVL 0048
CON	09	001	67-03304	565480 4822050	1075	1969/02	1906	04	FR	0050	5	20	10	3 :0	DO		BUCHANAN SMITH CLAY STNS GRVL 0019 BLCK LMSN 0050
CON	09	001	67-02689	564255 4820840	1125	1963/08	2406		FR	0080	45	50	10	3 :0	ST DO		ELLIOTT F PRDR 0055 BLCK ROCK 0080
CON	09	001	67-11471	564818 4821195	1066	1994/06	2336	06	FR	0125	45	87	10	1 :	DO		DYNES, R. BRWN CLAY STNS 0006 BRWN ROCK 0030 BRWN ROCK 0070 GREY ROCK 0090 GREY ROCK 0125
CON	09	002	67-10406	565287 4821214	1076	1990/07	2336	06	FR	0082	28	50	10	1 :	DO		OOSTERVELD, RON BRWN CLAY GRVL 0015 GREY CLAY SAND GRVL 0035 BRWN ROCK 0084
CON	09	002	67-07436	565200 4821200	1070	1980/10	1906	05	FR	0092	31	60	20	2 :0	DO		FRIDD G GRVL 0030 BLCK STNS 0067 GREY STNS 0092

MUNICIPALITY CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR:MN	WATER USE	SCREEN DEPTH FEET	SCREEN LENGTH FEET	OWNER DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
CONTINUING... PUSLINCH TOWNSHIP																	
CON	09	002	67-08693	565812 4821899	1043	1987/02	2336	05	SU	0085	8	75	3	1 :0	DO		DUNMILL CONST. LTD. BRWN LOAM FILL 0005 BRWN ROCK 0063 GREY ROCK 0071 GREY ROCK 0085 P U C LOAM 0002 MSND GRVL 0009 BRWN LMSN 0029 GREY LMSN 0068
CON	09	002	67-02696	565465 4821310	1075	1962/11	2801	10	UK	0010	1	8	700	24:0	MN		7-M PROPERTIES BRWN CLAY STNS 0010 BRWN CLAY SAND GRVL 0035 BRWN ROCK 0060 BRWN ROCK 0084
CON	09	002	67-09444	564364 4820701	1095	1988/10	2336	06	FR	0080	31	50	25	1 :0	DO		SHERWOOD ROBT PRDG 0008 BRWN CLAY STNS 0032 BRWN CLAY GRVL 0040 HPAN GRVL 0050 GRVL 0052
CON	09	002	67-06373	565700 4821980	1048	1977/04	2336	05	FR	0051	9	17	10	1 :0	DO		KUS JOHN FILL 0003 GREY LMSN 0040
CON	09	002	67-02695	565460 4821550	1040	1959/05	2521	04	FR	0040	2	10	10	1 :0	DO		GUERNEY F GRVL 0002 BLCK ROCK 0065
CON	09	002	67-02694	565850 4821860	1045	1957/10	2521	04	FR	0065	9	9	10	1 :0	DO		OSKIN T GRVL STNS 0035
CON	09	002	67-04360	565660 4821980	1048	1972/09	2521	05	FR	0035	8	8	10	2 :0	DO		WOORTH SAND STNS 0003 BLCK ROCK 0044
CON	09	002	67-05309	565800 4821850	1045	1974/10	1906	04	UK	0044	8	30	15	1 :0	DO		OOSTERVELD H BRWN CLAY STNS 0030 BRWN CLAY GRVL 0037 GREY CLAY GRVL DKCL 0044 BRWN ROCK DKCL 0050 ROCK DKCL 0060 BRWN ROCK DKCL 0066 BRWN CLAY ROCK DKCL 0067
CON	09	002	67-06372	565180 4821120	1068	1977/04	2336	05	FR	0065	26	32	10	2 :0	DO		CARTER EARL CLAY MSND 0028 BRWN SHLE 0034 BRWN ROCK 0087 BLCK ROCK 0110
CON	09	002	67-04005	564350 4820550	1125	1971/09	1906	04	FR	0075	32	35	10	1 :0	DO		SMITH PHILIP G CLAY STNS GRVL 0006 BRWN ROCK 0028
CON	09	002	67-04027	565500 4821560	1040	1971/09	1906	05	FR		2	3	8	1 :0	DO		MORRISON, PAUL BRWN ROCK 0030 GREY ROCK 0048
CON	09	002	67-12111	565959 4821750	1033	1996/10	2336	06	FR	0048		15	20	1 :0	DO		ABBY HOMES BRWN ROCK 0015 BRWN ROCK 0062
CON	09	002	67-12008	565783 4821882	1043	1996/07	2336	06	FR	0062	3	39	15	1 :0	DO		LODGE H PRDG 0007 HPAN STNS 0069 BLCK ROCK 0121 P U C
CON	09	003	67-02700	564900 4820005	1075	1954/08	2521	04	SU	0120	21	25	10	2 :0	DO		LOAM 0001 MSND GRVL 0005 BRWN MSND 0016 MSND GRVL CLAY 0065 GREY LMSN 0094 P U C
CON	09	003	67-02698	565770 4821245	1050	1962/10	2801	10	UK	0065	26	67	48	0 :5	MN		LOAM 0002 MSND GRVL BLDR 0029 BRWN LMSN 0033 GREY LMSN 0073
CON	09	003	67-02697	565880 4821350	1060	1962/10	2801	10						:	NU		DECORSO, A. BRWN CLAY STNS GRVL 0068 BRWN ROCK 0120 GREY ROCK 0178
CON	09	003	67-08860	564942 4820022	1099	1987/06	2336	06	FR	0178	32	60	20	1 :	DO		CURON JOHN GRVL STNS 0038 BRWN ROCK 0115
CON	09	003	67-05015	565452 4821016	1065	1974/02	2521	04	FR	0115	15	20	15	2 :0	DO		CITY OF GUELPH PEAT 0004 GRVL 0007 BRWN ROCK SHLE 0014 BRWN ROCK SHLE HARD 0030 BLCK ROCK SHLE 0052 GREY ROCK 0132 GREY ROCK SOFT 0136 GREY ROCK 0158
CON	09	003	67-05652	565760 4821220	1072	1975/06	1906	06	SU	0128	FLW	118	110	:	PS		DECORSO BRWN CLAY STNS 0037 BRWN SHLE LOOS 0049 BRWN ROCK HARD 0070 BLCK ROCK HARD 0095 GREY ROCK 0200 BLUE SHLE 0220 RED SHLE 0245
CON	09	003	67-09383	565171 4820240	1085	1988/07	1906	06	FR	0245	12	19	60	8 :	IR		PIZZIOLA G CLAY STNS 0040 GRVL 0051 SAND 0067 BRWN ROCK 0087 BLCK ROCK 0108
CON	09	003	67-05337	564915 4820015	1100	1974/07	1906	05	FR	0108	24	88	9	3 :0	DO		

MUNICIPALITY CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR:MN	WATER USE	SCREEN DEPTH FEET	SCREEN LENGTH FEET	OWNER DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
CONTINUING... PUSLINCH TOWNSHIP																	
CON	09	003	67-12009	565827 4821386	1046	1996/07	2336	02	UK	0005	2			:	IN		MCKENZIE BROS.GUELPH BRWN STNS SAND GRVL 0009 BRWN ROCK 0017
CON	09	003	67-12012	566278 4821457	1046	1996/07	2336	02	FR	0013	4			:	IN		MCKENZIE BROS.GUELPH BRWN SAND GRVL 0010 BRWN ROCK 0028 BRWN ROCK 0041
CON	09	003	67-12010	566169 4821340	1072	1996/07	2336	02	FR	0010	9			:	IN		MCKENZIE BROS.GUELPH BRWN SAND GRVL 0025 BRWN ROCK 0033
CON	09	003	67-12592	565494~ 4820858		1998/06	2336	06	FR	0080	6	35	20	1 :0	DO		ANTHONY, PAUL BRWN CLAY STNS 0010 GREY CLAY STNS 0050 GREY CLAY GRVL 0061 BRWN ROCK 0080
CON	09	003	67-12962	565494~ 4820858		1999/05	2336	06	FR	0140	32	87	10	1 :0	DO IR		RALSTON,ART BRWN SAND GRVL 0022 GREY CLAY STNS 0043 BRWN ROCK 0100 GREY ROCK 0140
CON	09	003	67-12011	566252 4821423	1053	1996/07	2336	02	FR	0010	9			:	IN		MCKENZIE BROS.GUELPH BRWN SAND GRVL 0022 BRWN ROCK 0030
CON	09	004	67-03432	565850 4820540	1110	1969/08	2406	04	UK	0143	45	50	15	1 :0	DO		PATERSON D L LOAM 0006 BRWN CLAY STNS 0030 BRWN CLAY GRVL 0055 BRWN LMSN 0143
CON	09	004	67-02699	566140 4821145	1090	1962/11	2801	10	FR	0021	5	13	1200	60:0	MN		P U C LOAM 0002 MSND GRVL 0006 CLAY GRVL 0021 BRWN LMSN 0029 GREY LMSN 0065
CON	09	004	67-10738	565768 4820617	1108	1991/07	2336	06	FR	0079	51	65	10	1 :0	DO		,THOMAS BRWN CLAY STNS 0025 GREY CLAY STNS 0036 BRWN ROCK 0068 BRWN ROCK 0081
CON	09	004	67-06690	565780 4820540	1108	1978/05	2904	06	UK	0210	37	210	22	2 :30	DO		JEFFERSON L A BRWN CLAY STNS LOOS 0028 GREY CLAY FGVL PCKD 0046 BRWN LMSN HARD 0072 BRWN LMSN HARD DKCL 0086 BRWN LMSN LTCL SOFT 0089 BRWN LMSN HARD DKCL 0110 GREY LMSN SOFT 0117 BRWN LMSN HARD 0135 WHIT LMSN HARD 0162 GREY LMSN HARD 0202 WHIT LMSN HARD 0213
CON	09	004	67-02701	565020 4819895	1095	1966/11	2521	04	FR	0140	25	90	5	2 :0	DO		KACZMARCZYK B CLAY 0074 BRWN ROCK 0140
CON	09	004	67-03560	565780 4820630	1102	1969/11	2521	04	FR	0077	50	65	10	2 :0	DO		PORTER L CLAY 0030 BRWN LMSN 0077
CON	09	004	67-02743	566500 4821165	1080	1958/05	4208	06	FR	0093	27	50	17	1 :0	ST DO		COMPHELL T CLAY GRVL 0084 LMSN 0095
CON	09	004	67-05702	565000 4819900	1055	1975/08	1906	04	UK	0107	30	80	12	3 :0	DO		BASA ERNESTO BRWN CLAY 0047 SAND GRVL 0072 BRWN ROCK 0108
CON	09	004	67-12013	566551 4821098	1099	1996/07	2336	02	FR	0010	8			:	IN		MCKENZIE BROS.GRAVEL BRWN SAND GRVL 0018 BRWN ROCK 0033
CON	09	004	67-13535	565786~ 4820580		2000/10	2663	06	FR	0210	45	48	30	1 :	DO		VICTORIA RD GOLE EAS BLCK LOAM 0002 GREY CLAY STNS 0054 BRWN LMSN 0080 BRWN LMSN 0120 GREY LMSN 0140 GREY LMSN 0210
CON	09	005	67-11027	566069~ 4820290		1992/11	6624	05	FR	0070	14	20	20	2 :0	DO		CANPOL CONST. LOAM 0001 BRWN CLAY 0007 BRWN CLAY GRVL 0015 GRVL SAND 0032 BRWN LMSN 0073
CON	09	005	67-08458	566796 4820366	1135	1986/05	1906	05	SU	0139	25	120	6	2 :	DO		MALDONADO, C. BLDR 0015 BRWN CLAY 0034 LMSN ROCK 0095 BLCK ROCK 0140
CON	09	005	67-03249	565880 4820500	1110	1968/09	1906	04	FR	0150	55	65	10	2 :0	DO		GALLOWAY RONALD E CLAY STNS 0010 CLAY MSND 0040 BRWN CLAY 0050 LMSN 0070 BRWN LMSN 0110 BLCK LMSN 0128 BLUE LMSN 0150
CON	09	005	67-03195	566100 4820300	1095	1968/08	2521	04	FR	0093	25	85	4	1 :0	DO		CARTER DAVID GRVL 0035 GREY LMSN 0085 BRWN LMSN 0093

MUNICIPALITY CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR:MN	WATER USE	SCREEN DEPTH FEET	SCREEN LENGTH FEET	OWNER DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
CONTINUING... PUSLINCH TOWNSHIP																	
CON	09 005	67-02703	565960 4820460	1100	1964/05	1906	04	FR	0167	42	45	12	2 :0	DO			GALLOWAY E STNS CLAY 0015 CLAY 0049 BRWN LMSN 0100 GREY SHLE 0110 BLCK LMSN 0129 BLUE LMSN 0167
CON	09 005	67-02702	566105 4820370	1100	1963/09	2521	04	FR	0075	30	60	12	2 :0	ST DO			CARTER H GRVL STNS 0033 BRWN LMSN 0075
CON	09 005	67-05226	565486 4819509	1090	1974/07	1906	05			35	70	20	3 :0	PS DO			DECORSO ENDERPRISES CLAY STNS 0051 BRWN ROCK 0100 BLCK ROCK 0119 BRWN ROCK 0132
CON	09 005	67-13313	566069~ 4820289		1999/12	4207		FR	0085	33	90	30	1 :	DO			JEFFERSON,TOM PRDR 0048 BLCK ROCK 0090
CON	09 005	67-11902	565947 4820350	1095	1995/07	4207	06	FR	0045	28	48	20	1 :0	DO			JEFFERSON, TOM BRWN CLAY STNS GRVL 0027 GREY LMSN 0048
CON	09 005	67-12611	566069~ 4820290		1998/07	2663	06	FR	0082	21	65	12	1 :0	DO			DUNNINK HOMES BRWN CLAY STNS 0015 GRVL 0025 BRWN CLAY SAND GRVL 0038 BRWN LMSN DKCL 0075 GREY LMSN 0082
CON	09 006	67-07525	566100 4820400	1100	1981/07	4868	06	FR	0172	40	90	10	:	DO			WYGA O BRWN CLAY STNS SILT 0059 BRWN LMSN SNDS HARD 0076 BLCK STNS VERY HARD 0172 GREY LMSN HARD 0176 BLCK STNS VERY HARD 0180
CON	09 006	67-02715	567275 4820440	1120	1961/02	2521	04	FR	0100	26	60	10	2 :0	DO			ELLIS J CLAY 0045 BRWN LMSN 0100
CON	09 006	67-02716	565965 4819500	1095	1963/04	2406	04	FR	0060	25	38	10	1 :0	DO			GOLDING C LOAM 0002 GRVL STNS 0018 BRWN CLAY GRVL 0026 BRWN LMSN 0073
CON	09 006	67-02714	567165 4820540	1125	1959/12	2521	04	FR	0102	22	40	10	2 :0	DO			HUME R CLAY 0010 GRVL 0030 CLAY 0046 BRWN LMSN 0102
CON	09 006	67-03454	566250 4819980	1095	1969/08	2406	04	FR	0116	25	37	10	1 :0	DO			RICHARDSON R R LOAM 0001 BRWN CLAY STNS 0035 BRWN LMSN 0105 GREY LMSN 0112 BRWN LMSN 0116
CON	09 006	67-08576	565904 4819756	1099	1986/10	2336	05	FR	0102	32	60	10	1 :	DO			WYGA CONSTRUCTION BRWN CLAY SAND STNS 0027 BRWN ROCK 0040 GREY ROCK 0078 BRWN ROCK 0102
CON	09 006	67-02717	567005 4820750	1125	1964/04	2521	04	FR	0145	25	80	4	2 :0	DO			BOREHAM N CLAY MSND 0015 CLAY GRVL 0050 GREY LMSN 0105 LMSN 0145
CON	09 006	67-02718	565960 4819505	1095	1964/06	2406		FR	0120	30	60	8	1 :0	DO			GOLDING C PRDR 0073 BLCK LMSN 0120 GREY LMSN 0130
CON	09 006	67-08887	565891 4819776	1099	1987/07	2336	05	FR	0116	23	60	15	1 :	DO			WYGA CONSTRUCTION BRWN CLAY SAND GRVL 0031 BRWN ROCK 0085 BRWN ROCK 0116
CON	09 006	67-02719	567145 4820495	1125	1961/06	2521	04	FR	0110	16	60	8	2 :0	PS			ARKELL UNITED CHURCH CLAY 0040 GRVL 0051 GREY LMSN 0110
CON	09 006	67-08575	566408 4820263	1105	1986/10	2336	05	FR	0107	25	60	8	1 :	DO			ROFFEL, MR. HARRY BRWN CLAY GRVL 0031 BRWN ROCK 0055 BRWN ROCK 0070 BRWN ROCK 0107
CON	09 006	67-02721	565960 4819500	1095	1965/11	2406	05	FR	0128	29	60	40	0 :30	DO			TRUSCOTT R LOAM 0001 STNS GRVL 0018 CSND 0024 GRVL CLAY 0031 BRWN LMSN 0075 BLCK LMSN 0098 GREY LMSN 0130
CON	09 006	67-11690	567004 4820773	1138	1995/02	2336	06	FR	0120	20	89	5	5 :0	DO			NASA HOLDINGS INC. BRWN CLAY GRVL 0015 GREY CLAY GRVL 0044 BRWN ROCK 0080 BRWN ROCK 0105 BRWN ROCK 0120
CON	09 006	67-02704	567005 4820465	1120	1948/12	2414		FR	0115	24	30	10	2 :0	ST DO			BOREHAM H PRDG 0028 HPAN 0047 BRWN LMSN 0120
CON	09 006	67-02708	567005 4820735	1125	1955/08	2414	05	FR	0100	24	70	8	3 :0	DO			AYRES H LOAM 0001 CLAY STNS 0052 GREY LMSN 0112 BLCK LMSN 0153 BLUE LMSN 0156

MUNICIPALITY CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP TEST LVL FEET	TEST RATE GPM	TEST TIME HR:MN	WATER USE	SCREEN DEPTH FEET	SCREEN LENGTH FEET	OWNER DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
CONTINUING... PUSLINCH TOWNSHIP																	
CON	09	006	67-02709	567140 4820585	1125	1950/11	2521	04	FR	0100	26	50	10	0 :30	DO		RIDLER G GRVL STNS 0032 LMSN 0100
CON	09	006	67-02707	566390 4819980	1100	1955/04	2521	04	FR	0106	24	90	10	2 :0	DO		CASHIE J GRVL STNS 0033 GREY LMSN 0086 BLCK LMSN 0106
CON	09	006	67-02706	566665 4820350	1125	1953/05	2414	05	FR	0118	38	50	6	4 :0	ST DO		LASBY G LOAM 0006 GRVL STNS 0011 MSND 0014 CLAY 0022 GRVL MSND 0025 CLAY STNS 0046 MSND GRVL 0049 CLAY STNS 0053 BRWN LMSN 0078 WHIT LMSN 0118 BLCK LMSN 0141 BRWN LMSN 0147
CON	09	006	67-07527	566000 4819700	1105	1981/11	1906	05	FR	0120	25	60	15	2 :0	DO		FERGUSON W CLAY STNS 0056 LMSN STNS 0120
CON	09	006	67-03307	566030 4819500	1095	1969/01	2406	05	FR	0122	23	40	10	0 :30	DO		BOREHAM GEORGE BRWN CLAY STNS 0018 BRWN CLAY GRVL 0037 BRWN LMSN 0116 GREY LMSN 0125
CON	09	006	67-02710	566450 4819955	1100	1957/07	2521	04	FR	0098	18	18	15	1 :0	DO		STERKEY J GRVL STNS 0021 GREY LMSN 0081 BLCK LMSN 0098
CON	09	006	67-02705	566520 4819920	1125	1951/05	2414	06	FR	0050	12	18	12	6 :0	DO		CUNNINGHAM K GRVL 0012 MSND 0018 CLAY BLDR 0031 WHIT LMSN 0046 BRWN LMSN 0091
CON	09	006	67-10768	567008 4820436	1125	1991/10	2336	06	FR	0118	42	70	10	1 :	DO		SMITH, DOUG BRWN CLAY STNS 0015 GREY CLAY GRVL 0047 BRWN ROCK 0120
CON	09	006	67-11691	567133 4820540	1135	1995/02	2336	06	FR	0120	20	44	10	24:0	DO		NASA HOLDINGS INC. BRWN CLAY GRVL 0020 GREY CLAY GRVL 0041 BRWN ROCK 0098 BRWN ROCK 0110 BRWN ROCK 0120
CON	09	006	67-10121	566432 4819969	1102	1989/11	2663	06	FR	0126	70		12	1 :0	DO		J & S CONSTRUCTION GRVL 0029 WHIT LMSN 0040 BRWN LMSN 0086 BRWN LMSN 0120 GREY LMSN 0126
CON	09	006	67-04893	566239 4819614	1094	1973/11	2406	05	FR	0090	29	35	15	1 :0	DO		WALTON V LOAM 0001 BRWN CLAY STNS 0025 BRWN CLAY GRVL 0039 BRWN ROCK 0065 BRWN ROCK 0123
CON	09	006	67-04944	566314 4820077	1095	1973/09	2332	04	FR	0130	28	47	8	3 :0	DO		MORRIS H BLCK LOAM 0002 BRWN GRVL CLAY 0023 GREY SHLE STNS 0029 BRWN ROCK 0036 BRWN ROCK 0075 BLCK ROCK 0112 GREY ROCK LMSN 0127 GREY LMSN 0165
CON	09	006	67-02711	567135 4820595	1120	1958/09	2521	04	FR	0108	24	65	10	1 :0	DO		BUITENDYK H CLAY GRVL 0046 GREY LMSN 0108
CON	09	006	67-02712	565990 4819700	1100	1958/10	2521	04	FR	0081	28	28	10	1 :0	DO		FERGUSON W PRDG 0025 MSND 0031 GREY LMSN 0065 BRWN LMSN 0081
CON	09	006	67-02713	566005 4819720	1100	1958/11	2521	04	FR	0080	25	25	10	1 :0	DO		RAE G GRVL 0032 GREY LMSN 0080
CON	09	006	67-05874	566973 4820411	1128	1975/01	4208	06	FR	0126	24	120	15	1 :0	DO		A REID CONST LTD GREY CLAY STNS GRVL 0047 GREY LMSN 0130
CON	09	006	67-10920	566461 4820248	1108	1992/04	2336	06	FR	0118	62	90	8	1 :	DO		PAGNAN, PAUL BRWN CLAY STNS 0029 BRWN ROCK 0055 BRWN ROCK 0085 BRWN ROCK 0121
CON	09	006	67-03643	565950 4819650	1090	1970/03	2521	04	SU	0100	28	50	10	2 :0	DO		SHORTREED W GRVL 0026 GREY ROCK 0100
CON	09	006	67-04851	565729 4819561	1102	1973/11	2406	05	FR	0115	27	75	10	4 :0	DO		DECORSO C BRWN CLAY GRVL 0030 BRWN CLAY GRVL STNS 0050 BRWN GRVL STNS 0057 BRWN ROCK 0115
CON	09	006	67-03749	566540 4819995	1095	1970/07	2521	04	FR	0099	17	40	12	2 :0	DO		RIDDLER R GRVL 0026 GREY ROCK 0099
CON	09	006	67-10778	567117 4820634	1135	1991/11	2336	06	FR		28	85	6	1 :0	DO		HUTCHINSON, HERB BRWN CLAY STNS 0018 GREY CLAY GRVL 0043 BRWN ROCK 0075 BRWN ROCK 0105 BRWN ROCK 0120

MUNICIPALITY CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR:MN	WATER USE	SCREEN DEPTH FEET	SCREEN LENGTH FEET	OWNER DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
CONTINUING... PUSLINCH TOWNSHIP																	
CON	09 006	67-04242	566500 4819900	1100	1972/06	2521	04	FR	0118	20	60	10	1 :30	DO			SANDERS H GRVL STNS 0024 GREY ROCK 0118
CON	09 006	67-04784	566696 4820077	1107	1973/09	2521	04	FR	0080	25	30	10	1 :0	DO			FRETSCHENSHU H GRVL STNS 0023 GREY LMSN 0080
CON	09 006	67-02720	565955 4819615	1095	1962/02	2521	04	FR	0077	32	40	10	2 :0	DO			BUSSHAFF A CLAY GRVL 0028 BRWN LMSN 0077
CON	09 006	67-08372	566558 4820190	1105	1985/12	1906	05	FR	0065	26	50	10	1 :30	DO			MCPHERSON,ALEXANDER GRVL CLAY STNS 0012 CLAY STNS 0028 LMSN ROCK 0035 GREY ROCK 0040 BLUE ROCK 0045 BRWN ROCK 0066
CON	09 006	67-11668	566095 4819972	1095	1994/12	4207	06	SU	0121	38	124	8	1 :0	ST			JEFFERSON FARMS LTD. BRWN GRVL 0015 BRWN SILT STNS 0041 GREY LMSN 0065 BLCK LMSN 0105 GREY LMSN 0124
CON	09 006	67-13777	566364~ 4820000		2001/07	2336	06	FR	0238	31	119	7	1 :	DO			DETERCO BUILDERS INC BRWN CLAY STNS 0028 BRWN ROCK 0110 GREY ROCK 0240
CON	09 006	67-12256	568548 4816570	340	1997/05	2663	06	FR	0090	36	70	25	1 :	DO			CAMPAGNOLO, ALDO GRVL SAND STNS 0090
CON	09 006	67-13407	566364~ 4820000		2000/07	2336	06	FR	0100	18	40	10	1 :	DO			HULSHOFF-JANZEN,RUTH BRWN CLAY GRVL BLDR 0020 BRWN CLAY STNS 0030 GREY CLAY STNS 0032 BRWN ROCK 0100
CON	09 006	67-13417	566364~ 4820000		1999/05	2663	06	UK	0125	18	29	5	1 :	DO			NASA HOLDINGS INC LOAM 0001 BRWN CLAY STNS 0020 BRWN CLAY GRVL SAND 0030 BRWN LMSN 0050 BRWN LMSN 0080 BRWN LMSN 0125
CON	09 006	67-13745	566364~ 4820000		2001/03	2663	06	FR	0185	35	57	10	1 :	DO			MANNING,TERRY BRWN LMSN 0160 GREY LMSN 0185
CON	09 007	67-02736	566770 4819805	1120	1957/12	2402	07	FR	0125	24	80	12	4 :0	ST DO			AGRICULTURAL COLLEGE LOAM 0001 HPAN BLDR 0035 CLAY 0048 HPAN 0052 GREY LMSN 0115 BRWN LMSN 0135 BLCK LMSN 0141
CON	09 007	67-02726	567220 4820495	1125	1963/03	2521	04	FR	0144	36	90	2	1 :0	DO			PAGE L CLAY 0052 GREY LMSN 0120 BRWN LMSN 0130 BLCK LMSN 0144
CON	09 007	67-02731	567140 4820500	1125	1961/02	2521	04	FR	0095	24	70	15	1 :0	DO			RONALD K CLAY 0040 GREY LMSN 0095
CON	09 007	67-10891	567237 4820552	1138	1992/02	2336	06	FR	0118	33	80	4	1 :0	DO			DALTON FINANCIAL INC BRWN CLAY STNS 0015 GREY SAND GRVL 0025 GREY CLAY GRVL 0052 BRWN ROCK 0120
CON	09 007	67-02737	566340 4819605	1100	1958/06	2521	04	FR	0100	30	50	10	1 :0	DO			TOLTON J CLAY 0038 GRVL 0043 GREY LMSN 0100
CON	09 007	67-03745	567200 4820520	1130	1970/08	2521	04	FR	0129	40	70	7	2 :0	DO			FLETCHER R CLAY GRVL 0056 GREY LMSN 0129
CON	09 007	67-07182	566100 4819350	1100	1979/05	2402	08	FR	0206	31	210	20	24:0	ST			ARKELL FARM LOAM 0001 CLAY STNS 0033 LMSN 0254
CON	09 007	67-02734	567100 4820450	1125	1957/05	2414	04	FR	0092	23	43	5	2 :0	DO			HUME S LOAM 0001 CLAY STNS 0040 CLAY 0044 BRWN LMSN 0100
CON	09 007	67-09504	567220 4820417	1138	1988/12	2336	06	FR	0120	32	65	10	1 :0	DO ST			GUTHRIE, MR.L. BRWN CLAY STNS 0015 BRWN SAND CLAY 0055 BRWN ROCK 0080 BRWN ROCK 0115 BRWN ROCK 0124
CON	09 007	67-03193	567350 4820350	1135	1968/05	2406	04	FR	0215	40	85	6	0 :30	DO			CROSWELL C H LOAM 0001 BRWN CLAY STNS 0010 GREY CLAY STNS 0038 MSND GRVL 0054 BRWN LMSN 0065 GREY LMSN 0090 BRWN LMSN 0125 BLCK LMSN 0155 GREY LMSN 0215
CON	09 007	67-02735	566940 4820255	1120	1957/11	2402	07	FR	0102	32	40	30	4 :0	ST DO			PUBLIC WORKS DEPT LOAM 0002 HPAN STNS 0034 BRWN LMSN 0090 GREY

MUNICIPALITY CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR:MN	WATER USE	SCREEN DEPTH FEET	SCREEN LENGTH FEET	OWNER DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
CONTINUING... PUSLINCH TOWNSHIP																	
CON	09 007	67-02728	567100 4820505	1125	1961/02	2521	04	FR	0134	33	80	5	2 :0	DO			BARNETT R CLAY 0051 BRWN LMSN 0134
CON	09 007	67-02729	566860 4820205	1125	1953/07	2414	04	FR	0050	9	29	5	3 :0	DO			METCALF L CLAY STNS 0033 BRWN LMSN 0096
CON	09 007	67-02730	567315 4820395	1120	1953/09	2521	04	FR	0200	40	100	10	1 :0	DO			ROBERTS K LOAM CLAY 0010 HPAN 0025 GRVL 0055 LMSN 0125 GREY LMSN 0200
CON	09 007	67-02727	567180 4820550	1125	1962/07	2521	04	FR	0132	35	85	5	1 :0	DO			WATSON H CLAY 0053 BRWN LMSN 0132
CON	09 007	67-02725	567010 4820360	1125	1964/04	2521	04	FR	0090	12	20	10	2 :0	DO			TOLTON R GRVL 0032 BRWN LMSN 0090
CON	09 007	67-02723	567280 4820445	1125	1964/01	2521	04	FR	0129	40	80	5	2 :0	CO ST			KNIGHT LUMBER CO CLAY GRVL 0053 GREY LMSN 0105 BRWN LMSN 0129
CON	09 007	67-10001	567478 4820291	1138	1989/09	1906	05	UK	0080	49	49	25	4 :0	DO			PEPPARD, MICHAEL BRWN CLAY STNS 0030 GRVL 0039 LMSN 0080
CON	09 007	67-02733	567065 4820410	1125	1956/04	2521	04	FR	0140	45	60	10	2 :0	DO			JAY A GRVL 0010 CLAY MSND 0054 GREY LMSN 0120 BRWN LMSN 0140
CON	09 007	67-04037	567350 4820320	1140	1971/05	4208	06	FR	0060	41	65	12	1 :0	DO			VANESCH JOHN GREY CLAY GRVL 0054 GREY LMSN 0075
CON	09 007	67-02722	566100 4819350	1075	1951/08	2414	06	FR	0060	16	40	60	8 :0	IR			AGRICULTURAL COLLEGE GRVL 0012 CLAY 0024 MSND GRVL 0030 WHIT LMSN 0040 MSND LMSN 0042 WHIT LMSN 0073 BRWN LMSN 0079 WHIT LMSN 0092 BLCK LMSN 0112 GREY LMSN 0136
CON	09 007	67-02741	567185 4820545	1125	1961/01	2521	04	FR	0120	30	70	4	1 :0	DO			COULSON L CLAY 0011 GRVL 0051 BRWN LMSN 0120
CON	09 007	67-02724	567100 4820440	1125	1965/01	1906	04	FR	0080	26	60	15	10:0	DO			FEIKEMA J PRDG 0020 GRVL CLAY 0050 BRWN LMSN 0080
CON	09 007	67-10504	567399 4820388	1138	1990/10	1906	05	UK	0230	94	137	8	3 :0	DO			DAMAREN, RENO CLAY STNS 0055 BRWN LMSN 0060 GREY ROCK 0100 BRWN ROCK 0125 BLCK ROCK 0147 GREY ROCK 0230
CON	09 007	67-08794	565753 4822255	1049	1987/05	2336	05	FR	0040	6	20	10	1 :	DO			RON INGLIS HOMES LTD BRWN CLAY SAND STNS 0019 BRWN ROCK 0040
CON	09 007	67-02739	567260 4820460	1125	1959/08	2521	04	FR	0105	25	40	10	1 :0	DO			ORME D GRVL CLAY 0046 BRWN LMSN 0105
CON	09 007	67-02738	567150 4820490	1125	1959/07	2521	04	FR	0112	35	40	10	2 :0	DO			LUMBER CO CLAY 0040 MSND 0043 GREY LMSN 0112
CON	09 007	67-02742	567225 4820495	1125	1961/02	2521	04	FR	0128	35	85	4	1 :0	DO			HAM M CLAY 0045 GRVL 0053 GREY LMSN 0128
CON	09 007	67-11568	567372 4820382	1135	1994/10	2663	06	FR	0163	36	80	12	1 :0	DO			GRANDMARK HOMES LOAM 0001 BRWN CLAY GRVL 0055 BRWN LMSN 0163
CON	09 007	67-02732	567045 4820380	1120	1954/02	2414	05	FR	0098	18	160	37	4 :0	DO			RYCHMAN V CLAY STNS 0019 GRVL 0021 CLAY STNS 0039 FSND 0041 BRWN LMSN 0079 WHIT LMSN 0104
CON	09 007	67-02740	567290 4820440	1125	1959/12	2521	04	FR	0100	20	70	10	1 :0	DO			HUME R CLAY 0030 GRVL 0043 BRWN LMSN 0100
CON	09 007	67-13413	566662~ 4819708		1999/05	2663	06	FR	0185	23	85	5	7 :	DO			NASA HOLDINGS INC LOAM 0001 BRWN CLAY STNS 0020 BRWN CLAY SAND GRVL 0031 BRWN LMSN 0055 BRWN LMSN 0080 BRWN LMSN 0135 GREY LMSN 0155 GREY LMSN 0185
CON	09 008	67-04361	567620 4820150	1140	1972/09	2521	04	FR	0145	60	90	10	2 :0	DO			PALMER S GRVL STNS 0066 GREY LMSN 0120 BLCK ROCK 0145
CON	09 008	67-13423	566954~ 4819418		1999/05	2663	06	FR	0180	19	116		1 :	DO			NASA HOLDING INC LOAM 0001 BRWN CLAY STNS 0020 BRWN CLAY SAND GRVL 0034 BRWN LMSN 0055 BRWN LMSN 0080 BRWN LMSN 0135 GREY LMSN 0155 GREY LMSN 0184

MUNICIPALITY CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR:MN	WATER USE	SCREEN DEPTH FEET	SCREEN LENGTH FEET	OWNER DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
CONTINUING... PUSLINCH TOWNSHIP																	
CON	09	009	67-07636	566220 4819320	1100	1981/07	2402	08	FR	0194	26	28	60	24:0	ST		ARKELL FARM LOAM 0001 SAND BLDR 0016 CLAY 0041 LMSN 0235
CON	09	009	67-13422	567244~ 4819130		1999/05	2663	06	FR	0182	28	41	8	7 :	DO		NASA HOLDINGS INC LOAM 0001 BRWN CLAY STNS 0020 BRWN CLAY SAND GRVL 0038 BRWN LMSN 0055 BRWN LMSN 0075 BRWN LMSN 0140 GREY LMSN 0182
CON	09	009	67-13347	567244~ 4819130		2000/05	2663	06	FR	0182	18	72	8	3 :	DO		NASA HOLDINGES INC GREY LMSN 0140 GREY LMSN 0182
CON	09	009	67-12761	567243~ 4819129		1998/11	2336	06	FR	0175	81	120	20	1 :0	DO		KUKOVICA, PETER BRWN CLAY STNS 0040 BRWN SAND GRVL 0085 GREY CLAY GRVL 0104 BRWN ROCK 0179
CON	09	010	67-04581	567725 4819920	1100	1973/03	1906	05	SU	0186	88	89	15	3 :0	DO		KUKOVICA I PRDG 0005 CLAY GRVL STNS 0055 STNS SAND 0080 GRVL CLAY 0123 HPAN STNS 0132 BRWN ROCK 0150 GREY ROCK 0176 BRWN ROCK 0187
CON	09	010	67-10962	568193 4819755	1194	1992/07	2336	06	FR	0138	87		15	1 :	DO		FITTON, B. BRWN CLAY STNS 0015 BRWN SAND GRVL 0085 GREY CLAY GRVL 0114 BRWN ROCK 0140
CON	09	010	67-13421	567544~ 4818844		1999/05	2663	06	FR	0182	20	43	8	3 :	DO		NASA HOLDINGS INC LOAM 0001 BRWN CLAY STNS 0020 BRWN SAND 0025 BRWN CLAY SAND GRVL 0038 BRWN LMSN 0055 BRWN LMSN 0075 BRWN LMSN 0135 GREY SNDS 0182
CON	09	010	67-13348	567544~ 4818844		2000/05	2663	06	FR	0182	20	43	8	3 :	DO		NASA HOLDINGES INC GREY LMSN 0135 GREY LMSN 0182
CON	09	011	67-06319	568500 4819140	1220	1976/01	2803	06	FR	0150	120	155	10	2 :0	ST		CONWAY C ABBOTT PRDR 0006 BRWN GRVL 0105 BRWN HPAN 0144 GREY LMSN 0170
CON	09	012	67-09162	568702 4819328	1190	1988/02	2336	06	FR	0190	95	125	15	2 :	DO		MITTEN, JOHN BRWN CLAY STNS 0015 BRWN CLAY GRVL 0070 BRWN GRVL SAND 0100 BRWN CLAY SAND 0133 BRWN ROCK 0180 BRWN ROCK 0191
CON	09	012	67-10195	568831 4819195	1167	1990/01	2336	06	FR	0140	84	100	15	1 :	DO		SPIKMAN, MR. RICK BRWN CLAY SAND STNS 0025 BRWN SAND GRVL 0045 BRWN GRVL 0065 BRWN CLAY GRVL 0115 BRWN ROCK 0141
CON	09	012	67-13420	568124~ 4818261		1999/09	2663	06	FR	0182	20	39	5	3 :	DO		NASA HOLDINGS INC LOAM 0001 BRWN CLAY STNS 0020 BRWN CLAY GRVL 0040 BRWN LMSN FCRD ROCK 0045 BRWN LMSN 0055 BRWN LMSN 0080 BRWN LMSN 0150 GREY LMSN 0182
CON	09	012	67-13349	568124~ 4818261		2000/05	2663	06	FR	0182	20		5	3 :	DO		NASA HOLDINGES BRWN LMSN 0150 GREY LMSN 0182
CON	09	013	67-10050	568405~ 4817977		1989/11	4552	05	FR	0055	8	20	10	1 :0	DO		ROTH, ROBERT BRWN FILL 0005 GREY CLAY STNY HARD 0048 BRWN GRVL CMTD 0055
CON	09	013	67-13414	568406~ 4817977		1999/04	2663	06	FR	0016	59	62	5	7 :	DO		NASA HOLDING INC LOAM 0001 BRWN CLAY STNS 0020 BRWN CLAY GRVL 0036 BRWN LMSN 0055 UNKN 0080 UNKN 0135 UNKN 0150 UNKN 0163
CON	09	014	67-08741	569322 4818124	1148	1986/09	2332	05	FR	0106	50	50	10	3 :0	DO		HUIZINGA, J. BRWN CLAY STNS GRVL 0035 GREY CLAY STNS 0105 GREY STNS ROCK 0106
CON	09	014	67-09948	569247 4818808	1131	1989/09	4005	06	FR	0108	68	92	25	1 :	DO		GATTO CONSTRUCTION BRWN SAND GRVL LOOS 0010 GREY GRVL SAND LOOS 0072 GREY CLAY SNDY LOOS 0103 GREY LMSN HARD 0110

MUNICIPALITY CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR:MN	WATER USE	SCREEN DEPTH FEET	SCREEN LENGTH FEET	OWNER DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
CONTINUING... PUSLINCH TOWNSHIP																	
CON	10	67-13297	999999~ 9999999		2000/02	2336	06	FR	0190	24	32	300	2 :	MN			CITY OF GUELPH BRWN LOAM 0001 BRWN CLAY SAND 0002 BRWN SAND GRVL CLAY 0027 BRWN ROCK 0122 GREY ROCK 0163 GREY ROCK FCRD 0190
CON	10	67-13298	999999~ 9999999		2000/02	2336	06	FR	0055				:	MN			CITY OF GUELPH BRWN SAND GRVL BLDR 0035 BRWN ROCK 0055
CON	10	67-13290	999999~ 9999999		2000/02	2336	02						:	MN	0042 10		CITY OF GUELPH BRWN CLAY STNS 0005 BRWN SAND GRVL BLDR 0047 BRWN ROCK 0052
CON	10	67-13287	999999~ 9999999		2000/01	2336	06	SU	0100	2	14	50	2 :	MN			CITY OF GUELPH BRWN FILL 0004 BLCK LOAM 0007 BRWN ROCK 0078 GREY ROCK 0100
CON	10	67-13293	999999~ 9999999		2000/03	2336	02			33			:	MN	0041 51		CITY OF GUELPH BRWN FILL 0002 BRWN CLAY SAND 0005 BRWN GRVL SAND 0051 BRWN ROCK 0052
CON	10	001 67-02760	565621~ 4822160	1050	1957/10	2521	04	FR	0040	15	15	10	1 :0	DO			NICKOLS B CLAY BLDR 0011 BLCK LMSN 0040
CON	10	001 67-08051	565980 4822660	1120	1983/10	2336	06	FR	0125	70	90	10	1 :0	ST DO			INGLIS B LOAM 0001 BRWN CLAY SAND STNS 0025 BRWN CLAY GRVL 0044 BRWN STNS LTCL 0070 BRWN STNS DKCL 0095 BLCK STNS 0127
CON	10	001 67-02761	565621 4822160	1050	1959/05	2521	04	FR	0040	16	16	10	1 :0	DO			MILLARD D CLAY SHLE 0018 GREY LMSN 0040
CON	10	001 67-02759	565595~ 4822235	1070	1955/06	4838	04	FR	0035	20	22	7	2 :0	DO			NEISH M PRDG 0015 BLCK LMSN 0042
CON	10	001 67-12003	565839 4822225	1046	1996/06	4207	06	FR	0070	23	76	7	1 :0	DO			HALL, MURRAY BRWN CLAY STNS GRVL 0009 GREY LMSN SOFT FCRD 0028 GREY LMSN 0076
CON	10	002 67-08695	565810 4821786	1040	1986/09	4207	06	SU	0057	3	58	30	1 :0	DO			GOSTERVELD, RANCE BRWN CLAY GRVL STNS 0005 BLCK LMSN 0058
CON	10	002 67-05032	567210 4823366	1125	1974/04	2336	06	FR	0114	60	70	15	1 :0	DO			HULLAND T J BRWN LOAM 0002 BRWN CLAY STNS 0012 BRWN ROCK 0030 GREY ROCK 0075 BLCK ROCK 0095 GREY ROCK 0114
CON	10	002 67-12772	566625~ 4822628		1998/10	2663	06	FR	0035	19	25	20	1 :0	DO			LODDER,TONY BRWN CLAY SAND STNS 0013 BRWN LMSN 0018 BRWN LMSN 0035
CON	10	002 67-11971	565800 4822041	1046	1996/05	2336	06	FR	0040	13	21	10	1 :0	DO			MACDONALD, TOM BRWN CLAY STNS 0010 BRWN SAND GRVL 0015 BRWN ROCK 0040
CON	10	002 67-11970	565798 4822044	1046	1986/05	2336	04						:	DO			MACDONALD, TOM PRDR 0042
CON	10	004 67-04351	567300 4822500	1050	1968/02	0001	20	FR	0006	3			:	NU			CITY OF GUELPH CLAY BLDR 0006 GRVL 0011
CON	10	004 67-02809	568056 4822756	1115	1963/06	2801	12	FR	0113	47	52	700	24:0	MN			GUELPH P U C LOAM 0001 GRVL MSND BLDR 0005 GRVL CLAY BLDR 0027 MSND GRVL CLAY 0032 MSND 0038 SHLE 0053 GREY LMSN 0113 LMSN 0115 GREY LMSN 0127 LMSN 0131 GREY LMSN 0138
CON	10	004 67-02763	566680 4821515	1075	1962/12	2801	01	FR	0038	37			:	NU	0049 10		GUELPH P U C LOAM 0001 GRVL MSND BLDR 0037 MSND GRVL 0054 BRWN LMSN 0066 BLCK SHLE 0072 BRWN LMSN 0083 BLCK SHLE 0092 BRWN LMSN 0103 BLCK SHLE 0105
CON	10	004 67-02764	567238 4822397	1140	1963/05	2801	01	FR	0048	46	68	200	24:0	NU	0034 20		GUELPH CITY LOAM 0001 BLDR GRVL 0040 GRVL 0048 GREY LMSN 0096

GROUND WATER BULLETIN REPORT

MUNICIPALITY CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR:MN	WATER USE	SCREEN DEPTH FEET	SCREEN LENGTH FEET	OWNER DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
CONTINUING... PUSLINCH TOWNSHIP																	
CON	10 005	67-02762	567792~ 4822260	1075	1963/04	2801	12	FR	0020	2	10	358	4 :30	NU			GUELPH P U C BLDR CLAY 0007 GRVL CLAY BLDR 0020 GRVL CLAY 0022 GRVL BLDR 0025 GREY LMSN 0040
CON	10 005	67-02770	567767 4822295	1110	1966/05	2801	02	UK		10	24	300	54:0	NU	0027	03	GUELPH WATERWORKS GRVL CLAY BLDR 0017 GRVL BLDR MSND 0031 GRVL 0038 GRVL MSND 0041 GREY CLAY GRVL 0056 LMSN 0057
CON	10 005	67-02769	567792~ 4822285	1075	1966/05	2801	08	FR	0013	14	29	500	26:0	MN	0032	15	GUELPH WATERWORKS LOAM BLDR 0001 GRVL CLAY BLDR 0006 GRVL BLDR 0031 GRVL CLAY BLDR 0034 GRVL MSND BLDR 0035 GRVL 0036 GRVL MSND BLDR 0044 RED CLAY GRVL 0066 LMSN 0067
CON	10 005	67-02768	566663 4821349	1020	1963/01	2801	12						:				GUELPH CITY BLCK LOAM 0001 BRWN CLAY MSND 0007 MSND GRVL BLDR 0015 MSND CLAY 0017 GRVL MSND CLAY 0020 BRWN LMSN 0047 LMSN 0052 BRWN LMSN 0083 BLCK LMSN 0085
CON	10 005	67-02767	567995 4822295	1075	1963/07	2801	02	UK	0028	11	17	150	3 :0	NU	0023	10	GUELPH CITY LOAM MSND 0001 BLDR 0003 GRVL BLDR 0006 CLAY GRVL BLDR 0028 MSND GRVL BLDR 0035 GRVL CLAY BLDR 0040 GRVL MSND CLAY 0056 CLAY MSND GRVL 0064 SHLE 0066
CON	10 005	67-02766	567882 4822302	1025	1963/06	2801	16	FR	0129	39	59	1000	68:0	MN			GUELPH CITY CLAY BLDR 0026 GRVL MSND 0055 GRVL CLAY 0061 BLUE CLAY 0072 GRVL CLAY 0074 GREY LMSN 0142
CON	10 005	67-02771	567976 4822991	1075	1966/05	2801	12						:				GUELPH WATERWORKS FSND 0003 BLDR CLAY GRVL 0022 GRVL MSND 0025 GRVL 0042 RED CLAY GRVL 0052 LMSN 0053
CON	10 005	67-02765	567463 4821813	1090	1963/03	2801	02	FR	0054	32			:	NU	0044	13	GUELPH CITY BRWN CLAY MSND GRVL 0003 MSND GRVL BLDR 0046 CLAY GRVL 0048 LMSN 0050 BRWN LMSN 0083 BLCK LMSN 0091 GREY LMSN 0093 BLCK LMSN 0095
CON	10 005	67-10921	567000 4821346	1095	1992/04	2336	06	FR	0138	46	100	5	1 :	DO			FERRARO, D BRWN CLAY GRVL 0025 GREY CLAY GRVL 0068 BRWN ROCK 0090 BRWN ROCK 0135 BRWN ROCK 0160
CON	10 005	67-03252	566800 4821050	1125	1968/11	1906	04	FR	0141	30	60	5	1 :0	DO			SHERWOOD ROBERT CLAY STNS 0050 CLAY GRVL 0055 BRWN LMSN 0109 GREY LMSN 0130 BLUE LMSN 0135 BLCK LMSN 0141
CON	10 005	67-11714	566889 4821353	1082	1995/04	2336	06	FR	0160	48	110	5	1 :	DO			FERRARO, D BRWN CLAY STNS 0030 BRWN SAND 0050 GREY CLAY STNS 0066 BRWN ROCK 0120 BRWN ROCK 0160
CON	10 005	67-11758	566954 4820924	346	1995/07	2336	06	FR	0158	95	120	10	1 :0	DO			LAKING, BILL BRWN CLAY STNS 0035 GREY CLAY STNS 0056 BRWN ROCK 0150 GREY ROCK 0158
CON	10 006	67-07023	567100 4820700	1125	1979/07	2904	06	FR	0170	65	172	10	2 :30	DO			DYER B BRWN CLAY STNS BLDR 0046 BRWN LMSN SOFT 0065 BRWN LMSN HARD DKCL 0086 GREY LMSN HARD 0090 BRWN LMSN DKCL 0132 GREY LMSN HARD 0172
CON	10 006	67-02772	568302 4822098	1125	1963/02	2801	02	FR	0028	24	29	250	6 :0	NU	0022	11	GUELPH CITY BRWN CLAY MSND 0005 MSND GRVL CLAY 0017 SILT CLAY MSND 0024 MSND GRVL CLAY 0028 BRWN LMSN 0078 GREY LMSN 0087 BLCK LMSN 0101 GREY LMSN 0122
CON	10 006	67-09937	567197 4820910	1115	1989/08	1906	05	FR	0245	51	150	6	8 :	DO			LINDSAY, CAROL BRWN CLAY STNS 0047 LMSN 0065 GREY ROCK 0115 BLCK ROCK 0180 GREY ROCK 0245

MUNICIPALITY CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR:MN	WATER USE	SCREEN DEPTH FEET	SCREEN LENGTH FEET	OWNER DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
CONTINUING... PUSLINCH TOWNSHIP																	
CON	10 006	67-13324	567788~ 4821477		2000/05	2336	06	FR	0160	25	110	10	1 :	DO			DETERCO BUILDERS INC BRWN CLAY STNS 0030 GREY CLAY STNS 0038 BRWN ROCK 0085 BLCK ROCK 0135 GREY ROCK 0160
CON	10 006	67-13787	567788~ 4821477		2001/08	2663	06	FR	0205	89	148	10	1 :	DO			GRINYER,IVAN LOAM 0002 BRWN CLAY STNS 0041 LMSN SOFT FCRD 0043 LMSN 0090 BRWN LMSN 0125 LMSN 0205
CON	10 006	67-13185	567788~ 4821477		1999/10	2336	06	FR	0175	53	123	8	1 :0	DO			GARSON,REID HOMES BRWN CLAY STNS 0020 GREY CLAY GRVL 0047 BRWN ROCK 0085 BLCK ROCK 0150 GREY ROCK 0175
CON	10 007	67-10077	567338 4820897	1135	1989/10	1906	05	FR	0172	77	95	12	5 :0	DO			VANRYN, MARK BRWN CLAY STNS 0039 BRWN ROCK 0055 GREY ROCK 0070 BRWN ROCK 0115 GREY ROCK 0120 BLCK ROCK 0140 GREY ROCK 0173
CON	10 007	67-05715	568258 4821566	1134	1975/09	2336	05	FR	0153	84	100	10	1 :0	DO			WATSON MURRAY LOAM 0001 BRWN CLAY STNS 0040 BRWN CLAY SAND GRVL 0093 BRWN ROCK 0118 BRWN ROCK DKCL 0140 BLCK ROCK 0153
CON	10 007	67-06077	567425 4820726	1114	1976/06	2336	05	FR	0092	24	35	15	1 :0	DO			GEO REID CONST BRWN CLAY STNS 0015 BRWN CLAY GRVL 0033 BRWN ROCK 0070 BRWN ROCK DKCL 0095
CON	10 007	67-08056	568480 4821600	1180	1983/10	2336	05	FR	0234	100	150	12	1 :0	DO			SLATER J PRDR 0153 BLCK STNS 0185 GREY STNS DKCL 0236
CON	10 007	67-07923	568500 4821560	1140	1983/09	2336	06	FR	0223	129	150	30	1 :0	IR			SLATER J PRDG 0011 BRWN CLAY SAND STNS 0045 BRWN CLAY GRVL HARD 0055 BRWN CLAY SAND 0102 BRWN STNS 0145 BRWN STNS DKCL 0160 BLCK STNS 0185 GREY STNS DKCL 0226
CON	10 007	67-02774	568318~ 4821747	1150	1958/08	1532	06	FR	0127	40	60	10	0 :30	DO			BASCH P BRWN CLAY 0003 GREY MSND 0125 LMSN 0127
CON	10 007	67-02775	567393 4820558	1125	1965/03	2521	04	FR	0125	30	120	4	2 :0	DO			TOWNSEND G CLAY 0046 BRWN LMSN 0125
CON	10 007	67-02773	567314 4820511	1130	1964/07	2521	05	FR	0140	40	130	4	2 :0	DO			TOWNSEND G CLAY 0045 GRVL 0053 GREY LMSN 0130 BLCK LMSN 0140
CON	10 007	67-12591	568080~ 4821182		1998/07	2336	06	FR	0090	17	18	20	1 :0	DO			POPOFSKI, JOHN BRWN CLAY STNS 0040 GREY CLAY SAND GRVL 0077 BRWN ROCK 0090
CON	10 007	67-12507	567347 4820610	344	1998/04	2663	06	FR	0201	34	90	10	1 :	DO			SATZEWICH, VICTOR LOAM 0001 BRWN CLAY SAND STNS 0030 BRWN CLAY GRVL 0039 BRWN LMSN 0165 GREY LMSN 0201
CON	10 007	67-12521	567488 4820770	342	1998/04	2336	06	FR	0118	30	76	25	1 :0	DO			EUTENEIER, TOM BRWN CLAY STNS 0010 BRWN CLAY SAND GRVL 0029 BRWN ROCK 0120
CON	10 008	67-03988	567650 4820150	1148	1971/07	2521	04	FR	0130	57	60	10	2 :0	DO			WALKER R GRVL STNS 0061 GREY LMSN 0130
CON	10 008	67-13509	568372~ 4820895		2000/08	2336	06	FR	0340	151	185	25	1 :	IR			SLATER,JIM PRDR 0226 GREY ROCK 0320 BLUE ROCK SHLE 0335 RED SHLE 0340
CON	10 008	67-13996	568372~ 4820895		2001/12	2663	06	UK	0192	98	127	8	1 :0	DO			FAVAO,MARIO BRWN CLAY STNS 0055 GRVL CLAY 0098 BRWN CLAY STNS 0122 BRWN LMSN FCRD 0124 BRWN LMSN 0142 BRWN LMSN 0160 BRWN LMSN 0222
CON	10 008	67-13303	568372~ 4820895		2000/04	2663	06	FR	0162	88	145	20	1 :	DO			PINDER,KEN BRWN CLAY STNS 0065 BRWN CLAY STNS LOAM 0085 BRWN LMSN 0125 BRWN LMSN 0145 BRWN LMSN 0162
CON	10 009	67-03650	567880 4819950	1165	1970/03	2414	04	FR	0151	77	87	10	1 :0	DO			WALKER A LOAM 0001 BRWN CLAY STNS 0015 BRWN CLAY GRVL 0087 BRWN ROCK 0151

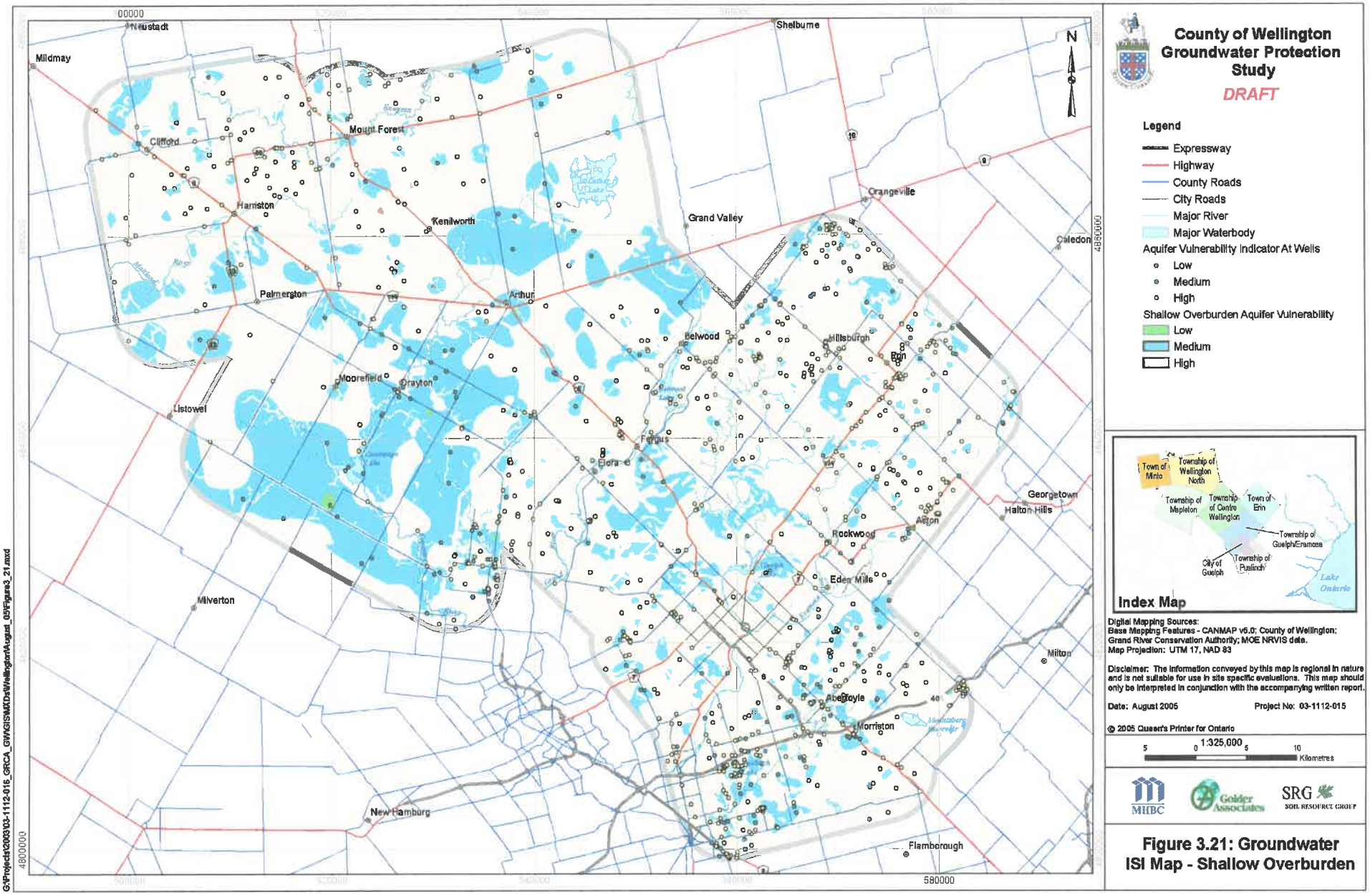
MUNICIPALITY CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR:MN	WATER USE	SCREEN DEPTH FEET	SCREEN LENGTH FEET	OWNER DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
CONTINUING... PUSLINCH TOWNSHIP																	
CON	10	009	67-04688	568070 4819895	1180	1973/05	4208	06	FR	0150	80	130	8	1 :0	DO		FELAUER N BRWN GRVL CLAY 0065 GREY CLAY GRVL HPAN 0097 GREY LMSN 0160 BLCK LMSN 0225 GREY LMSN 0232
CON	10	010	67-03975	568720 4820200	1200	1971/06	3316	04	FR	0163	78	84	9	3 :0	DO		JAMIESON D M GRVL STNS CLAY 0130 BRWN LMSN 0167
CON	10	010	67-02783	569338 4820719	1173	1966/06	2521	04	FR	0097	23	45	12	2 :0	DO		ROGERS R CLAY STNS GRVL 0058 BRWN LMSN 0097
CON	10	010	67-02782	569166 4820465	1170	1965/05	2406	04	FR	0105	52	90	6	2 :0	DO		SPURRELL R LOAM 0001 BRWN CLAY MSND STNS 0035 BRWN CLAY GRVL 0070 GREY CLAY 0088 BRWN LMSN 0115 BLCK LMSN 0182
CON	10	010	67-03422	568650 4819900	1175	1969/06	2406	04	FR	0180	80	85	10	:	DO		SHIAN NORMAN E F BRWN CLAY STNS 0045 BRWN CLAY GRVL MSND 0060 BRWN CLAY STNS 0085 BRWN GRVL MSND 0107 BRWN LMSN 0180
CON	10	010	67-02781	569476 4820862	1125	1965/05	2406	05	FR	0099	20	40	30	1 :0	DO		GORDON R LOAM 0001 BRWN CLAY MSND GRVL 0035 GRVL STNS 0044 BRWN CLAY STNS 0068 BRWN LMSN 0080 BLCK LMSN 0100
CON	10	010	67-02780	569188 4820677	1080	1964/09	2406	05	FR	0080	8	25	25	7 :0	DO		RILEY E BRWN CLAY STNS 0032 BRWN MSND 0043 GREY CLAY GRVL 0068 BRWN LMSN 0090
CON	10	010	67-07911	568740 4820400	1180	1984/06	2336	05	FR	0165	80	95	10	1 :0	DO		DAWKINS F BRWN CLAY STNS 0025 BRWN CLAY SAND GRVL 0070 BRWN SAND GRVL CLAY 0090 BRWN CLAY SAND 0095 BRWN CLAY GRVL HARD 0114 BRWN STNS 0135 BRWN STNS 0155 BRWN STNS 0170
CON	10	010	67-05098	569245 4820476	1170	1974/04	4208	06	FR	0115	41	120	15	1 :0	DO		JEFFERY W BRWN CLAY SAND 0025 GREY CLAY GRVL STNS 0103 GREY LMSN 0120
CON	10	010	67-02776	568231 4819612	1195	1961/11	4208	06	FR	0112	75	80	12	1 :0	ST DO		DOUGLAS W CLAY STNS 0020 GRVL CLAY 0055 GRVL STNS 0070 GRVL CLAY HPAN 0108 LMSN 0116
CON	10	010	67-02777	569447 4820776	1150	1966/11	2521	04	FR	0130	60	85	7	2 :0	DO		BIFFIS R CLAY STNS 0092 BRWN LMSN 0130
CON	10	010	67-02778	569605~ 4820949	1125	1963/03	2406	05	FR	0083	20	20	15	1 :0	DO		LEFNESKI R BLDR CLAY 0022 GRVL STNS 0037 BRWN CLAY 0064 HPAN STNS 0082 BLCK SLTE 0083
CON	10	010	67-05163	569070 4820277	1180	1974/04	3316	04	FR	0175	78	85	10	2 :0	DO		BALMER DAVID BRWN CLAY STNS 0020 GREY CLAY STNS GRVL 0075 GREY CLAY STNS 0125 GREY LMSN 0132 BRWN ROCK 0176
CON	10	010	67-02779	569003 4820277	1180	1964/10	1906	04	FR	0125	80	85	10	5 :0	DO		YOUNG K CLAY STNS 0025 GRVL CLAY 0085 FSND 0091 BRWN LMSN 0125
CON	10	010	67-09267	568739 4820090	1194	1988/05	2336	06	FR	0180	80	98	20	1 :0	DO		PROKIPLAK, MR.J. BRWN CLAY SAND GRVL 0045 BRWN CLAY GRVL HARD 0085 BRWN CLAY GRVL FSND 0110 BRWN SAND 0118 BRWN GRVL SAND HARD 0123 BRWN ROCK 0150 BRWN ROCK 0170 BRWN ROCK 0180
CON	10	010	67-14103	568954~ 4820314		2002/06	2663	06	FR	0122	65	65	20	1 :0	DO		BUNYOUSKY,STEVE BRWN CLAY BLDR 0090 BRWN LMSN SOFT FCRD 0101 BRWN LMSN 0122
CON	10	010	67-12202	568466 4819584	365	1997/03	2336	06	FR	0120	82	100	15	1 :0	DO		PILKEY, DOUG BRWN CLAY STNS 0018 GREY CLAY GRVL 0050 BRWN GRVL 0095 GREY CLAY GRVL 0112 BRWN ROCK 0120

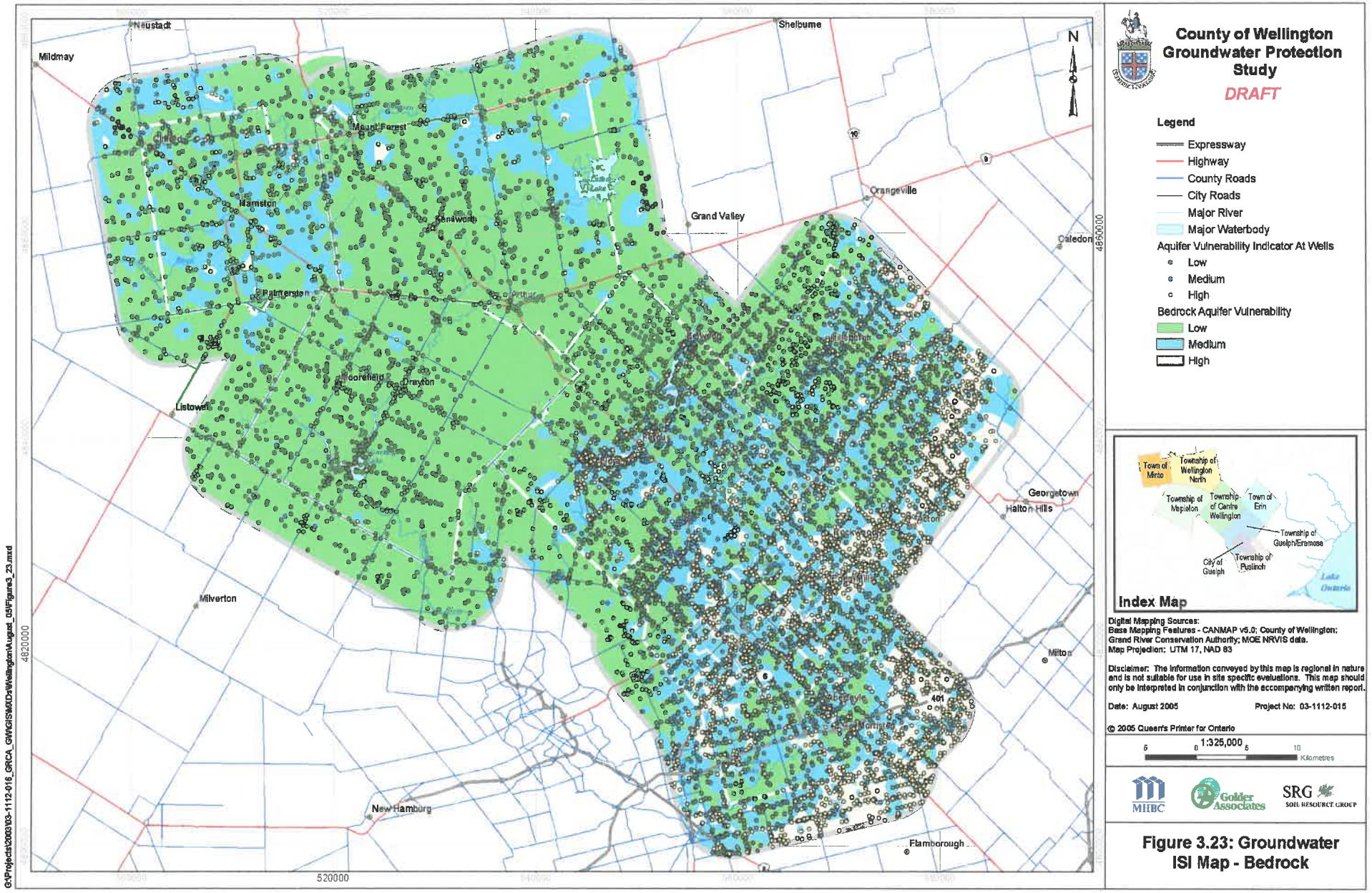
MUNICIPALITY CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR:MN	WATER USE	SCREEN DEPTH FEET	SCREEN LENGTH FEET	OWNER DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
CONTINUING... PUSLINCH TOWNSHIP																	
CON	10	011	67-10767	569084 4820091	1171	1991/08	2336	06	FR	0120	56	70	25	1 :0	DO		MANNING, G.F. BRWN CLAY STNS 0025 GREY CLAY SAND GRVL 0055 BRWN SAND GRVL 0105 BRWN ROCK 0121
CON	10	011	67-02787	568640 4819453	1180	1967/07	4208	06	FR	0105	68	75	25	2 :0	DO		MACTAGGART W LOAM CLAY MSND 0015 CLAY GRVL 0050 CLAY STNS 0080 CLAY GRVL 0095 MSND 0103 GRVL 0105
CON	10	011	67-03392	568450 4819430	1195	1969/05	2521	04	FR	0157	90	110	10	2 :0	DO		PETTERSEN J GRVL STNS 0114 BRWN LMSN 0157
CON	10	011	67-03325	569550 4820550	1140	1969/04	2406	04	FR	0104	20	35	15	:	DO		CROSS BRIAN BRWN CLAY STNS 0015 BRWN MSND 0025 BRWN CLAY GRVL 0066 BRWN LMSN 0107
CON	10	011	67-02786	568515 4819466	1200	1967/04	2406	04	FR	0120	80	85	8	1 :0	DO		HYDE E LOAM 0002 BRWN CLAY STNS 0015 BRWN CLAY GRVL 0070 STNS 0075 BRWN CLAY GRVL 0107 BRWN LMSN 0180
CON	10	011	67-05000	569287 4820268	1155	1974/02	4005	06	FR	0073	41	55	18	1 :30	DO		SCRIVENER W BRWN SAND GRVL BLDR 0042 BRWN SAND GRVL 0065 GREY SAND GRVL 0072 GREY LMSN 0075
CON	10	011	67-02784	569479 4820686	1140	1966/04	2521	04	FR	0083	5	5	25	2 :0	DO		MELZER J GRVL STNS 0063 BRWN LMSN 0083
CON	10	011	67-05331	569639 4820559	1125	1974/10	2336	04	FR	0110	27	60	10	1 :0	DO		TYSZKA GEORGE BRWN CLAY GRVL SAND 0070 GREY CLAY GRVL SAND 0085 BRWN ROCK 0110
CON	10	011	67-02785	569650 4820669	1125	1965/04	2406	05	FR	0076	4	18	15	1 :30	DO		MCNINCH C LOAM 0001 BRWN CLAY STNS 0035 GREY CLAY GRVL 0068 BRWN LMSN 0095
CON	10	011	67-08371	568989 4820170	1181	1985/07	3317	05	FR	0125	49	70	20	2 :	DO		LUE-KIM, H CLAY GRVL 0055 CLAY BLDR 0070 CLAY STNS SAND 0093 GREY LMSN 0105 BRWN ROCK 0156
CON	10	011	67-05358	569316 4820209	1145	1974/11	2336	05	FR	0118	57	80	20	1 :0	DO		LUE-KIM H LOAM 0001 BRWN CLAY STNS GRVL 0076 GREY CLAY STNS GRVL 0093 GREY ROCK 0112 BRWN ROCK 0118
CON	10	011	67-05376	568570 4819374	1190	1974/07	4208	06	FR	0120	81	120	20	1 :0	DO		VONFIELITZ JURGEN GREY CLAY STNS GRVL 0050 GREY GRVL 0090 GREY CLAY SAND GRVL 0115 GREY LMSN 0125
CON	10	011	67-10493	570046 4820778	1122	1990/07	4207	06	FR	0088	21	80	75	1 :	DO		CARSON REED HOMES GREY GRVL CLAY 0084 BRWN LMSN 0089
CON	10	011	67-02788	569173 4820345	1160	1967/07	1906	04	FR	0105	50	60	15	3 :0	DO		PALMER A LOAM 0001 STNS CLAY 0050 CLAY MSND 0065 STNS CLAY 0078 BRWN LMSN 0105
CON	10	011	67-03925	569840 4820850	1125	1971/05	2406	05	FR	0095	25	30	20	1 :0	DO		CULLEN BARRY BRWN CLAY MSND STNS 0010 BRWN CLAY MSND GRVL 0043 GRVL 0080 BRWN CLAY MSND GRVL 0088 BRWN ROCK 0098 BLCK ROCK 0103
CON	10	011	67-11982	569246 4820220	1164	1996/05	2663	06	FR	0101	40	65	20	1 :0	DO		FERGUSON, H. LOAM 0001 BRWN CLAY SAND GRVL 0040 GRVL SAND LOOS 0060 GRVL CLAY 0068 BRWN LMSN SOFT 0101
CON	10	011	67-12733	569255~ 4820030		1998/10	2336	06	FR	0115	70	71	20	1 :0	DO		MOORE,DAVE-SANDY BRWN CLAY STNS 0020 BRWN GRVL SAND BLDR 0060 BRWN GRVL SAND 0090 GREY CLAY GRVL 0108 GREY ROCK 0120
CON	10	011	67-13638	569255~ 4820029		2001/02	2663	06	FR	0082	38	48	20	1 :	DO		GANSON,IAN BRWN CLAY STNS SAND 0058 LMSN FCRD SOFT 0069 LMSN 0082
CON	10	011	67-13784	569255~ 4820029		2001/08	2663	06	FR	0102	24	28	30	1 :	DO		DIXON,KICTH BRWN CLAY 0020 BRWN CLAY GRVL 0055 BRWN SAND 0091 BRWN LMSN FCRD 0092 BRWN LMSN 0102

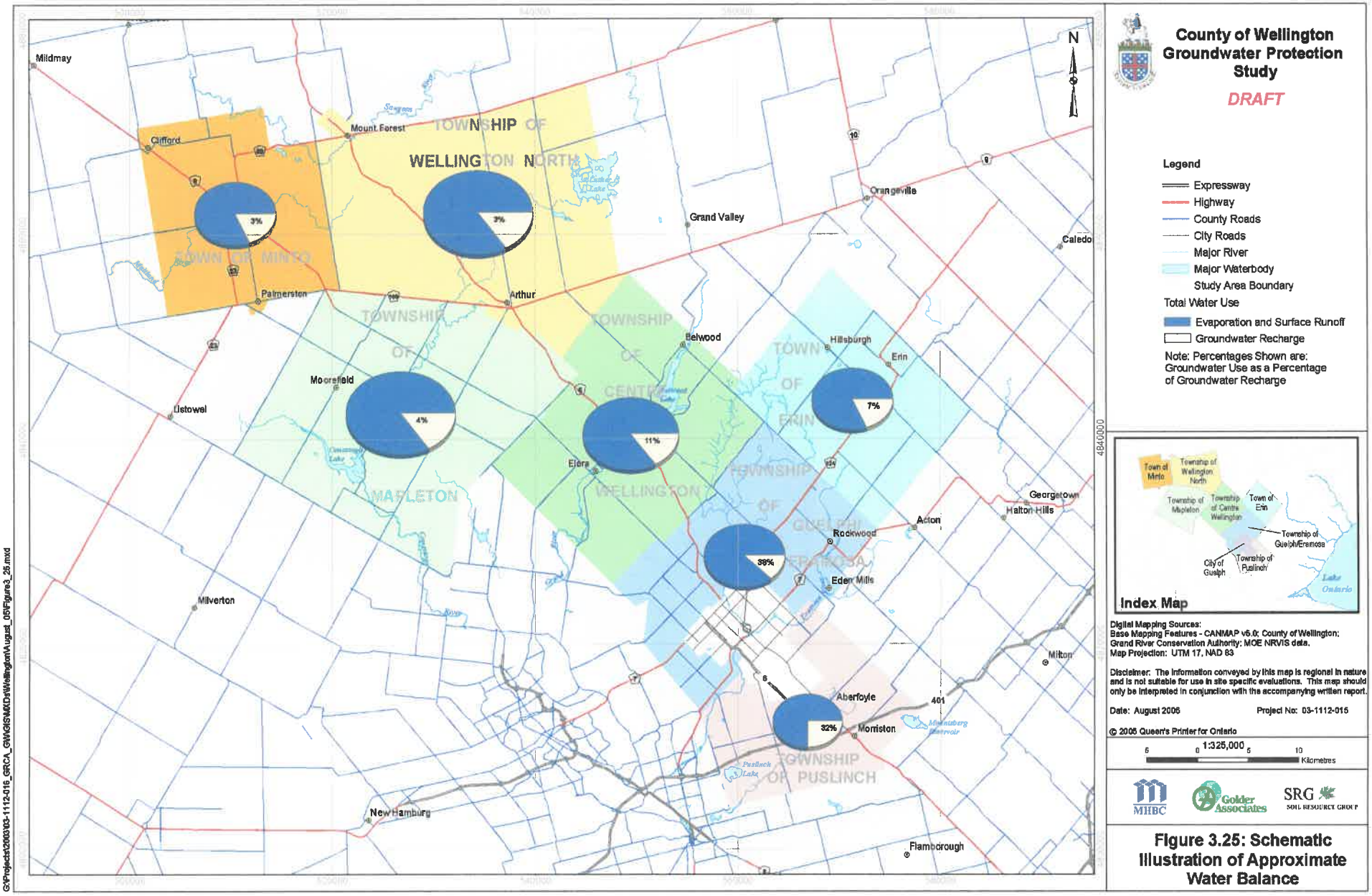
MUNICIPALITY CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR:MN	WATER USE	SCREEN DEPTH FEET	SCREEN LENGTH FEET	OWNER DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
CONTINUING... PUSLINCH TOWNSHIP																	
CON	10 011	67-13998	569255~ 4820029		2002/01	2336	06	FR	0120	35	68	10	1 :0	DO			VERDONE HOMES LTD BRWN CLAY STNS 0030 BRWN GRVL SAND 0058 GREY CLAY SAND GRVL 0063 BRWN ROCK 0120
CON	10 011	67-13559	569255~ 4820029		2000/10	4005	06	FR	0135	96	130	15	1 :	DO			GATTO CONSTRUCTION BRWN SAND GRVL BLDR 0025 BRWN GRVL SAND 0075 BRWN CLAY SAND GRVL 0094 BRWN LMSN HARD 0144
CON	10 012	67-07024	569050 4818800	1100	1979/07	2904	08						:				GROENENDYK BRWN CLAY STNS SAND 0008 BRWN STNS BLDR GRVL 0073 BLUE CLAY STNS SAND 0076 GREY SAND STNS CLAY 0087 GREY SAND CLAY BLDR 0094 GREY LMSN BLDR 0098 UNKN 0099
CON	10 012	67-07199	569050 4818800	1100	1979/11	1906	05	FR	0095	57	58	15	2 :0	DO			GROENENDYK C BRWN CLAY STNS 0008 GRVL STNS 0087 GREY STNS 0112
CON	10 012	67-10112	568762 4819307	1184	1989/11	2336	06	FR	0158	81	98	15	1 :	DO			HUME, P. BRWN CLAY STNS 0015 BRWN CLAY SAND GRVL 0114 BRWN ROCK 0160
CON	10 012	67-09880	570296 4820561	1125	1989/07	2336	06	FR	0059	17	35	25	1 :	DO			RUHL, A BRWN CLAY SAND STNS 0015 BRWN CLAY SAND GRVL 0045 BRWN GRVL CSND 0060
CON	10 012	67-11514	568947 4819193	1164	1994/07	3317	06	FR	0108	65	67	15	1 :30	DO			FILIPPIN, SILVANO GRVL SAND BLDR 0090 GREY CLAY GRVL 0103 GREY LMSN 0110
CON	10 013	67-02789	569065~ 4818958	1130	1958/12	2521	04	FR	0142	24	30	10	1 :0	ST DO			SMEENK J PRDG 0020 GRVL 0055 CLAY 0066 BRWN LMSN 0142
CON	10 013	67-07624	569825~ 4819454		1981/07	2564	04	FR	0069	23	45	25	6 :0	DO ST			WILSON, WIM. BRWN CLAY SNDY 0025 GRVL 0040 SAND 0065 GREY ROCK 0069
CON	10 013	67-07666	569160 4818880	1110	1981/07	2564	04	FR	0069	23	45	25	6 :0	DO			WILSON W BRWN CLAY SNDY 0025 GRVL 0040 SAND 0065 STNS 0069
CON	10 013	67-05871	569113 4818850	1132	1975/01	4208	06	MN	0070	27	30	30	1 :0	DO			WILSON W GREY CLAY GRVL 0067 GREY LMSN 0072
CON	10 013	67-08888	570567 4820316	1115	1987/07	2336	05	FR	0118	20	50	20	1 :	DO			READER, MR. BRWN CLAY SAND STNS 0015 BRWN CLAY GRVL 0025 BRWN FSND GRVL 0040 GREY CLAY SAND 0082 BRWN ROCK 0118
CON	10 013	67-10663	569825~ 4819454		1991/06	4005	06	UK	0075	15	55	20	1 :0	DO			APPLEHILL CONST.INC. BRWN SAND LOOS 0008 BRWN CLAY LOOS 0014 BRWN SAND GRVL LOOS 0038 GREY CLAY LOOS 0069 GREY GRVL SAND LOOS 0075
CON	10 013	67-11656	568761 4819279	1184	1994/07	1737	02						:	NU	0120	05	G.R.C.A. BRWN GRVL BLDR SAND 0012 GREY GRVL SAND STNS 0122 BRWN LMSN 0125
CON	10 014	67-05093	569239 4818631	1160	1974/02	4208	06	FR	0093	45	50	20	1 :0	DO			CLARK C BRWN CLAY SAND GRVL 0030 GREY CLAY GRVL 0090 GREY GRVL 0093
CON	10 014	67-03465	569550 4818700	1150	1969/08	2406	05	FR	0140	26	38	15	1 :0	ST DO			ANGERMANN P PRDG 0006 BRWN CLAY STNS 0025 BRWN MSND 0030 BRWN CLAY 0045 BRWN CLAY GRVL 0087 BRWN LMSN 0143
CON	10 015	67-10999	571044 4819879	1148	1992/09	2336	06	FR	0158	17	65	15	1 :	DO			PARKER HOMES BRWN CLAY STNS 0010 BRWN CLAY GRVL 0035 GREY CLAY GRVL 0064 BRWN ROCK 0090 BRWN ROCK 0120 GREY ROCK 0160

BURNSIDE

Appendix C
Portions of County of Wellington
Groundwater Protection Study


County of Wellington
Groundwater Protection
Study
DRAFT
Legend
Expressway
Highway
County Roads
City Roads
Major River
Major Waterbody
Aquifer Vulnerability Indicator At Wells
Low
Medium
High
Shallow Overburden Aquifer Vulnerability
Low
Medium
High
Index Map
Digital Mapping Sources:
Base Mapping Features - CANMAP v6.0; County of Wellington;
Grand River Conservation Authority; MOE NRVIS data.
Map Projection: UTM 17, NAD 83
Disclaimer: The information conveyed by this map is regional in nature and is not suitable for use in site specific evaluations. This map should only be interpreted in conjunction with the accompanying written report.
Date: August 2005
Project No: 03-1112-015
© 2005 Queen's Printer for Ontario
1:325,000
Kilometres
Figure 3.21: Groundwater
ISI Map - Shallow Overburden
G:\Projects\1200303-1112-016_GRCA_GW\GIS\MXD\sWellington\August_05\Figure3_21.mxd


Neustadt
Mildmay
Shelburne
Mount Forest
Arthur
Hamilton
Kenilworth
Grand Valley
Orangeville
Caledon
Palmerston
Moorefield
Drayton
Listowel
Milverton
Georgetown
Halton Hills
Acton
Milton
Campbellville
Morriston
401
New Hamburg
Flamborough
N
520000
4820000
4860000
County of Wellington
Groundwater Protection
Study
DRAFT
Legend
Expressway
Highway
County Roads
City Roads
Major River
Major Waterbody
Aquifer Vulnerability Indicator At Wells
Low
Medium
High
Bedrock Aquifer Vulnerability
Low
Medium
High
Town of Minto
Township of Wellington North
Township of Mapleton
Township of Centre Wellington
Town of Erin
Township of Guelph/Eramosa
City of Guelph
Township of Puslinch
Lake Ontario
Index Map
Digital Mapping Sources:
Base Mapping Features - CANMAP v5.0; County of Wellington;
Grand River Conservation Authority; MOE NRVIS data.
Map Projection: UTM 17, NAD 83
Disclaimer: The information conveyed by this map is regional in nature and is not suitable for use in site specific evaluations. This map should only be interpreted in conjunction with the accompanying written report.
Date: August 2005
Project No: 03-1112-015
© 2005 Queen's Printer for Ontario
1:325,000
5 0 5 10
Kilometres
MHBC
Golder Associates
SRG
SOIL RESOURCE GROUP
Figure 3.23: Groundwater
ISI Map - Bedrock
G:\Projects\2003\03-1112-016_GRCA_GMWG\ISM\MXDs\Wellington\August_05\Figure3_23.mxd


N
Mildmay
Clifford
Mount Forest
TOWNSHIP OF WELLINGTON NORTH
Grand Valley
Orangeville
Caledo
TOWN OF MINTO
Palmerston
Arthur
TOWNSHIP OF CENTRE WELLINGTON
Belwood
Hillsburgh
Erin
TOWN OF ERIN
Moorefield
Listowel
Elora
MAPLETON
TOWNSHIP OF WELLINGTON NORTH
Georgetown
Halton Hills
Acton
Rockwood
Eden Mills
Milverton
Milton
Aberfoyle
Morriston
401
TOWNSHIP OF PUSLINCH
New Hamburg
Flamborough
3%
3%
4%
11%
7%
39%
32%
4840000
County of Wellington
Groundwater Protection
Study
DRAFT
Legend
Expressway
Highway
County Roads
City Roads
Major River
Major Waterbody
Study Area Boundary
Total Water Use
Evaporation and Surface Runoff
Groundwater Recharge
Note: Percentages Shown are:
Groundwater Use as a Percentage
of Groundwater Recharge
Town of Minto
Township of Wellington North
Township of Mapleton
Township of Centre Wellington
Town of Erin
Township of Guelph/Eramosa
City of Guelph
Township of Puslinch
Lake Ontario
Index Map
Digital Mapping Sources:
Base Mapping Features - CANMAP v5.0; County of Wellington;
Grand River Conservation Authority; MOE NRVIS data.
Map Projection: UTM 17, NAD 83
Disclaimer: The information conveyed by this map is regional in nature and is not suitable for use in site specific evaluations. This map should only be interpreted in conjunction with the accompanying written report.
Date: August 2006
Project No: 03-1112-015
© 2006 Queen's Printer for Ontario
1:325,000
5 0 5 10
Kilometres
MHBC
Golder Associates
SRG
SOIL RESOURCE GROUP
Figure 3.25: Schematic Illustration of Approximate Water Balance
G:\Projects\3200303-1112-015_GRCA_GWGMS\MXD's\Wellington\August_05\Figure3_25.mxd

BURNSIDE

Appendix D
Borehole Logs

REFERENCE No: G2547-6-2

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

BOREHOLE No: 1

ENCLOSURE No: 2

SUPERVISOR: B.R.F.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	MONITORING WELL	SAMPLE NUMBER	SAMPLE TYPE	'N' BLOWS/0.3m	PENETRATION RESISTANCE BLOWS/0.3m (20 40 60 80)	WATER CONTENT % (5 10 15 20 25)	UNIT WEIGHT
0.0	Ground Surface	340.5								
0.3	300mm Topsoil	340.2								
	brown, compact to very dense SANDY GRAVEL trace silt, occasional cobble, moist to dry				1	SS	17			
					2	SS	61			
					3	SS	45			
					4	SS	52			
					5	SS	57	150mm		
					6	SS	42			
7.7	brown, very dense SILT some clay, some sand, trace gravel, occasional cobble & boulder, moist	332.8			7	SS	79			
8.4	grey Dolostone Rock Fragments wet	331.6			8	SS	50	100mm		
	Auger Refusal/Boulder/Bedrock									

Bentonite Hole Plug
W.L. @ 333.3m (February 2, 2006)
51mm OD Trilock Pipe
Industrial Sand
Screen

DRILLED BY: Aardvark Drilling Inc.

DRILL METHOD: Hollow-Stem Auger

DRILL DATE: January 12, 2006

HOLE DIAMETER: 210mm

DATUM: Geodetic

SHEET: 1 of 1

REFERENCE No: G2547-6-2

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

BOREHOLE No: 2

ENCLOSURE No: 3

SUPERVISOR: B.R.F.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	340.1								
0.4	400mm Topsoil	339.7								
	brown, dense to very dense SANDY GRAVEL trace silt, occasional cobble, moist to dry			DRY CAVE-IN @ 335.4m (January 12, 2006)	1	SS	48			
					2	SS	63			
					3	SS	49			
	occasional boulder @ 4.3m				4	SS	61			
					5	SS	50	50mm		
6.6		333.5			6	SS	81			
	End of Borehole									

DRILLED BY: Aardvark Drilling Inc.

DRILL METHOD: Hollow-Stem Auger

DRILL DATE: January 12, 2006

HOLE DIAMETER: 210mm

DATUM: Geodetic

SHEET: 1 of 1

REFERENCE No: G2547-6-2

BOREHOLE No: 3

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 4

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: B.R.F.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	339.9								
0.2	200mm Topsoil	339.7								
	brown, very dense SANDY GRAVEL trace silt, occasional cobble, dry			DRY (January 12, 2006)	1	SS	36			
					2	SS	50	125mm		
	occasional boulder @ 3.6m				3	SS	45			
					4	SS	50			
					5	SS	40			
6.6		333.3			6	SS	43			
	End of Borehole									

DRILLED BY: Aardvark Drilling Inc.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow-Stem Auger

DATUM: Geodetic

DRILL DATE: January 12, 2006

SHEET: 1 of 1

REFERENCE No: G2547-6-2

BOREHOLE No: 4

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 5

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: B.R.F.

SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	340.9								
0.2	200mm Topsoil	340.7								
	brown, dense to very dense SANDY GRAVEL some silt, occasional cobble, moist to dry			DRY CAVE-IN @ 336.1m (January 13, 2006)	1	SS	41			
					2	SS	46			
					3	SS	48			
					4	SS	61			
					5	SS	54	125mm		
6.3		334.6			6	SS	50	75mm		
	End of Borehole									

DRILLED BY: Aardvark Drilling Inc.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow-Stem Auger

DATUM: Geodetic

DRILL DATE: January 13, 2006

SHEET: 1 of 1

REFERENCE No: G2547-6-2

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

BOREHOLE No: 5

ENCLOSURE No: 6

SUPERVISOR: B.R.F.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	341.9								
0.2	200mm Topsoil	341.7								
	brown, very dense to compact SANDY GRAVEL trace silt, occasional cobble, moist to dry			DRY CAVE-IN @ 336.9m (January 13, 2006)	1	SS	67	275mm		
					2	SS	26			
					3	SS	26			
					4	SS	30			
					5	SS	37			
6.6		335.3			6	SS	24			
	End of Borehole									

DRILLED BY: Aardvark Drilling Inc.

DRILL METHOD: Hollow-Stem Auger

DRILL DATE: January 13, 2006

HOLE DIAMETER: 210mm

DATUM: Geodetic

SHEET: 1 of 1

REFERENCE No: G2547-6-2

BOREHOLE No: 6

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 7

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: B.R.F.

SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	342.9		DRY (January 13, 2006)						
0.3	250mm Topsoil	342.6								
	brown, compact to very dense GRAVEL AND SAND some silt, occasional cobble & boulder, moist				1	SS	18			
					2	SS	73			
					3	SS	99			
3.3		339.6			4	SS	50	125mm		
	Refusal on Probable Boulder/Bedrock									

DRILLED BY: Aardvark Drilling Inc.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow-Stem Auger

DATUM: Geodetic

DRILL DATE: January 13, 2006

SHEET: 1 of 1

REFERENCE No: G2547-6-2

BOREHOLE No: 7

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 8

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: MN

SUBSURFACE PROFILE					SAMPLE					
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	PENETRATION RESISTANCE BLOWS/0.3m (20 40 60 80)	WATER CONTENT % (5 10 15 20 25)	UNIT WEIGHT
0.0	Ground Surface	344.4								
	1500mm Topsoil				1	SS	6	o	•	
1.5		342.9								
	brown, compact to very dense GRAVEL AND SAND some silt, occasional cobble, dry				2	SS	20	o		
					3	SS	27	o	•	
					4	SS	30	o		
	occasional boulder @ 4.5m			DRY (January 16, 2006)	5	SS	19	o	•	
					6	SS	53	o		
7.2		337.2								
7.3	grey Dolostone Rock Fragments	337.1			7	SS	50	100mm o	•	
	Refusal on Probable Boulder/Bedrock									

DRILLED BY: Aardvark Drilling Inc.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow-Stem Auger

DATUM: Geodetic

DRILL DATE: January 16, 2006

SHEET: 1 of 1

REFERENCE No: G2547-6-2

BOREHOLE No: 8

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 9

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: B.R.F.

SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	344.3								
0.2	200mm Topsoil	344.1								
	brown, compact to very dense SANDY GRAVEL some silt, occasional cobble, moist to dry			DRY CAVE-IN @ 340.3m (January 13, 2006)	1	SS	28			
					2	SS	53			
					3	SS	40			
					4	SS	78			
					5	SS	50	100mm		
5.2		339.1			6	SS	50	25mm		
	Refusal on Probable Boulder/Bedrock									

DRILLED BY: Aardvark Drilling Inc.

DRILL METHOD: Hollow-Stem Auger

DRILL DATE: January 13, 2006

HOLE DIAMETER: 210mm

DATUM: Geodetic

SHEET: 1 of 1

REFERENCE No: G2547-6-2

BOREHOLE No: 9

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 10

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: B.R.F.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	343.3								
0.3	250mm Topsoil	343.1								
	brown, dense to very dense GRAVEL AND SAND some silt, occasional cobble, moist to dry			∇ DRY CAVE-IN @ 338.7m (January 13, 2006)	1	SS	31			
					2	SS	53	150mm		
					3	SS	45			
					4	SS	55	150mm		
					5	SS	50	25mm		
6.2		337.1			6	SS	50	100mm		
	End of Borehole									

DRILLED BY: Aardvark Drilling Inc.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow-Stem Auger

DATUM: Geodetic

DRILL DATE: January 13, 2006

SHEET: 1 of 1

REFERENCE No: G2547-6-2

BOREHOLE No: 10

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 11

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: MN

SUBSURFACE PROFILE					SAMPLE					
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	MONITORING WELL	NUMBER	TYPE	'N' BLOWS/0.3m	PENETRATION RESISTANCE BLOWS/0.3m (20 40 60 80)	WATER CONTENT % (5 10 15 20 25)	UNIT WEIGHT
0.0	Ground Surface	344.9								
0.8	800mm Topsoil	344.1								
	brown, very dense GRAVEL AND SAND some silt, occasional cobble, dry				1	SS	65			
					2	SS	64			
					3	SS	50	50mm		
					4	SS	40			
					5	SS	76	275mm		
6.9		338.0								
	brown, very dense GRAVELLY, SILTY SAND TILL dry				6	SS	52			
					7	SS	91			
					8	SS	74			
10.1		334.8								
11.0	brown, very dense SAND AND SILT trace clay, trace gravel, saturated	333.9			9	SS	68			
11.7	brown, very dense GRAVELLY, SILTY SAND TILL moist	333.2								
12.6	brown, very dense SAND some silt, trace gravel, wet	332.3			10	SS	86	250mm		
	End of Borehole									

Bentonite Hole Plug
Industrial Sand
Auger Cuttings
W.L. @ 334.9m (February 2, 2006)
51mm OD Trilock Pipe
Screen

DRILLED BY: Aardvark Drilling Inc.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow-Stem Auger

DATUM: Geodetic

DRILL DATE: January 16, 2006

SHEET: 1 of 1

BURNSIDE

Appendix E
Laboratory Certificates of Analysis

AGAT® Laboratories

Certificate of Analysis

AGAT WORK ORDER: 06T154459

PROJECT NO: 10312.0

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: David Wilson

Water Quality Assessment

DATE SAMPLED: January 26 2006 **DATE RECEIVED:** January 30 2006 **DATE REPORTED:** February 07 2006 **SAMPLE TYPE:** Water

	Unit	G / S	M.D.L.	MW1 494294	M.D.L	MW2 494295
Electrical Conductivity	uS/cm		2	808	2	792
pH	N/A			8.05		8.05
Saturation pH			N/A	6.93	N/A	6.84
Total Dissolved Solids	mg/L		20	414	20	450
Total Hardness (as CaCO3)	mg/L		10	291	10	348
Alkalinity (as CaCO3)	mg/L		10	294	10	299
Bicarbonate (as CaCO3)	mg/L		10	294	10	299
Carbonate (as CaCO3)	mg/L		10	<10	10	<10
Hydroxide	mg/L		10	<10	10	<10
Fluoride	mg/L	1.5	0.05	0.08	0.05	0.09
Chloride	mg/L		0.10	70.9	0.10	51.0
Bromide	mg/L		0.05	<0.05	0.05	0.18
Nitrate as N	mg/L	10.0	0.05	3.34	0.05	4.18
Nitrite as N	mg/L	1.0	0.05	<0.05	0.05	0.09
Sulphate	mg/L		0.10	15.3	0.10	27.0
Calcium	mg/L		0.05	71.5	0.05	79.6
Magnesium	mg/L		0.05	27.3	0.05	36.3
Sodium	mg/L	20	0.05	**38.9**	0.05	16.5
Potassium	mg/L		0.05	9.68	0.05	2.11
Ammonia (as N)	mg/L		0.05	0.76	0.05	1.01
Orthophosphate as P	mg/L		0.10	<0.10	0.10	<0.10
Total Organic Carbon *	mg/L		5	154	1	21
Reactive Silica *	mg/L		0.05	7.54	0.05	10.2
Colour	Colour Units		5	<5	5	<5
Turbidity	NTU		0.5	3.8	0.5	2.0
Aluminum	mg/L		0.004	0.020	0.004	0.015
Arsenic	mg/L	0.025	0.003	<0.003	0.003	<0.003
Barium	mg/L	1.0	0.002	0.032	0.002	0.021
Boron	mg/L	5.0	0.010	0.025	0.010	0.076
Cadmium	mg/L	0.005	0.002	<0.002	0.002	<0.002
Chromium	mg/L	0.05	0.003	<0.003	0.003	<0.003

Certified By: [redacted]

Certificate of Analysis

AGAT WORK ORDER: 06T154459
PROJECT NO: 10312.0

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: David Wilson

Water Quality Assessment

DATE SAMPLED: January 26 2006 **DATE RECEIVED:** January 30 2006 **DATE REPORTED:** February 07 2006 **SAMPLE TYPE:** Water

	Unit	G / S	M.D.L.	MW1 494294	M.D.L	MW2 494295
Copper	mg/L		0.003	0.004	0.003	0.004
Iron	mg/L		0.005	0.349	0.005	0.341
Lead	mg/L	0.01	0.002	<0.002	0.002	<0.002
Manganese	mg/L		0.002	0.018	0.002	0.140
Mercury	mg/L	0.001	0.0001	<0.0001	0.0001	<0.0001
Molybdenum	mg/L		0.002	<0.002	0.002	0.012
Nickel	mg/L		0.003	<0.003	0.003	<0.003
Total Phosphorus	mg/L		0.05	0.11	0.05	0.59
Selenium	mg/L	0.01	0.004	<0.004	0.004	<0.004
Silver	mg/L		0.002	<0.002	0.002	<0.002
Strontium	mg/L		0.005	0.093	0.005	0.137
Thallium	mg/L		0.006	<0.006	0.006	<0.006
Titanium	mg/L		0.001	<0.001	0.001	<0.001
Uranium	mg/L	0.02	0.001	<0.001	0.001	<0.001
Vanadium	mg/L		0.001	<0.001	0.001	<0.001
Zinc	mg/L		0.004	0.016	0.004	0.022
% Difference/Ion Balance	%			4.0		5.54
Langlier Index				1.12		1.21

Comments: M.D.L. - Method Detection Limit; G / S - Guideline / Standard: Refers to ODWS-Schedule 23

494294 * Analysis performed at AGAT Laboratories Calgary.

494295 * Analysis performed at AGAT Laboratories Calgary.

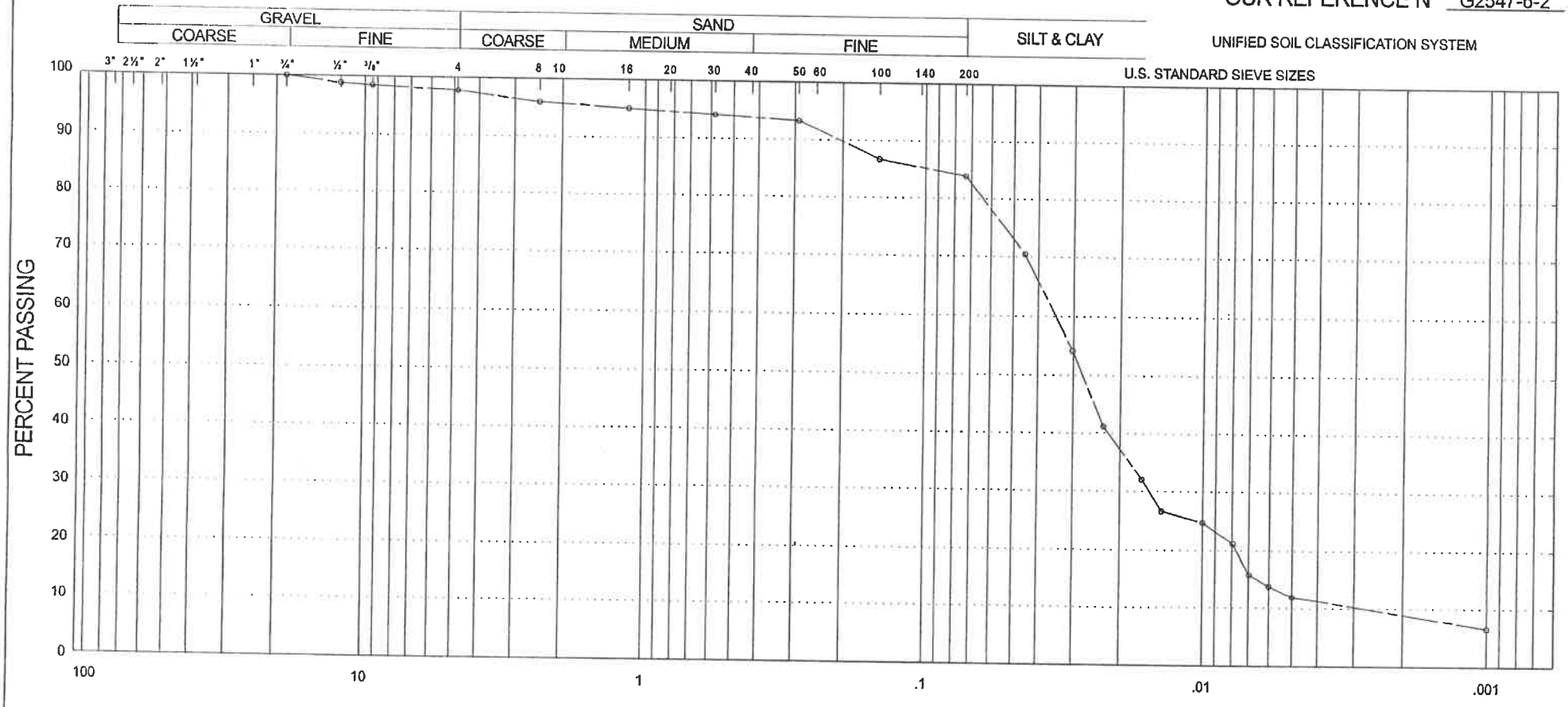
Certified By: [redacted]

BURNSIDE

Appendix F
Grainsize Analysis

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G2547-6-2



PROJECT: Proposed Residential Subdivision
LOCATION: Pt Lots 7, 8 & 9, Con. 10, Puslinch,ON
BOREHOLE N°: 1
SAMPLE N°: 7
DEPTH: 7.6 - 8.1m±
ELEVATION: 332.9 - 332.4m±

COEFFICIENT OF UNIFORMITY:
COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SILT, some clay, some sand, trace gravel (ML)

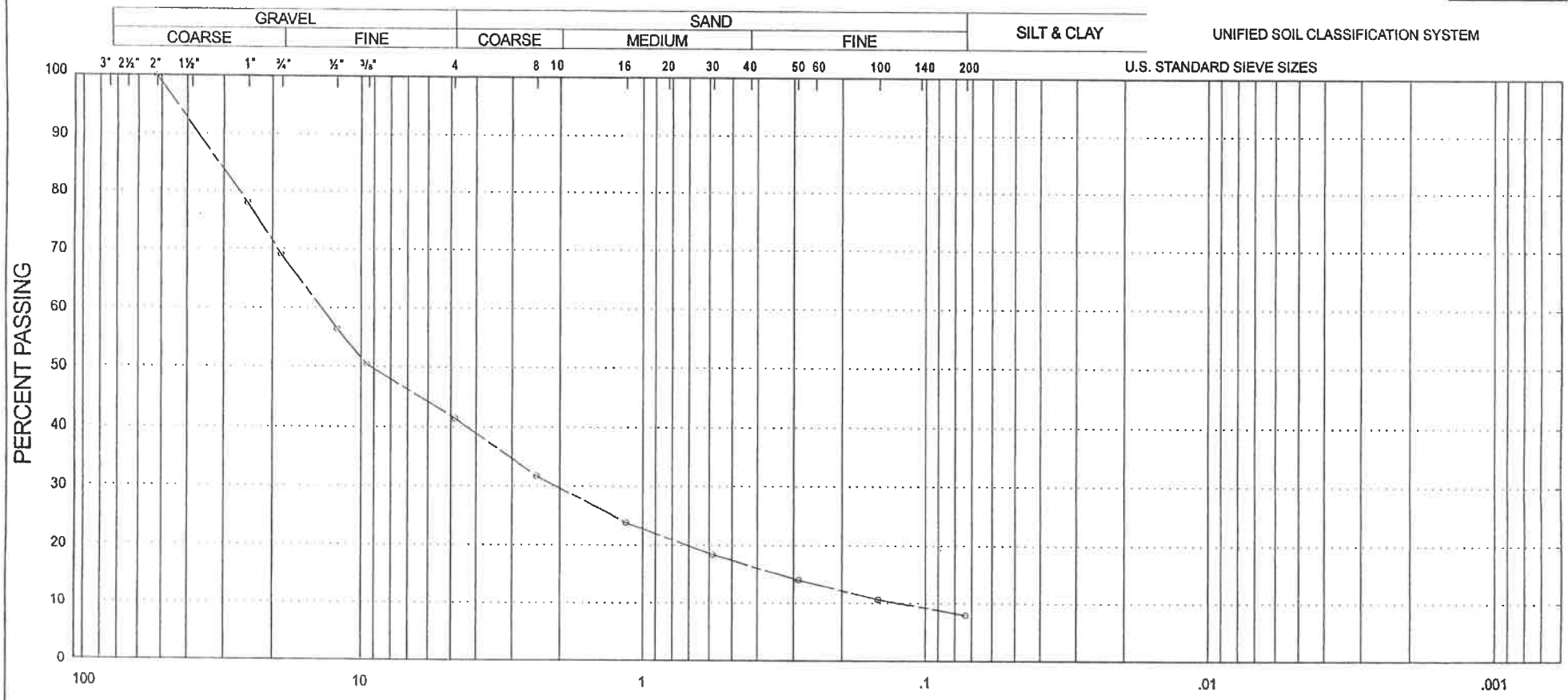
PLASTIC PROPERTIES
LIQUID LIMIT % =
PLASTIC LIMIT % =
PLASTICITY INDEX % =
MOISTURE CONTENT % = 14.8

ENCLOSURE N° 16

V. A. WOOD (GUELPH) INCORPORATED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G2547-6-2



PROJECT: Proposed Residential Subdivision
LOCATION: Pt Lots 7, 8 & 9, Con 10, Puslinch, ON
BOREHOLE N°: 5
SAMPLE N°: 4
DEPTH: 3.0 - 3.5m±
ELEVATION: 338.9.0 - 338.4m±

COEFFICIENT OF UNIFORMITY: 6.4
COEFFICIENT OF CURVATURE: 2.5

Classification of Sample and Group Symbol:

SANDY GRAVEL, trace silt (GW-GM)

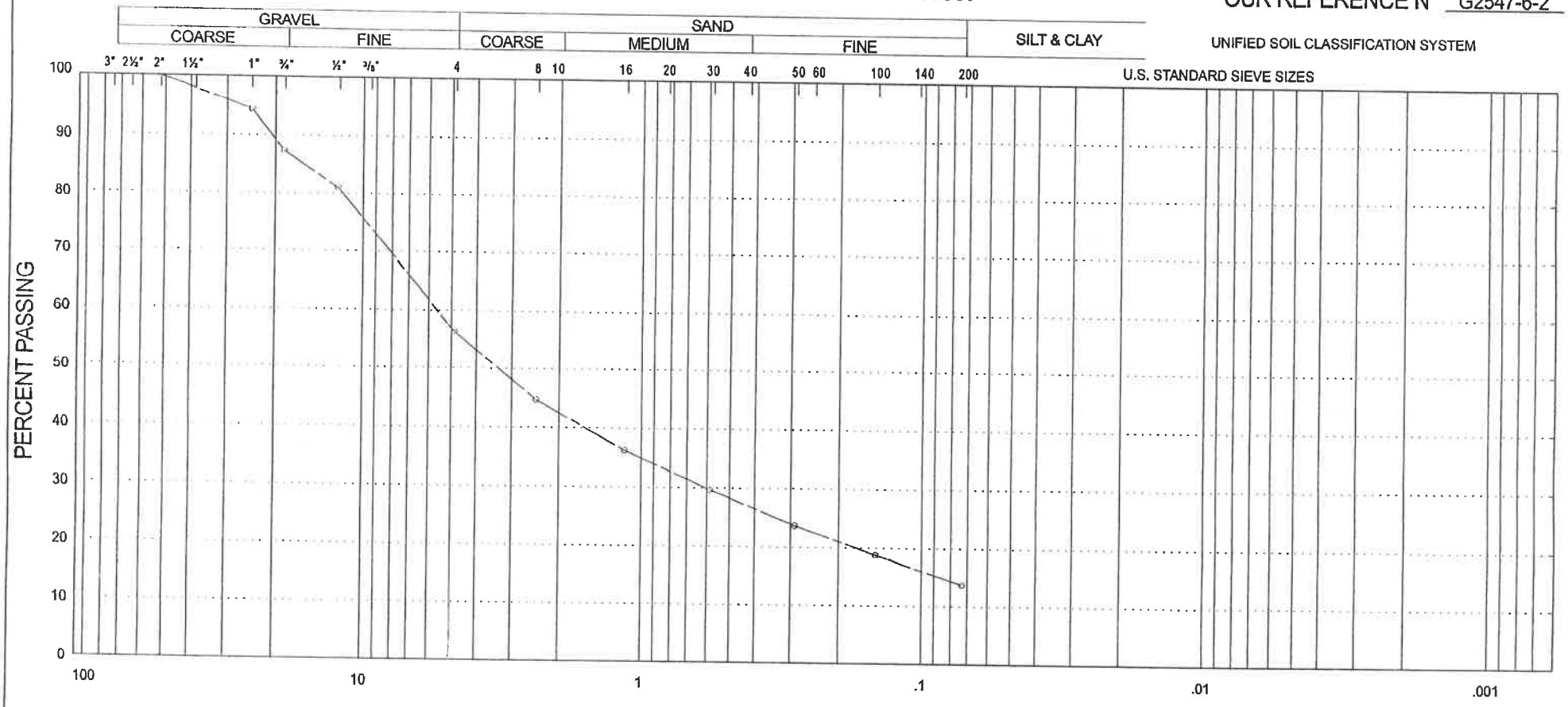
PLASTIC PROPERTIES
LIQUID LIMIT % =
PLASTIC LIMIT % =
PLASTICITY INDEX % =
MOISTURE CONTENT % = 2.8

ENCLOSURE N° 12

V. A. WOOD (GUELPH) INCORPORATED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G2547-6-2



PROJECT: Proposed Residential Subdivision
LOCATION: Pt Lots 7, 8 & 9, Con 10, Puslinch, ON
BOREHOLE N°: 6
SAMPLE N°: 2
DEPTH: 1.5 - 2.0m±
ELEVATION: 341.4.0 - 340.9m±

COEFFICIENT OF UNIFORMITY:
COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

GRAVEL AND SAND, some silt (GM)

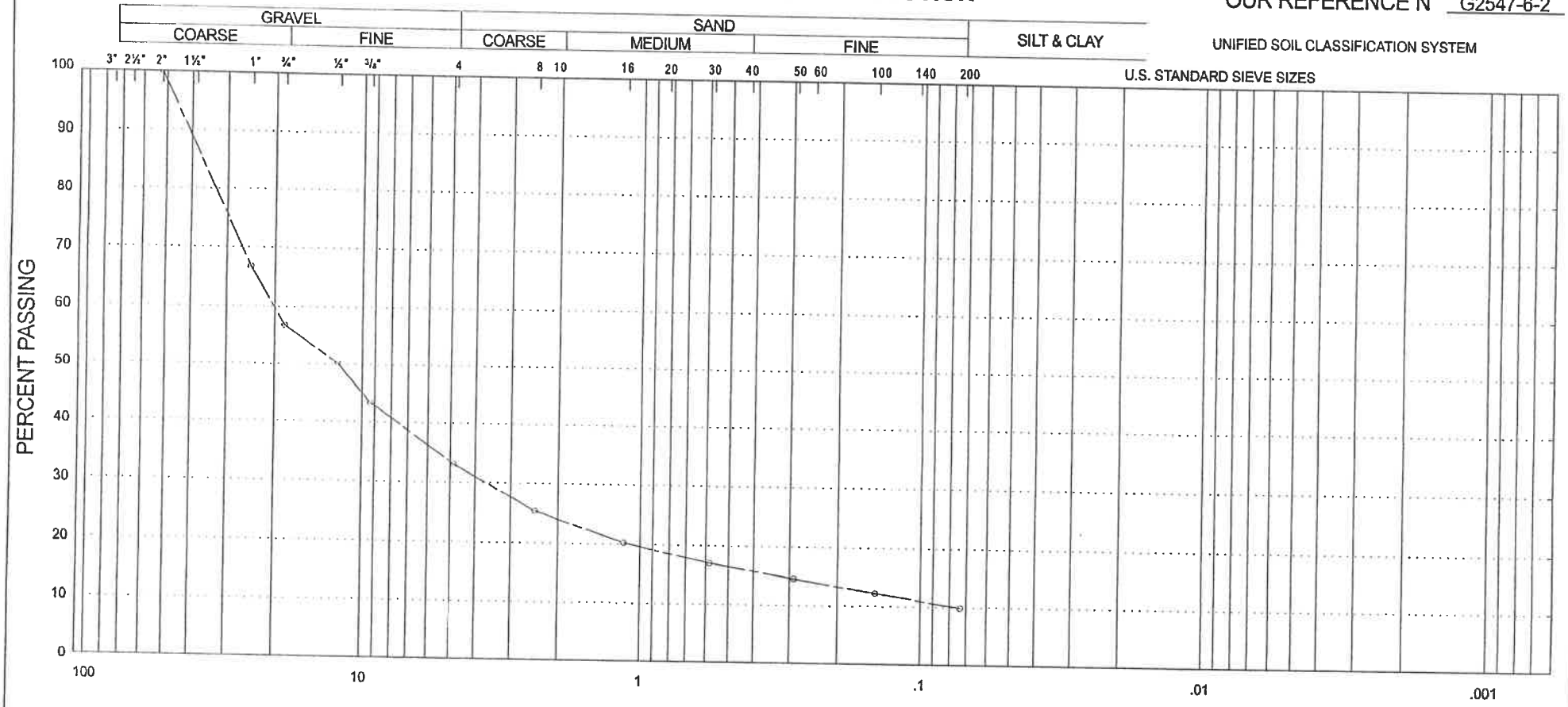
PLASTIC PROPERTIES
LIQUID LIMIT % =
PLASTIC LIMIT % =
PLASTICITY INDEX % =
MOISTURE CONTENT % = 3.7

ENCLOSURE N° 14

V. A. WOOD (GUELPH) INCORPORATED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G2547-6-2



PROJECT: Proposed Residential Subdivision
LOCATION: Pt Lots 7, 8 & 9, Con 10, Puslinch, ON
BOREHOLE N°: 8
SAMPLE N°: 2
DEPTH: 1.5 - 2.0m±
ELEVATION: 342.8.0 - 342.3m±

COEFFICIENT OF UNIFORMITY: 273.9
COEFFICIENT OF CURVATURE: 8.9

Classification of Sample and Group Symbol:

SANDY GRAVEL, trace silt (GP-GM)

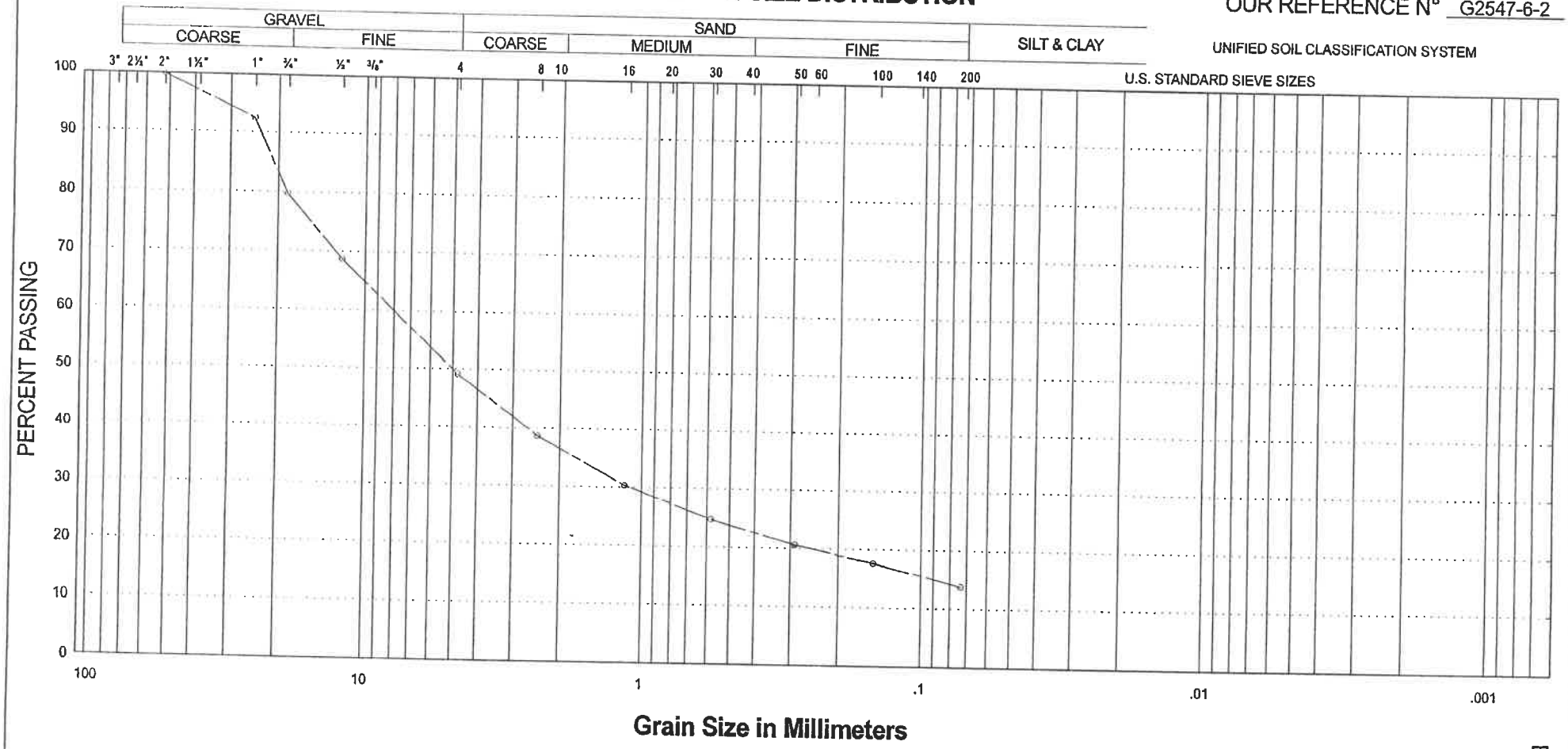
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LIQUID LIMIT % =
PLASTIC LIMIT % =
PLASTICITY INDEX % =
MOISTURE CONTENT % = 2.6

ENCLOSURE N° 13

V. A. WOOD (GUELPH) INCORPORATED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G2547-6-2



PROJECT: Proposed Residential Subdivision
LOCATION: Pt Lots 7, 8 & 9, Con 10, Puslinch, ON
BOREHOLE N°: 9
SAMPLE N°: 3
DEPTH: 2.3 - 2.7m±
ELEVATION: 341.0 - 340.6m±

COEFFICIENT OF UNIFORMITY:
COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

GRAVEL AND SAND, some silt (GM)

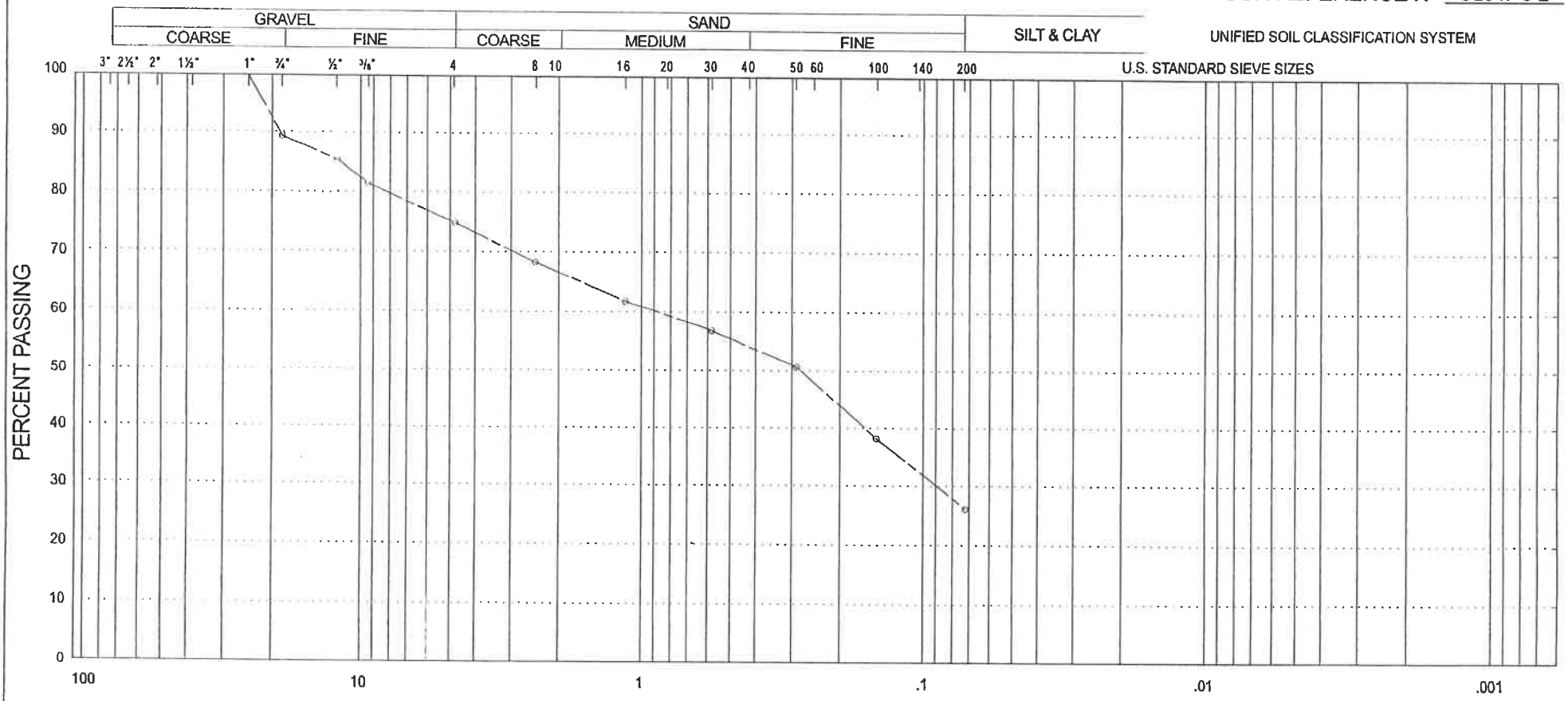
PLASTIC PROPERTIES
LIQUID LIMIT % =
PLASTIC LIMIT % =
PLASTICITY INDEX % =
MOISTURE CONTENT % = 3.6

ENCLOSURE N° 15

V. A. WOOD (GUELPH) INCORPORATED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G2547-6-2



PROJECT: Proposed Residential Subdivision
LOCATION: Pt Lots 7, 8 & 9, Con 10, Puslinch, ON
BOREHOLE N°: 10
SAMPLE N°: 8
DEPTH: 9.1 - 9.6m±
ELEVATION: 331.4 - 330.9m±

COEFFICIENT OF UNIFORMITY:
COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

GRAVELLY, SILTY SAND TILL (SM)

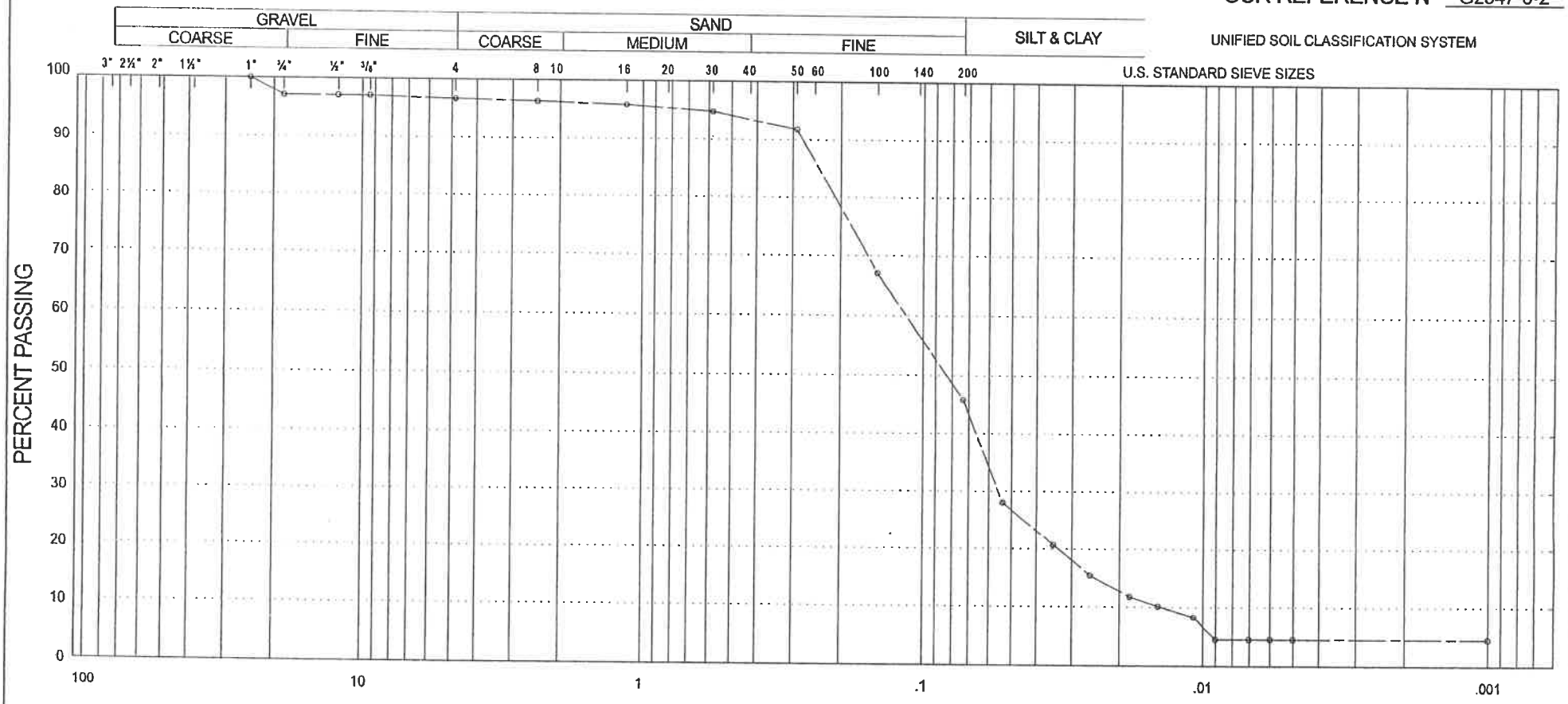
PLASTIC PROPERTIES
LIQUID LIMIT % =
PLASTIC LIMIT % =
PLASTICITY INDEX % =
MOISTURE CONTENT % =

ENCLOSURE N° 17

V. A. WOOD (GUELPH) INCORPORATED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G2547-6-2



PROJECT: Proposed Residential Subdivision
LOCATION: Pt Lots 7, 8 & 9, Con 10, Puslinch,ON
BOREHOLE N°: 10
SAMPLE N°: 9
DEPTH: 10.7 - 11.1m±
ELEVATION: 334.2.0 - 333.8m±

COEFFICIENT OF UNIFORMITY:
COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SAND AND SILT, trace clay, trace gravel (SM)

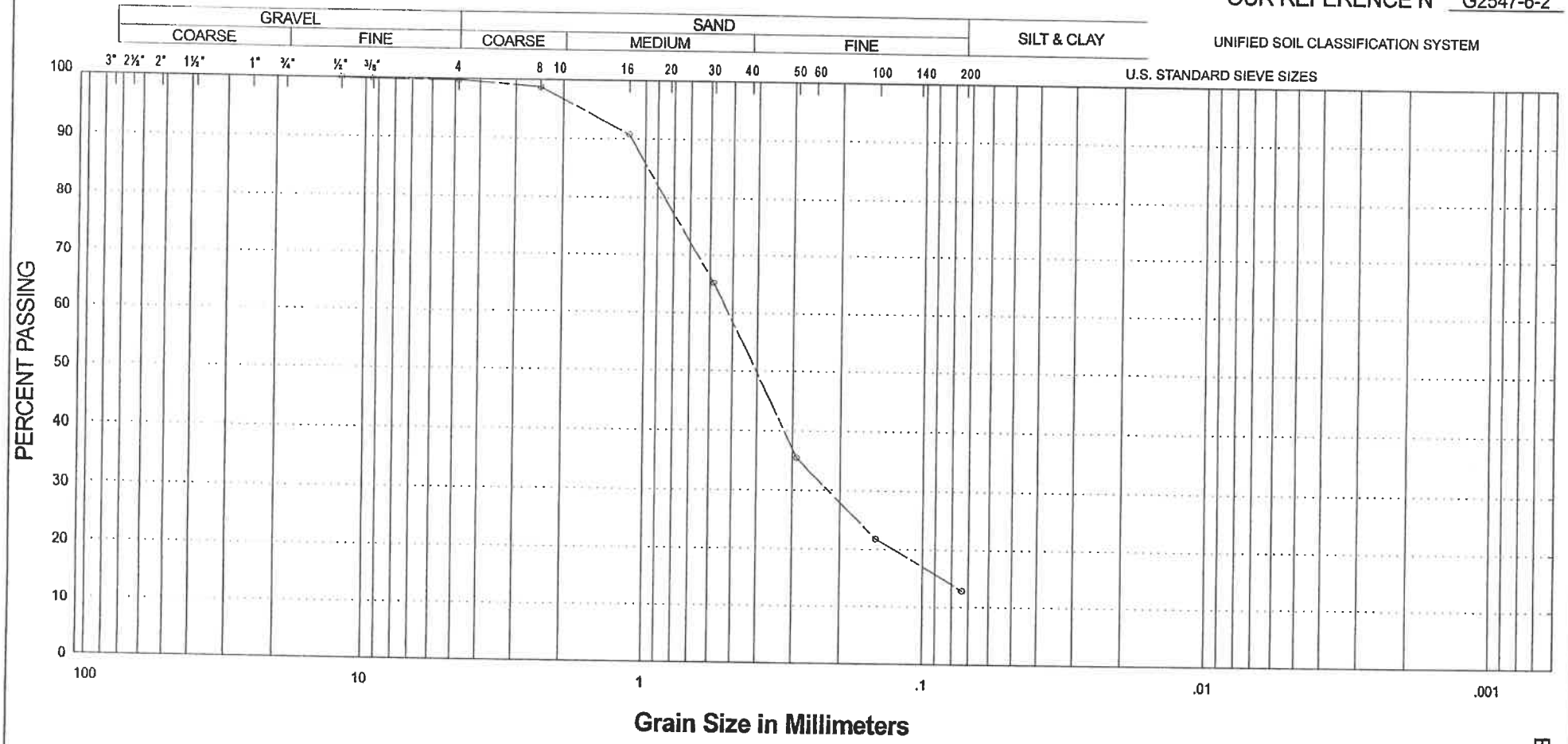
PLASTIC PROPERTIES
LIQUID LIMIT % =
PLASTIC LIMIT % =
PLASTICITY INDEX % =
MOISTURE CONTENT % = 15.7

ENCLOSURE N° 18

V. A. WOOD (GUELPH) INCORPORATED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G2547-6-2



PROJECT: Proposed Residential Subdivision

LOCATION: Pt Lots 7, 8 & 9, Con 10, Puslinch, ON

BOREHOLE N°: 10

SAMPLE N°: 10

DEPTH: 12.2 - 12.6m±

ELEVATION: 332.7 - 332.3m±

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SAND, some silt, trace gravel (SM)

PLASTIC PROPERTIES

LIQUID LIMIT % =

PLASTIC LIMIT % =

PLASTICITY INDEX % =

MOISTURE CONTENT % =

ENCLOSURE N° 19

V. A. WOOD (GUELPH) INCORPORATED

BURNSIDE

Appendix G
Nitrate Calculations

Kukovica Development - Arkell
MOE Mass Balance Equation
Nitrate Loading Calculations

$$Q_t C_t = Q_e C_e + Q_i C_i$$

Where:

Q_e	13870	**m^3/year**	Sewage Effluent Volume	(38 units @ 1000 litres/day)
Q_i	48780	**m^3/year**	Infiltration Volume = (recharge * study area)	(21.68 ha x .225 m)
Q_t	62650	**m^3/year**	Total Volume	
C_e	40000	**mg/m^3**	Concentration of sewage effluent	40 mg/L
C_i	100	**mg/m^3**	Concentration of precipitation	0.1 mg/L

$$C_t = (Q_e C_e + Q_i C_i)/Q_t$$

$Q_e C_e$	554800000	**mg/year**
$Q_i C_i$	4878000	**mg/year**
C_t =	8933	**mg/m^3**
	8.93	**mg/L**

Therefore the predicted concentration of nitrate being introduced to groundwater by the Class IV septic systems is 8.93 mg

Kukovica Development - Arkell
MOE Mass Balance Equation
Nitrate Loading Calculations

$$Q_t C_t = Q_e C_e + Q_i C_i$$

Where:

Q_e	13870	**m^3/year**	Sewage Effluent Volume	(38 units @ 1000 litres/day)
Q_i	48780	**m^3/year**	Infiltration Volume = (recharge * study area)	(21.68 ha x .225 m)
Q_t	62650	**m^3/year**	Total Volume	
C_e	20000	**mg/m^3**	Concentration of sewage effluent	20 mg/L
C_i	100	**mg/m^3**	Concentration of precipitation	0.1 mg/L

$$C_t = (Q_e C_e + Q_i C_i)/Q_t$$

$Q_e C_e$	277400000	**mg/year**
$Q_i C_i$	4878000	**mg/year**
C_t =	4506	**mg/m^3**
	4.51	**mg/L**

Therefore the predicted concentration of nitrate being introduced to groundwater by the Tertiary Treatment systems is 4.51 mg/L

Kukovica Development - Arkell
MOE Mass Balance Equation
Nitrate Loading Calculations - Hard Capped Surfaces

$$Q_t C_t = Q_e C_e + Q_i C_i$$

Where:

Q_e	13870	**m^3/year**	Sewage Effluent Volume	(38 units @ 1000 litres/day)
Q_i	40770	**m^3/year**	Infiltration Volume = (recharge * study area)	(18.12 ha x .225 m)
Q_t	54640	**m^3/year**	Total Volume	
C_e	40000	**mg/m^3**	Concentration of sewage effluent	40 mg/L
C_i	100	**mg/m^3**	Concentration of precipitation	0.1 mg/L

$$C_t = (Q_e C_e + Q_i C_i)/Q_t$$

$Q_e C_e$	5.5E+08	**mg/year**
$Q_i C_i$	4077000	**mg/year**
C_t =	10228	**mg/m^3**
	10.23	**mg/L**

Therefore the predicted concentration of nitrate being introduced to groundwater by the septic systems is 10.23 mg/L.

BURNSIDE

Hydrogeological Review and Predictive Nitrate Assessment
Proposed Residential Subdivision
Part Lots 7, 8 & 9, Concession 10
Township of Puslinch
Kukovica Development - Arkell

P10/06

Prepared by

R.J. Burnside & Associates Limited
292 Speedvale Avenue West Unit 7 Guelph ON N1H 1C4 Canada

July 2006

File No: PTA 10312

The material in this report reflects best judgement in light of the information available at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. R. J. Burnside & Associates Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

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1.0 Introduction

R.J. Burnside & Associates Limited (Burnside) was retained by Kukovica Development to complete a hydrogeological assessment and predicative nitrate impact study as part of the approval process for a residential development near Guelph, Ontario. Burnside understands that the proposed development includes a Draft Plan of Subdivision to create 38 single-family residential lots on 21.68 ha of land. The lots will be individually serviced with septic systems and private water supply wells. A copy of the Draft Plan of Subdivision is provided in Appendix A.

1.1 Site Description

The site is currently a vacant parcel of land located on the eastern edge of Guelph, Ontario. The property is approximately 21.68 ha (53.57 acres) and is located on the southeast corner of the intersection of Arkell Road and Watson Road South. The site is generally flat with a gentle slope to the north. The Town of Arkell is located to the west of the property. A railway line (Guelph Junction) is present along the southern property boundary.

Current land use in the vicinity of the site is primarily rural residential and agricultural. A small, treed area is present along the southern boundary of the property. Surface water features with a kilometre of the site include two large marsh areas to the east and southeast and the Eramosa River to the north.

The legal description of the property, as provided by Van Harten Surveying, is Part Lots 7, 8 & 9, Concession 10, Township of Puslinch. Figure 1 provides a site location map.

2.0 Scope of Work

The scope of work for the project is based upon the Ministry of the Environment's *Hydrogeological Technical Information Requirements for Land Development Applications*.

Burnside worked in cooperation with V.A.Wood (Guelph) Incorporated (V.A.Wood) on this assignment. V.A.Wood arranged utility locates, conducted all drilling and soil testing activities and surveyed the locations of installed monitoring wells and boreholes. Burnside used the information generated by V.A.Wood, such as borehole logs and grainsize analysis to complete the hydrogeological assessment.

The scope of work for the groundwater impact assessment included:

- Review of available geological information including mapping, water well records and regional hydrogeological reports;
- Observation of drilling activities and inspection during the construction of two monitoring wells;
- Collection of water samples for analysis of general chemistry including nitrogen and phosphorus;
- Hydraulic testing of the monitoring wells to assess groundwater velocity;
- Collection and analysis of groundwater elevations to assess groundwater conditions; and
- Preparation of a technical report complete with figures, tables and cross-sections along with the necessary analysis and interpretation.

3.0 Geological Setting

Background information for the site was obtained from MOE water well records, geologic reports and mapping for the area.

The site is located in the physiographic region known as the Horseshoe Moraines, which occupies approximately 8.73 km^2 (2158 square miles) including the southeast portion of Wellington County. In the area of the site the Horseshoe Moraines physiographic region is represented by the Paris Moraine. The soils are generally a coarse textured, open, stony till composed largely of dolostone with traces of red shale, which are highly calcareous. The overburden is typically greyish brown or pale to dark brown in colour (Chapman & Putnam, 1984).

3.1 Overburden Geology

Based upon a review of the Ministry of Northern Mines and Development Map 2556 the overburden in the area of the site varies. Glaciofluvial outwash sand and gravel deposits are prevalent throughout the area. The Port Stanley Till, which is a strongly calcareous, silt to sandy silt till is also present in the vicinity of the site. Figure 2 illustrates the quaternary geology of the area.

3.2 Bedrock Geology

The Middle and Lower Silurian group of formations is found over the major portion of Wellington County. In the Guelph area this group includes the Guelph Formation and the Amabel Formation, which are made up of dolostone. Figure 3 shows the bedrock geology of the area.

Based on review of the Ontario Department of Mines Map P. 2224 there appears to be a bedrock ridge in the area of the site. The bedrock surface, located at an elevation of approximately 328 mASL (1078 feetASL), slopes to the north, west and south. In general the bedrock slopes to the southwest at a rate of two to three metres per kilometre. Based upon a comparison of the bedrock and surface topography, the overburden thickness in the area of the site ranges from approximately 12 to 17 metres (40 to 55 feet).

3.3 Hydrogeology

Groundwater is an abundant and reliable resource in Wellington County. Overburden aquifers are not as commonly exploited as the bedrock aquifers. Groundwater recharge is enhanced in areas of coarse-textured soils with either limited slope or hummocky topography. Approximately 25 percent of the precipitation in Puslinch Township infiltrates as groundwater recharge (Golder, 2005). The site is located within the Zone 1 (0-2 year time of travel) capture zone of the Arkell Springs municipal wells located to the north.

Based upon a review of Figure 3.12 "*Groundwater Elevations in the Overburden*" from the County of Wellington's "*Groundwater Protection Study*" the groundwater in the overburden is present at an elevation of approximately 331 to 340 mASL (1086 to 1115 feetASL). In comparison with the surface topography, groundwater in the overburden is present at a depth of approximately 10 metres. This corresponds to the groundwater elevations of approximately 334 mASL encountered in the monitoring wells installed on-site. Groundwater flow in the overburden is generally towards the Eramosa River to the north; however there may be to be local variations due to topography and groundwater discharge features.

Based upon a review of Figure 3.13 "*Groundwater Elevations in the Bedrock*" from the County of Wellington's "*Groundwater Protection Study*" the groundwater in the bedrock is present at an elevation of approximately 330 to 350 mASL (1099 to 1150 feetASL). Groundwater flow in the bedrock is generally towards the Eramosa River to the north.

The specific capacity of the wells constructed in the bedrock range between 0.1 and 2,908 L/min/m having a geometric mean of 7.8 L/min/m. The transmissivity, calculated from the specific capacity, ranges between 0.1 and 7,548 m^2/day with a geometric mean of 15.5 m^2/day. The relatively high geometric means indicate that the Guelph-Amabel-Lockport hydrogeologic unit has good water-yield capabilities (Singer et al, 1994).

3.3.1 Water Well Records

Burnside completed a review of the water wells records for the Township of Puslinch. There were a total of 17 registered water wells on Lots 7, 8 and 9 of Concession 10. All the wells were constructed in the bedrock at depths ranging from 27 metres to 104 metres and produced fresh water. There were no concerns noted of sulphurous or saline water. The depth to the bedrock ranged from approximately 17 metres to 50 metres below grade (~ 323 mASL to 290 mASL). Pumping rates ranged from 18 L/min to 136 L/min (4 to 30 Igpm). Accordingly it appears that the bedrock aquifer is capable of producing sufficient quantities of water for this residential development.

The overburden descriptions in the water well records indicate that the soils in the vicinity of the site are predominantly a clayey till although there are some indications of sand or gravelly sand deposits. Copies of the water well records are included in Appendix B. Figure 4 illustrates the location of the water wells in the vicinity of the site. A geological cross section is provided as Figure 5.

3.4 Water Quality

Groundwater quality at each municipal pumping well servicing the City of Guelph was documented in a report titled "City of Guelph – Water System Study Resource Evaluation Summary" dated 1999. The study indicated that groundwater from bedrock wells in the Arkell Springs well field was hard and enriched in calcium and magnesium, which is to be expected, given the origin of the water is a carbonate bedrock aquifer. Chloride concentrations are low (ranging from 22mg/L to 43mg/L) whereas nitrate concentrations are slightly elevated (ranging from 0.8mg/L to 3mg/L).

As part of the testing program samples were also submitted for micro particulate analysis. Micro particulate concentrations were generally below laboratory method detection limits however low concentrations of algae suggest a small portion of the groundwater pumped from the Arkell Springs wells originated as surface water. The Arkell Springs well field also contains an overburden municipal pumping well. Groundwater collected from this well contained lower concentrations of calcium and magnesium as well as lower chloride and nitrate concentrations versus the bedrock wells. Micro particulate analysis showed a slightly higher concentration of algae in the overburden groundwater versus the bedrock groundwater suggesting surface water infiltration. No surface water organisms such as Giardia or Cryptosporidium were detected in either the overburden or bedrock groundwater samples. No organic compounds have been detected in samples collected from these wells.

3.5 Groundwater Pollution Susceptibility

Figure 3.21 "*Groundwater ISI Map – Shallow Overburden*" from the County of Wellington's "*Groundwater Protection Study*" indicates that the shallow overburden groundwater resources in the vicinity the site have a high susceptibility to surface sources of pollution.

Figure 3.23 "*Groundwater ISI Map – Bedrock*" from the County of Wellington's "*Groundwater Protection Study*" indicates that bedrock groundwater resources in the vicinity the site have a medium susceptibility to surface sources of pollution. However there is a small area in the vicinity of the property that has a high susceptibility index.

The area of high susceptibility near the site is likely due to the thinner overburden and presence of sand and gravel deposits as noted in the water wells records.

The Intrinsic Susceptibility Index (ISI) is determined based upon a review of soil types, conductivity of the soil and overall depth to water. The above-mentioned figures have been included in Appendix C.

4.0 Field and Laboratory Program

4.1 Borehole Drilling

A borehole drilling program was completed on January 12, 13 and 16, 2006. Aardvark Drilling Inc. completed the drilling program and a V.A.Wood representative logged the soil stratigraphy and collected representative soil samples. Burnside representatives were present during the installation of the two monitoring wells.

A total of ten boreholes were advanced using a CME 75 hollow stem auger and monitoring wells (MW1 and MW2) were installed in BH1 and BH10 to allow the collection of water level measurements and water quality samples. Originally three monitoring wells were proposed however many of the holes were terminated on either boulders or bedrock and as a result a suitable location for a third well was not identified.

The depths explored ranged between 3.3 and 12.6 metres below ground surface (~11 to 41 feet).

The stratigraphy at the site included a layer of topsoil typically 0.2 to 0.4 metres thick, with two locations (BH7 and BH10) having considerably more topsoil cover (0.8 metres and 1.5 metres respectively). A brown, compact to very dense sandy gravel or sand and gravel underlies the topsoil. A layer of brown very dense silt was noted in BH1 followed by grey dolostone fragments. A layer of brown, very dense gravely, silty

sand till was identified in BH10 containing layers of very dense sand and silt. The till is interpreted to be Port Stanley Till.

Figure 6 shows the locations of the boreholes and monitoring wells. Borehole logs are included in Appendix D.

4.2 Water Level Data

Burnside collected water levels on Jan 26, 2006. The following table provides the results.

Table 1: Water Level Data

Location	Ground Elevation	Stickup	January 26, 2006	
MW1	340.45 mASL	0.88 m	8.31 mbtp	333.02 mASL
MW2	344.90 mASL	0.41 m	10.78 mbtp	334.53 mASL

mASL: metres above mean sea level.

mbtp: metres below top of pipe.

The data indicates that the groundwater table is located at depths ranging between 8.31 and 10.78 metres below top of pipe, corresponding to an approximate elevation of 333.02 to 334.53 mASL.

4.3 Groundwater Sampling

Groundwater samples were collected from MW1 and MW2 on January 26, 2006 and submitted to AGAT Laboratories for water quality analysis. The sample was collected using industry standard practices. The certificate of analysis is included in Appendix D.

The analytical results indicate that nitrates are present in the shallow groundwater at an elevated concentration of 3.76 mg/L. Although this concentrations is below the Ministry of the Environment Ontario Drinking Water Standard of 10 mg/L, the concentration is considered elevated above a typical background concentration of 1.0 mg/L. The elevated concentrations are likely due to the influence of fertilizer application, especially on local crop fields. Septic systems present in the Town of Arkell may also be providing a source of nitrates. Analytical results also indicated a concentration of sodium in MW1 of 38.9 mg/L exceeds the MOE OWDS of 20 mg/L. This may be due to winter de-icing activities on the nearby roadways. However, additional sampling would be required to further investigate these results. Additional sampling would also be required to evaluate seasonal variations in nitrate loads.

4.4 Grainsize Analysis

V.A.Wood collected representative soil samples at various boreholes across the site. The samples were collected from BH1, BH5, BH6, BH8, BH9, and BH10 from depths ranging from 1.5 metres to 12.2 metres below ground surface and submitted for grainsize analysis.

- The soil sample collected from 7.6 to 8.1 metres below ground surface Borehole 1 is described as silt with some clay, some sand and trace gravel. The proportions are approximately 8 percent clay, 76 percent silt, 13 percent sand and 3 percent gravel.
- The soil sample collected from 3 to 3.5 metres below ground surface in Borehole 5 is described as sandy gravel with trace silt. The proportions are approximately 8 percent silt, 34 percent sand and 58 percent gravel.
- The soil sample collected from 1.5 to 2 metres below ground surface in Borehole 6 is described as gravel and sand with some silt. The proportions are approximately 14 percent silt, 42 percent sand and 44 percent gravel.
- The soil sample collected from 1.5 to 2 metres below ground surface in Borehole 8 is described as sandy gravel with trace silt. The proportions are approximately 10 percent silt, 23 percent sand and 67 percent gravel.
- The soil sample collected from 2.3 to 2.7 metres below ground surface in Borehole 9 is described as gravel and sand with some silt. The proportions are approximately 14 percent silt, 35 percent sand and 51 percent gravel.
- The soil from Borehole 10 is described as gravely, silty clay till at 9.1 metres below ground surface, sand and silt with trace clay and trace gravel at 10.7 metres below ground surface and sand with some silt and trace gravel at 12.2 metres below ground surface. The proportions approximately range from 0 to 4% clay, 13 to 42 percent silt, 47 to 87 percent sand and 1 percent to 26 percent gravel.

The laboratory reports from V.A.Wood are provided in Appendix F.

5.0 Development Impact Assessment

Burnside understands that the development will be serviced with on-site sewage disposal and individual water wells. To assess the effects of the proposed septic systems, Burnside completed a nitrate loading assessment. The assessment was based upon the MOE's *Hydrotechnical Information Requirements for Land Development Application* dated April 1995 (HTIR).

The following equation was used to determine the potential concentrations of nitrate on the groundwater due to the effects of the proposed septic systems:

$$Q_t * C_t = Q_e * C_e + Q_i * C_i$$

Where:

- Q_t is the total volume of water entering the system;
- C_t is the total concentration of nitrates;
- Q_e is the volume of effluent disposed in the subsurface;
- C_e is the concentration of nitrates in the effluent;
- Q_i is the volume of infiltration from precipitation; and
- C_i is the concentration of nitrates in the infiltration.

The equation takes into account dilution from infiltrating precipitation, which is assumed to be 225 mm/year and a septic system effluent loading rate of 1,000 L/day per unit. The infiltration assumption of 225 mm/year is based on Figure 3.25 "*Schematic Illustration of Approximate Water Balance*" from the County of Wellington's "*Groundwater Protection Study*", which is included in Appendix C. The nitrate concentration of the wastewater from a Class IV septic system is assumed to be 40 mg/L. The assumed nitrate concentration in the precipitation is estimated to be 0.1 mg/L. Table 2 illustrates the anticipated effects on the groundwater. Worksheets illustrating the calculations are attached in Appendix E.

Table 2: Summary of Nitrate Evaluation

System Type	Effluent Concentration	Nitrate Loading Concentrations
38 Class IV System	40 mg/L	8.93 mg/L
38 Tertiary Systems	20 mg/L	4.51 mg/L

The results indicate that 38 Class IV septic systems operating on the property will result in an additional 8.93 mg/L of nitrate being introduced to the shallow groundwater. However Burnside understands that tertiary treatment systems will be installed to improve the quality of the septic effluent. Burnside calculates that the use of tertiary systems will result in an additional 4.51 mg/L of nitrate being introduced to the shallow groundwater. These concentrations are below the MOE Ontario Drinking Water Standard (ODWS) of 10 mg/L.

It should be noted that the proposed residential development would result in the construction of hard surfaces that will affect the infiltration and effluent dilution volume. Based upon information provided by Van Harten Surveying the area of the roadways is estimated to be 2.23 ha. Burnside has assumed an average lot impervious

area (roofs and driveways) of 0.035 ha/lot for a total of 3.56 ha of impervious surfaces. Accounting for this loss of infiltration the predicted nitrate loading is 10.23 mg/L. This is slightly above the MOE ODWS of 10 mg/L. To mitigate the effects of hard capped surfaces, at-source infiltration techniques will need to be employed to balance pre and post development infiltration volumes. A worksheet illustrating the calculation is attached in Appendix G.

5.1 Arkell Water Management Protection Area

The subject property is located within the Arkell Water Management Protection Area and as a result Policy 4.9.5 of the County of Wellington Official Plan requires that:

a) Landuses that may create groundwater contamination problem will not be located with the protection area; and
b) Storm water management options to promote clean water recharge to the aquifer will be promoted.

The development of the property for residential use will not result in an increase in groundwater contamination given that tertiary treatment systems are being proposed. As indicated in the policy, the design of the storm water management system should promote clean water recharge to the aquifer.

6.0 Conclusions

The following can be concluded from the study discussed above:

6.1 Water Supply

- The wells for the development should be constructed in the bedrock aquifer at depths ranging between 17 to 50 metres (~56 to 164 feet) below ground surface. Based upon the information reviewed pumping rates will likely range between 18 L/min to 136 L/min (4 to 30 Igpm). The bedrock aquifer is capable of producing sufficient quantities of water for typical domestic purposes.
- Bedrock wells were observed to have generally higher calcium and magnesium concentrations. As a result homes will likely have to be equipped with standard ion exchange equipment such as water softeners.

6.2 Nitrate Loading

- The result of groundwater sampling indicates that the average background nitrate concentrations are 3.76 mg/L.

- The results indicate that 38 Class IV septic systems operating on the property will result in an additional 8.93 mg/L of nitrate being introduced to the shallow groundwater. However Burnside understands that tertiary treatment systems will be installed to improve the quality of the septic effluent. Burnside calculates that the use of tertiary systems will result in 4.51 mg/L of nitrate being introduced to the shallow groundwater. These concentrations are below the MOE Ontario Drinking Water Standard (ODWS) of 10 mg/L.

6.3 Septic System Design

- Grainsize analysis indicates that the soil on the site is generally comprised of gravel and sand with some silt. Septic system design and construction should be completed under the supervision of a qualified engineer.
- Burnside understands that the development will serviced using tertiary treatment systems.

6.4 Groundwater Resource Protection

- Overburden groundwater resources in the vicinity of the site have a high susceptibility to surface sources of pollution. This is likely due to the presence of sand and gravel deposits as noted in the water wells records.
- Bedrock groundwater resources in the vicinity of the site have a medium susceptibility to surface sources of pollution.
- Given the use of tertiary treatment systems an increase in groundwater pollution due to the residential development is not anticipated.

7.0 Discussion

Based upon the work completed during this study, Burnside offers the following recommendations.

The information suggests that the bedrock aquifer is capable of producing sufficient quantities of water to service the residential development. Groundwater samples collected at the site in the shallow overburden suggests that nitrates are present in the shallow water table aquifer at slightly elevated concentrations. *Burnside recommends that water wells be constructed in the bedrock aquifer according to Ontario Regulation 903. Water quality sampling should be completed on water supply wells to assess the quality of the water in the bedrock aquifer at the site. The analytical program should include nitrates, nitrites, TKN, ammonia, hardness, iron, and sulphates.*

Typical rural residential developments result in land surface being covered in hard surfaces. *Burnside recommends that, if possible, at-source infiltration techniques such as soak away pits, grass swales and infiltration galleries be employed to minimize the effects infiltration losses from the construction of impermeable surfaces.* This condition should be reviewed with a development engineer to determine feasibility.

8.0 Summary of Recommendations

- *Water wells should be constructed in the bedrock aquifer according to Ontario Regulation 903.*

- *Water quality sampling should be collected from newly constructed water supply wells to confirm the potability of the supply. Testing should include nitrates, nitrites, TKN, ammonia, hardness, iron, sodium, chlorides and sulphates.*

- *At-source infiltration techniques such as soak away pits, grass swales and infiltration galleries should be employed to minimize the effects infiltration losses from the construction of impermeable surfaces.*

- *Storm water management facilities should be designed to meet the requirements of the County of Wellington's OP Policy 4.9.5.*

9.0 Limitations

Services provided by R.J. Burnside & Associates Limited were conducted in a manner consistent with the level of care and skill ordinarily exercised by member of the Environmental Engineering and Geoscience Consulting Profession. No other representations, expressed or implied as to the accuracy of the information, conclusions or recommendations is included, or intended in this report.

It should be recognized that the passage of time might affect the views, conclusions and recommendations provided in this report because environmental conditions of a property can change. Should additional or new information become available, Burnside recommends that it be brought to our attention in order that we may re-assess the contents of this report.

We trust that this report is suitable, if you have any questions please do not hesitate to contact the undersigned.

Respectfully Submitted,

R.J. Burnside & Associates Limited

[redacted]

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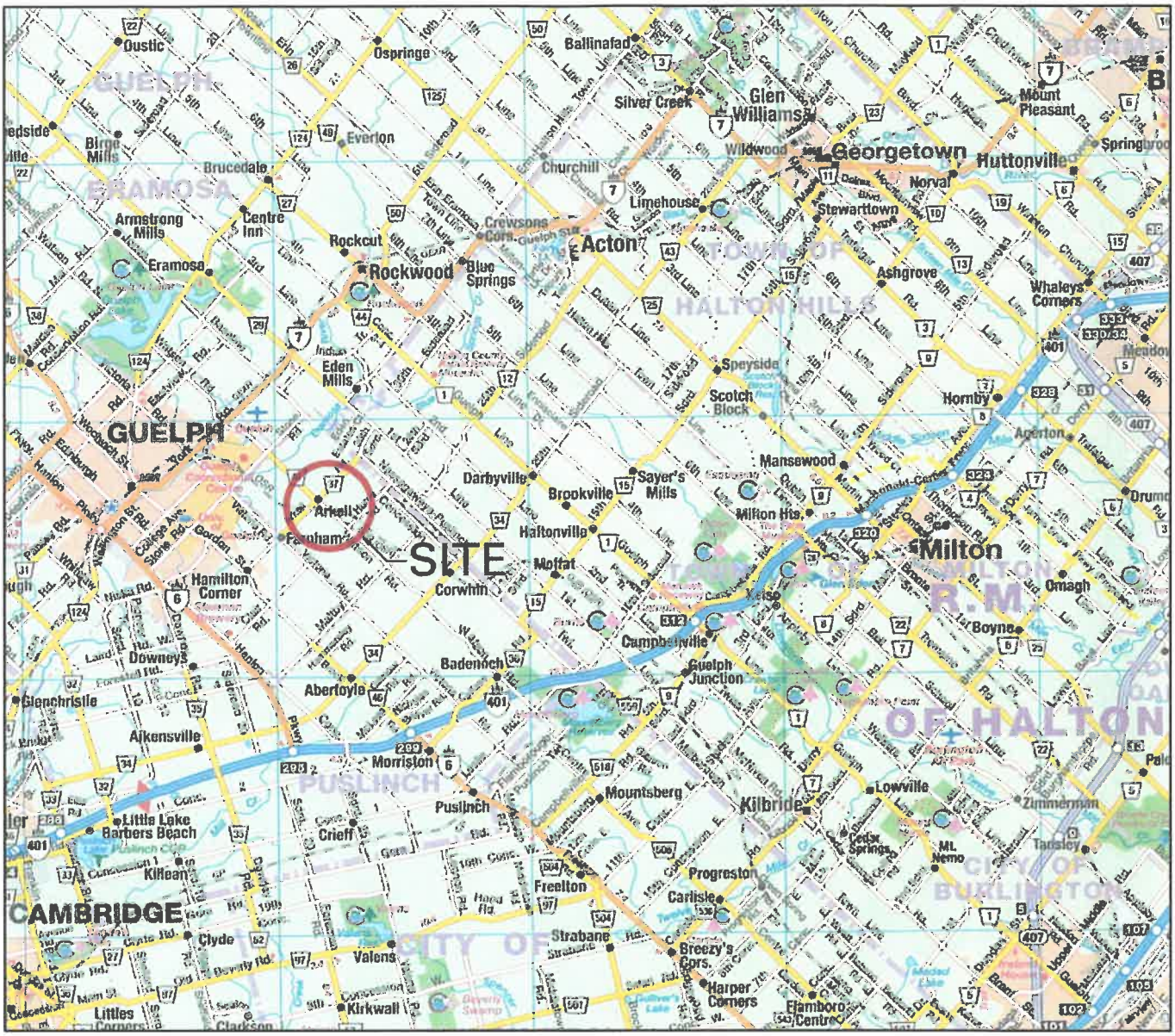
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Figures



Map Reference:
Map Art Publishing
Ontario Road Atlas



KEY MAP OF ONTARIO

FIGURE 1 - SITE LOCATION MAP

KUKOVICA SUBDIVISION
ARKELL, ONTARIO
HYDROGEOLOGICAL ASSESSMENT

February 2006
Project Number: PTA 10312

Prepared by: C. Reynolds

Verified by: D. Marks

BURNSIDE

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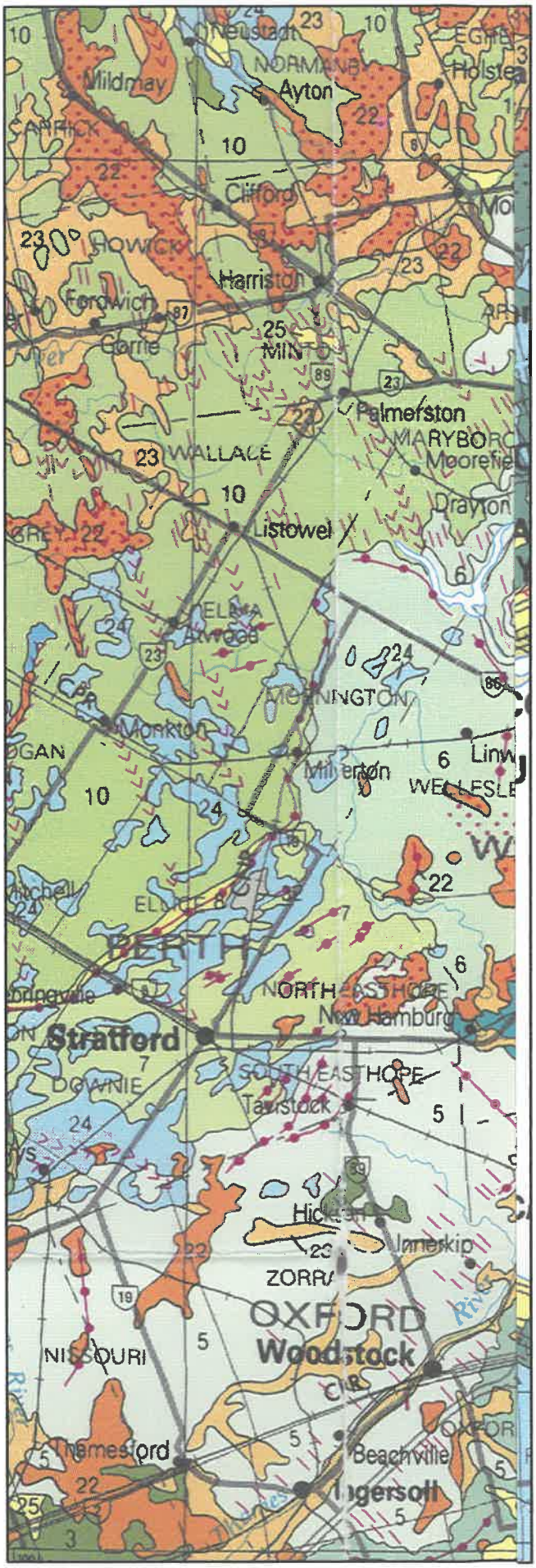
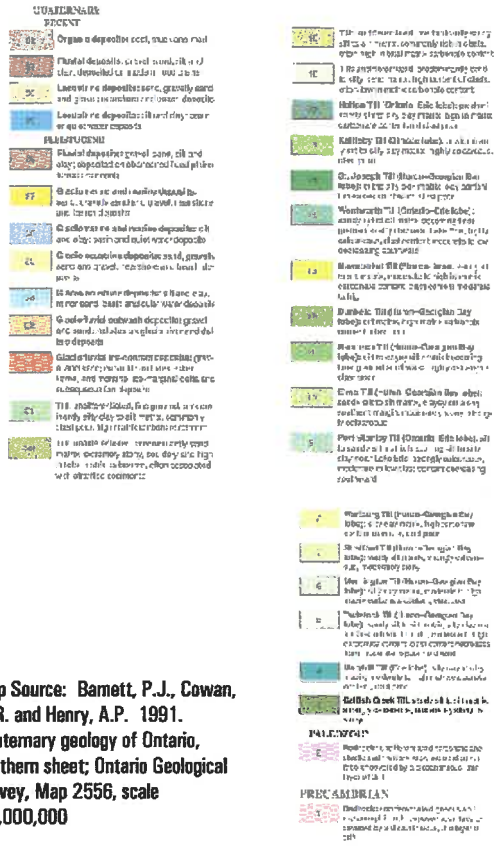


FIGURE 2

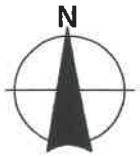
KUKOVICA SUBDIVISION

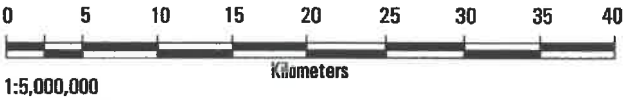
HYDROGEOLOGICAL ASSESSMENT

QUATERNARY GEOLOGY



Map Source: Barnett, P.J., Cowan, W.R. and Henry, A.P. 1991. Quaternary geology of Ontario, southern sheet; Ontario Geological Survey, Map 2556, scale 1:1,000,000





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February 2006
Project Number: PTA 10312

Prepared by: C. Reynolds

Verified by: D. Marks

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P10/06

HGC ENGINEERING
noise · vibration · acoustics

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July 24, 2006

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Figure 3: Vibration Criterion Curve
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Appendix A: Development Concept Plan
Appendix B: Rail Volume Data
Appendix C: Sample STAMSON data

1 INTRODUCTION AND SUMMARY

Howe Gastmeier Chapnik Limited (HGC Engineering) was retained by Van Harten Surveying Inc. to conduct a rail noise and vibration impact assessment for a proposed residential development in the Township of Puslinch, County of Wellington, Ontario. The site is located on the northeast corner of the intersection of Watson Road South and the Guelph Junction Railway. This study follows the guidelines of the Ontario Ministry of the Environment (MOE) with regard to the impact of noise and vibration.

This assessment is based on the attached Development Concept Plan (Appendix A) and on rail volume data obtained from the Guelph Junction Railway (Appendix B). A key plan showing the location of the site is attached to this report as Figure 1.

The site was visited on May 17, 2006 to investigate the acoustic and topographic environment, and to conduct a measurement of ground vibration during a railway passby. Sound levels due to the operation of the railway have been predicted and compared to the guideline limits of the MOE.

The results of the study indicate that it is feasible to achieve the MOE sound level guidelines at the proposed residential development. The predicted sound levels at the closest lots exceed the applicable MOE limits, but the excess is such that physical mitigation in the form of berms or barriers is not required under MOE guidelines. Air conditioning, warning clauses and appropriate selection of wall and window constructions are required for the closest lots, with various less restrictive requirements applying for the remaining lots.

Groundborne vibration levels from the rail passbys were measured and found to be below the applicable guideline limits at the 30 metre railway buffer setback shown in the concept plan, and no mitigation is thus required in this regard.

2 DESCRIPTION OF THE SITE & SIGNIFICANT NOISE SOURCES

The site is located on the northeast corner of Watson Road South and the Guelph Junction Railway in Guelph, Ontario. On the south side, the site abuts the railway, and on the west side, abuts the roadway. The surrounding lands are agricultural in nature. The tracks are elevated by a few metres above the site.

The proposed development will consist of single family homes, as shown in the attached concept plan (Appendix A) and Figure 2. The plan suggests that the homes closest to the railway right-of-way could be about 40 metres from the tracks, and about 30 metres from the right-of-way.

3 CRITERIA

3.1 Rail Traffic Noise Criteria

Guidelines for acceptable levels of rail traffic noise impacting residential developments are given in the MOE publication LU-131 "Noise Assessment Criteria in Land Use Planning", its Annex and its accompanying document "Requirements, Procedures and Implementation, 1999". The levels are listed in Table I below.

Table I: MOE Rail Traffic Noise Criteria (dBA)

Area	Daytime L_{EQ} (16 hour) Rail	Nighttime L_{EQ}(8 hour) Rail
Outside Bedroom Windows	55 dBA	50 dBA
Outdoor Living Area	55 dBA	--
Living/Dining Room	40 dBA	--
Bedroom	--	35 dBA

Daytime refers to the period between 07:00 and 23:00, while nighttime refers to the period between 23:00 and 07:00. The term "Outdoor Living Area" (OLA) is used in reference to an outdoor patio, a backyard, a terrace or other area where passive recreation is expected to occur. Balconies that are less than 4 m in depth are not considered to be outdoor living areas under MOE guidelines.

Indoor guidelines are 5 dBA more stringent for rail noise than for road noise, to account for the low frequency (rumbling) character of locomotive sound, and its greater potential to transmit through exterior wall/window assemblies.

The guidelines in the MOE publication allow the sound level in an Outdoor Living Area to be exceeded by up to 5 dBA, without mitigation, if warning clauses are placed in the purchase and rental agreements to the property. Where OLA sound levels exceed 60 dBA (road and rail noise combined), physical mitigation is required to reduce the OLA sound level to below 60 dBA and as close to 55 dBA as technically, economically and administratively feasible.

Forced air ventilation systems with ductwork sized for the future installation of central air conditioning is required where nighttime sound levels at bedroom windows exceed 50 dBA so that bedroom windows can remain closed. Central air conditioning is a requirement under MOE guidelines where nighttime sound levels outside bedroom windows exceed 60 dBA. The specification of sound attenuating building constructions is required when nighttime sound levels exceed 55 dBA at the plane of the bedroom window.
Warning clauses are required to notify future residents of possible excesses are also required when nighttime sound levels exceed 50 dBA at the plane of the bedroom window and daytime sound levels exceed 55 dBA in the outdoor living area and at the plane of the living room window due to road and rail traffic.

MOE guidelines recommend brick exterior walls from foundation to rafters as a minimum construction for any dwellings with a 24 hour L_{EQ} that is greater than 60 dBA, and which are within 100 m of the right of way of the railway.

The railways also provide minimum requirements for safety as well as sound and vibration for proposed residential developments located adjacent to their rights-of-way. These refer to minimum required setbacks, berms, fencing and warning clauses, and the Guelph Junction Railway should be consulted for any particular requirements.

3.2 Groundborne Vibration due to Rail Traffic

MOE guidelines require measurements of ground-borne vibration when dwelling units are to be located within 75 metres of a rail line.

Vibration is typically measured in terms of oscillatory velocity or acceleration. Commonly, logarithmic units of decibels referenced to a standard vibration level, such as 1 mm/s, are used. The MOE maintains a vibration limit of 0.14 mm/s (-17 dB re 1 mm/s). Typical railway limits for acceptable ground-borne vibration are frequency dependent and are presented as a curve of maximum allowable vibratory acceleration versus frequency. Figure 3 shows the criterion curve.

4 NOISE & VIBRATION ASSESSMENT

4.1 Rail Traffic Noise Assessment

Rail traffic data for typical operations on the Guelph Junction Railway were obtained from staff at the Guelph Junction Railway Company, and is provided in Appendix B. At present, a maximum of eight passbys occur during a 24 hour day. The trains pass by the site slowly, with a maximum permissible train speed in the area of 40 kph (25 mph). In conformance with typical railway assessment requirements, the maximum speeds and maximum number of cars per train were used in the traffic noise analysis to yield a worst case estimate of train noise. The data was projected to the year 2016 using a 2.5% per year growth rate, and this future volume data is summarized in Table II.

Table II: Rail Traffic Data Projected to Year 2016

Type of Train	Number of Trains Day/Night	Number of locomotives	Number of cars	Max Speed (kph)
Freight	6 / 4	2	100	40

To assess the levels of rail traffic noise which will impact the site in the future, predictions were made using STAMSON version 5.04, a computer algorithm developed by the MOE. Sample STAMSON output is included in Appendix C. At present, trains whistle at the Watson Road

crossing, and the train whistle noise was considered in the predictions for indoor sound levels, but not for outdoor living area predictions as per MOE guidelines. As we understand that there is a possibility that signals or crossing barriers will be installed at the Watson Road crossing in the near future, and that a bylaw restricting whistles in the area may be passed, consideration has also been given in this report to indoor sound levels without whistle noise.

Predictions of the traffic sound levels were made at representative lots, as shown in Figure 2. The results of these predictions are summarized in Tables III and IV.

Future daytime sound levels were predicted in outdoor living areas at 1.5 metres above ground level to determine whether noise barriers will be necessary. Sound levels were also predicted in the plane of the second floor bedroom windows during nighttime hours to investigate ventilation requirements.

Table III: Future Daytime OLA Sound Levels, Rail Traffic, Without Mitigation [dBA, $L_{EQ(16)}$]

Location	Description	Rail
A	Lot 17	59
B	Lot 20 and Lot 24	52
C	Lot 22	49
D	Lot 7	42

Table IV: Future Nighttime Sound Levels at the Facade, Rail Traffic, Without Mitigation [dBA, $L_{EQ(8)}$]*

Location	Description	Rail
A	Lot 17	65
B	Lot 20 and 24	59
C	Lot 22	56
D	Lot 7	49

Note: * Includes consideration of whistle noise at Watson Road South

Calculations indicate that if in future the trains will not whistle, nighttime sound levels at the facades will be 5 to 6 dBA lower.

4.2 Groundborne Vibration

Vibration was measured on May 17, 2006. Actual rail usage was light at the time, and only a single passbys was measured. Vibration was measured at the 30 metre railway buffer setback shown on the concept plant (a location about 40 metres from the tracks), and at a location 10 metres further back (about 50 metres from the tracks).

The results of the measurement at the 30 metre railway buffer is summarized in Figure 4, together with the relevant vibration criteria. The further measurement is summarized in Figure 5. As shown in the figures, ground-borne vibration was below the relevant limits at the measurement location on the day of the measurements. The measurements indicate that groundborne vibration is not a concern with respect to the MOE and typical railway vibration criteria, and vibration is not considered further in this report.

5 DISCUSSION

The predicted sound levels at the many of the lots in the interior of the subdivision are within the MOE guidelines. However, with no mitigation, there are sound level excesses at the lots most exposed to the railway.

5.1 Outdoor Living Areas and Sound Barriers

Without mitigation, the predicted daytime sound levels in the OLA's exposed to a large degree to the railway line exceed the 55 dBA guideline by up to 4 dBA due to rail traffic, and this excess can be addressed through the use of warning clauses. Physical mitigation in the form of berms or barriers is not required under MOE guidelines.

5.2 Indoor Living Areas and Ventilation Requirements

Air Conditioning

The predicted nighttime sound levels outside the second storey bedroom windows of the future dwellings closest to the railway line are greater than 60 dBA. To address these excesses, the MOE guidelines require that affected dwellings be equipped with central air conditioning systems, so that the windows can be closed. Affected lots are shown with double cross-hatching in Figure 2, and include lots 16 through 20 and 24 and 25. Window or through-the-wall air conditioning units are not recommended because of the noise they produce and because the units penetrate through the exterior wall which degrades the overall sound insulating properties of the envelope. The location, installation and sound ratings of the outdoor air conditioning devices should minimize noise impacts and comply with criteria of MOE publication NPC-216, Residential Air Conditioning Devices.

Provision for the Future Installation of Air Conditioning

For most of the remaining lots, lots 8 through 15, 21 through 23, and 26 through 36, the predicted nighttime sound levels are in the range of 51 to 60 dBA. These dwellings will require forced air ventilation systems with ducts sized to accommodate the future installation of central air conditioning by the occupant. Lots subject to this recommendation are shown with single cross-hatching in Figure 2. The future location, installation and sound ratings of the outdoor air conditioning devices should minimize noise impacts and comply with criteria of MOE publication NPC-216, Residential Air Conditioning Devices.

Lots 1 through 7 do not require any particular ventilation system to address rail traffic noise.

5.3 Building Facade Constructions

Future rail traffic sound levels adjacent to the railway right of way will exceed 55 dBA at night. MOE guidelines recommend that the windows, walls and doors of affected units be designed so that the indoor sound levels comply with MOE noise criteria.

The building plans were not yet available for review by HGC Engineering at the time of this report, but preliminary calculations have been performed to determine the building envelope constructions likely to be required to maintain indoor sound levels to MOE guideline limits. The calculation methods were developed by the National Research Council (NRC). They are based on the predicted future sound levels at the building facades, and the anticipated area ratios of the facade components (walls, windows and doors) and the floor area of the adjacent room.

Exterior Wall Construction

MOE guidelines recommend brick exterior walls from foundation to rafters as a minimum construction for any dwellings with a 24 hour L_{EQ} that is greater than 60 dBA which are within 100 m of the right of way of the railway. This applies to the lots shown with double hatching in Figure 2, lots 16 through 20 and 24 and 25.

Glazing Construction

The minimum necessary specification for the building envelope is Acoustical Insulation Factor AIF-32 for lots requiring brick (lots 16 through 20 and 24 and 25), based on the assumption that significant acoustic energy will enter the buildings through the windows only. As a general guideline, a glazing construction with two panes of 6 mm glass and a 13 mm airspace will be sufficient for the dwelling units along the rail line as long as the window to floor area ratio does not exceed 25%. If patio doors are to be used in the dwellings, they must be included in the window area. If larger glazing areas than those currently assumed are anticipated, an acoustical consultant should be contacted to develop revised glazing constructions.

For other units with nighttime sound levels outside bedroom window in excess of 55 dBA, wall and window constructions meeting AIF-29 are appropriate. Details can be refined at the site plan approval stage, when floor plans and elevations are available, building constructions such as windows, walls and doors can be refined for those units which have nighttime sound levels greater than 55 dBA. Calculations indicate that this requirement applies to lots 12 through 15, 22, 23, and 26.

For the remaining units, i.e., those largely shielded from the rail line (lots 1 through 11, 21, 27, and 37), any double glazed window construction meeting the minimum requirements of the Ontario Building Code (OBC) will provide adequate sound insulation for the dwelling units.

Entrance doors should not enter into bedroom or living rooms, but into entrance lobbies/hallways or foyers. If patio or balcony doors are to be used in the dwellings units, they must be counted as part of the total window area. For any ancillary spaces (other than bedrooms, living and dining rooms), any window meeting the minimum requirements of the OBC will be sufficient.

5.4 Warning Clauses

The MOE guidelines recommend that warning clauses be included in the property and tenancy agreements and offers of purchase and sale for all lots or blocks with anticipated traffic sound level excesses. The actual wording of the warning clauses will depend on the nature of the excess. The following warning clauses may be needed individually or in combination. Examples are provided below.

A general warning clause for lots significantly affected by noise from the rail line is provided below:

Type A:

> Purchasers/tenants are advised that despite the inclusion of noise control features in the development and within the building units, sound levels due to increasing rail traffic may occasionally interfere with some activities of the dwelling occupants as the sound levels exceed the noise criteria of the Municipality and the Ministry of the Environment.

Suitable wording for future dwellings requiring forced air ventilation systems is given below:

Type B:

> This dwelling unit has been fitted with a forced air heating system and the ducting etc., was sized to accommodate central air conditioning. Installation of central air conditioning will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the noise criteria of the Municipality and the Ministry of the Environment. (Note: The location and

installation of the outdoor air conditioning device should be done so as to minimize the noise impacts and comply with criteria of MOE publication NPC-216, Residential Air Conditioning Devices.)

Suitable wording for future dwellings requiring central air conditioning systems is given below:

Type C:

This dwelling unit has been supplied with a central air conditioning system which will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the noise criteria of the Municipality and the Ministry of the Environment.

The railway may require a specific warning clause as this development is located near a principal mainline, and should be consulted in this regard. For reference, a typical clause follows:

Type D:

Warning: Purchasers or tenants are to be advised that the Guelph Junction Railway or its successors or assigns, have an operating right-of-way within 300 metres from the land subject hereof and there may be alterations to the right-of-way including the possibility that the Railway may expand its operations, which expansion may affect the living environment of the residents notwithstanding the inclusion of any noise and vibration attenuating measures in the design of the subdivision and individual units, and that the Railway will not be responsible for complaints or claims arising from use of its facilities and/or operations.

These sample clauses are provided by the MOE as examples and can be modified by the Municipality as required.

6 SUMMARY OF RECOMMENDATIONS

The following list and Table V summarizes the recommendations made in this report. Please refer to Figure 2 for more information regarding the locations to which these recommendations apply.

1) Inclusion of a central air conditioning system as an alternative means of ventilation for the identified units near the rail line is required.

2) Forced air ventilation systems with the future provision of central air conditioning systems by the occupant for most of the remaining units are required.

3) Masonry exterior wall construction is required for the dwellings closest to the rail line.

4) The use of warning clauses in the property and tenancy agreements and offers of purchase and sale for the specified lots is required

5) Upgraded wall and window constructions for many of the dwelling units should be provided.

The reader is referred to the above sections of the report where these recommendations are discussed in more detail.

Table V: Summary of Noise Control Requirements and Warning Clauses

Lots	Description	Acoustic Barrier	Ventilation Requirements	Type of Warning Clause	Acoustical Insulation Factor[3]	Brick Exterior Façade
16 – 20, 24, 25	Lots with significant OLA and façade exposure to the rail line	**No**[1]	Air conditioning[2]	A, C, D	32[5]	**Yes**[4]
12 – 15, 22, 23, 26	Lots with significant façade exposure to the rail line	**No**[1]	Forced air	A, B, D	29[6]	**No**
8 – 11, 21, 27 - 37	Lot with reduced exposure	**No**[1]	Forced air	A, B, D	OBC[7]	**No**
1 - 7	Other lots	**No**[1]	No specific requirement	D	OBC[7]	**No**

Table VIb: Summary of Noise Control Requirements and Warning Clauses – Assuming Train Whistling will be Discontinued

Lots	Description	Acoustic Barrier	Ventilation Requirements	Type of Warning Clause	Acoustical Insulation Factor[3]	Brick Exterior Façade
16 – 20, 24, 25	Lots with significant OLA and façade exposure to the rail line	**No**[1]	Air conditioning[2]	A, C, D	26	**Yes**[4]
12 – 15, 22, 23, 26	Lots with significant façade exposure to the rail line	**No**[1]	Forced air	A, B, D	OBC[5]	**No**
8 – 11, 21, 27 - 37	Lot with reduced exposure	**No**[1]	Forced air	A, B, D	OBC[5]	**No**
1 - 7	Other lots	**No**[1]	No specific requirement	D	OBC[5]	**No**

Notes on the Tables

1. No specific acoustic requirement under MOE guidelines.
2. The location, installation and sound rating of the air conditioning condensers must be compliant with MOE Guideline NPC-216.
3. Windows, walls and doors to be specified to meet these minimum AIF requirements.
4. Brick exterior façade construction will be required from foundation to rafters for the units or lots in the first row and within 100 m of the railway right of way.
5. OBC – meets the minimum requirements of the Ontario Building Code

7 IMPLEMENTATION

To ensure that the noise control recommendations outlined above are fully implemented, it is recommended that:

1) Prior to the issuance of building permits for this development, a Professional Engineer qualified to perform acoustical services in the province of Ontario or the municipal building department shall review the builder's plans to certify that the sound control measures as approved have been incorporated, and

2) Prior to the issuance of occupancy permits for this development, a Professional Engineer qualified to perform acoustical services in the province of Ontario or the municipal building department shall certify that the sound control measures have been properly installed and constructed.

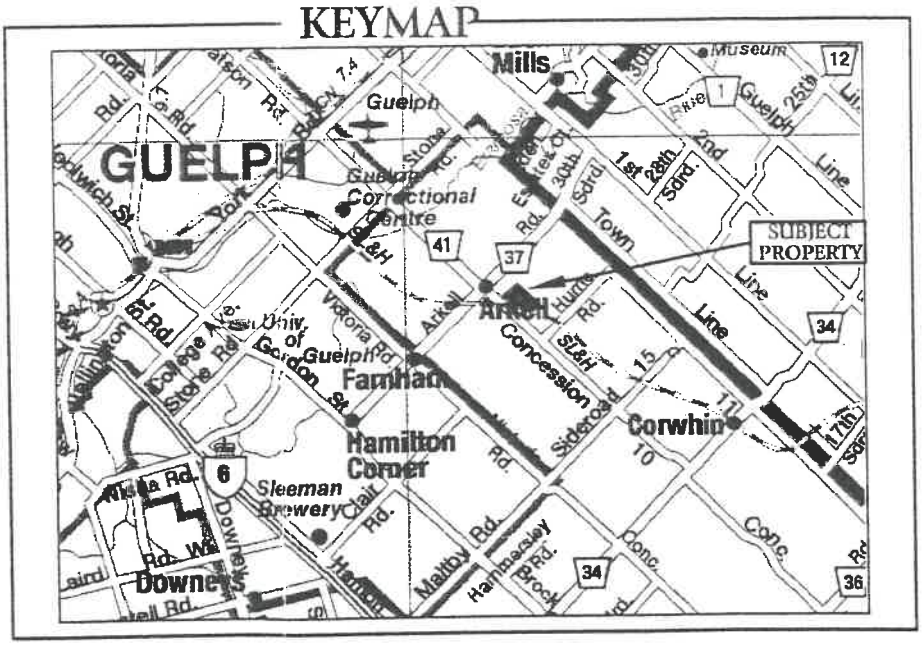


Figure 1: Key Plan

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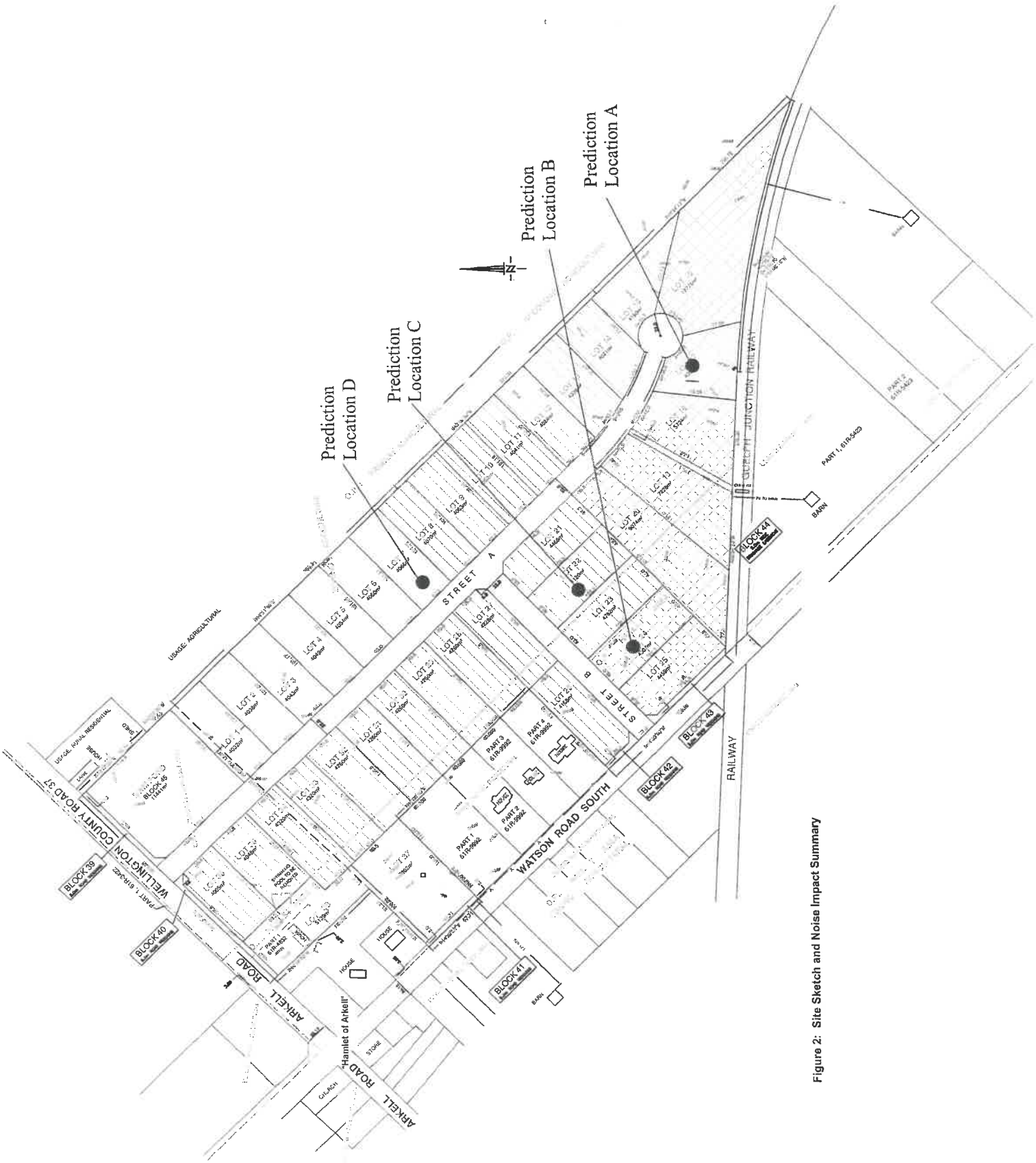


Figure 2: Site Sketch and Noise Impact Summary

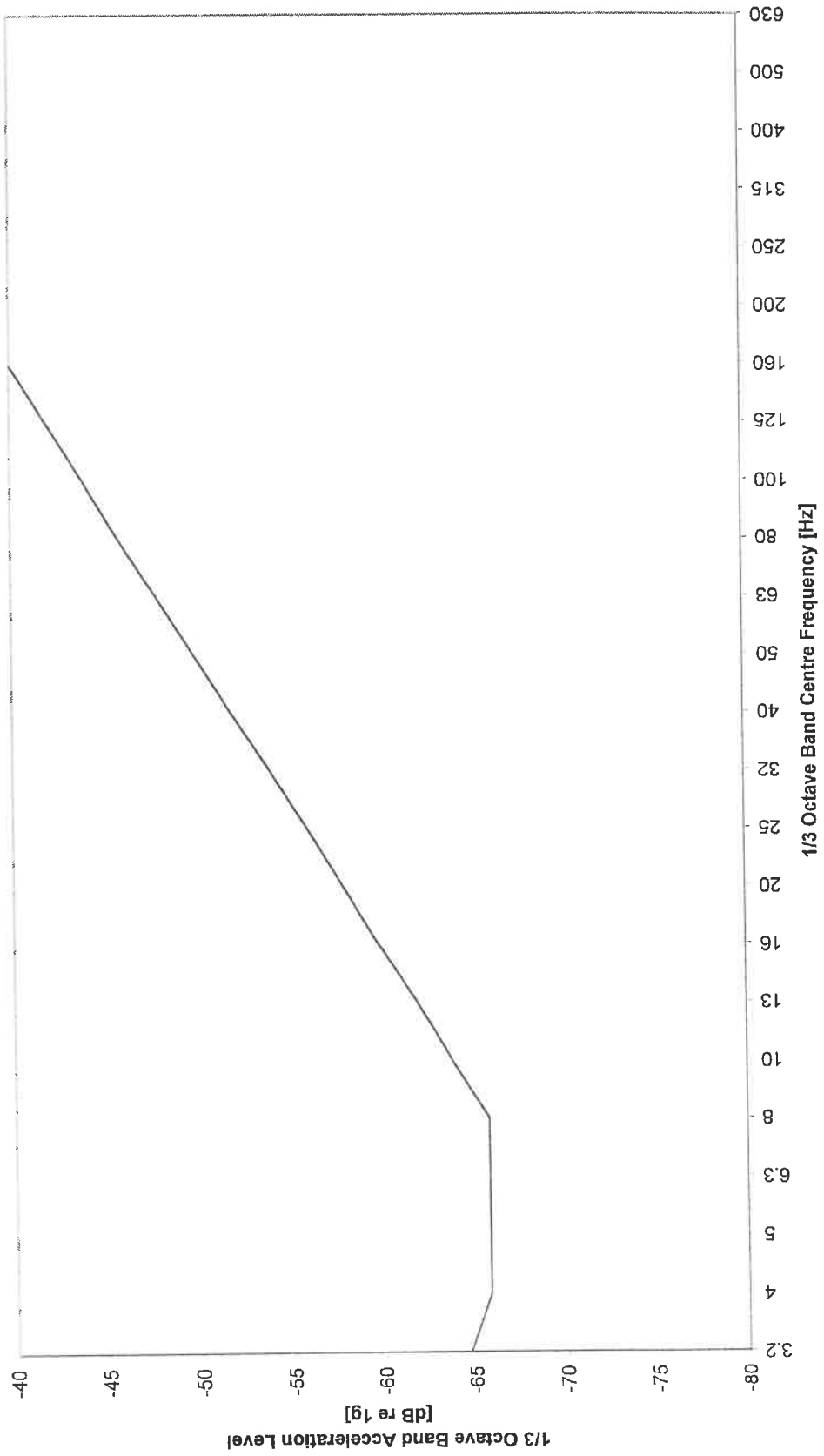


Figure 3: Vibration Criterion Curve

Figure 4a: Eastbound Freight Train, Passby 1 @ 30m
Van Haarten, May 17, 2006 @ 14:50
Measured Vibratory Velocity Level

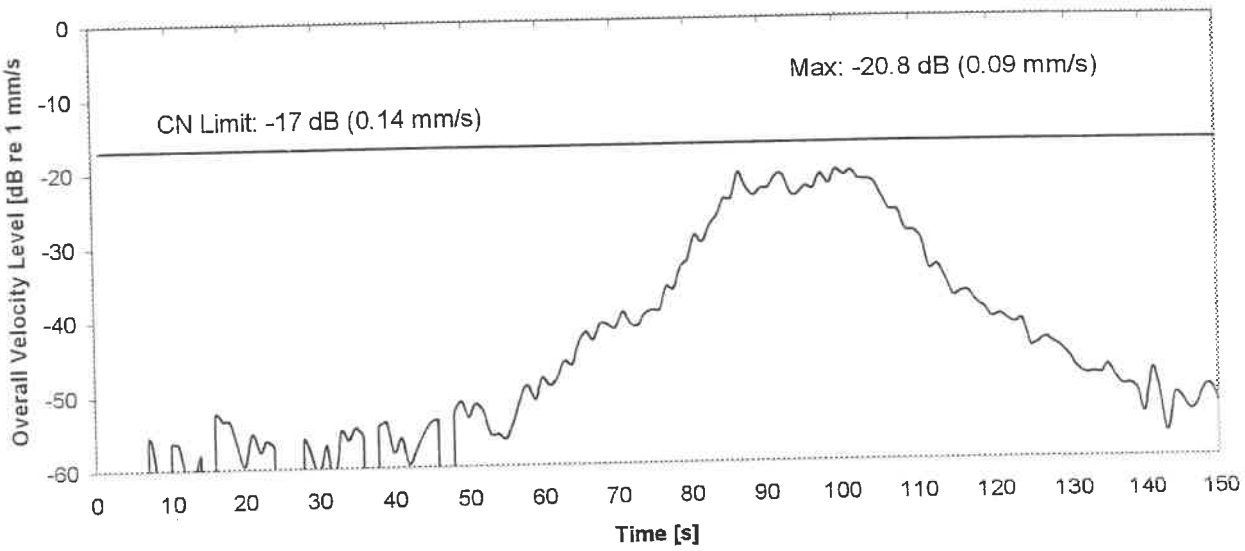
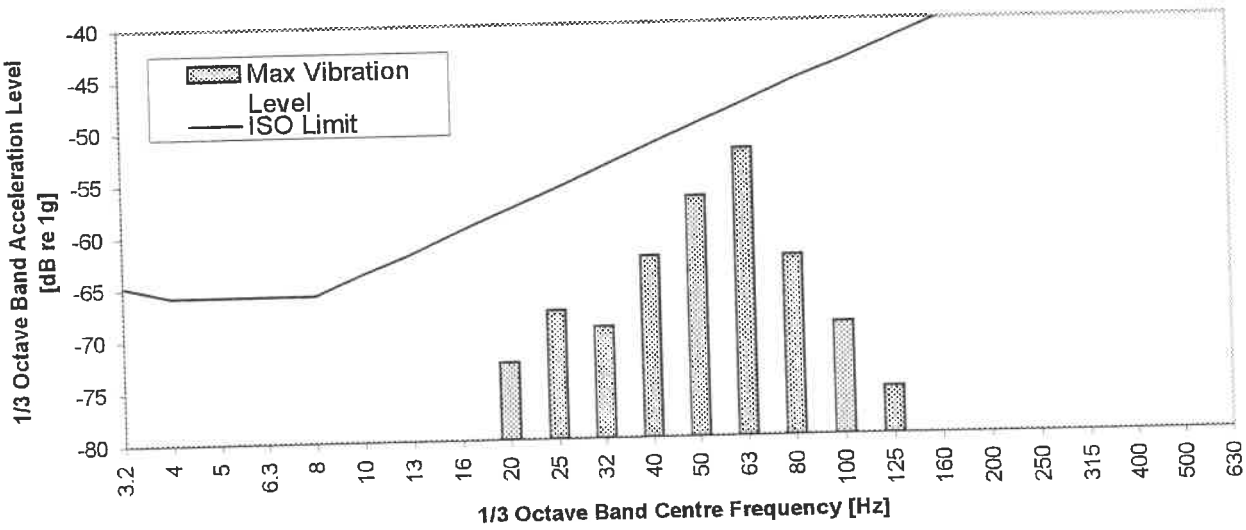


Figure 4b: Eastbound Freight Train, Passby 1 @ 30m
Acceleration Spectrum @ Peak Level (1 sec. Duration)



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Figure 5a: Eastbound Freight Train, Passby 1 @ 40m
VanHaarten, May 17, 2006 @ 14:50
Measured Vibratory Velocity Level

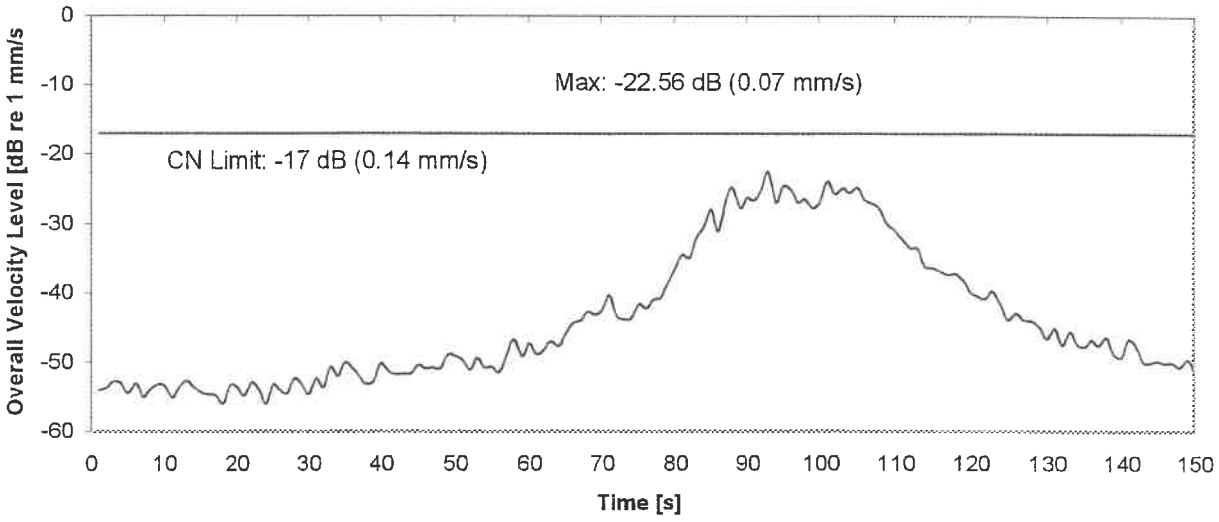
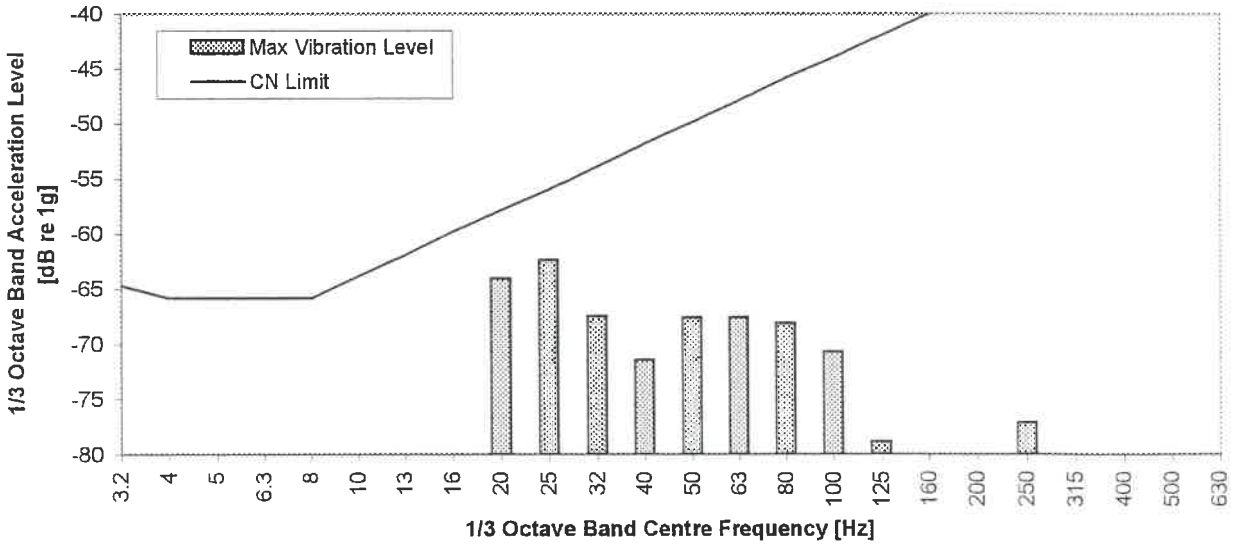
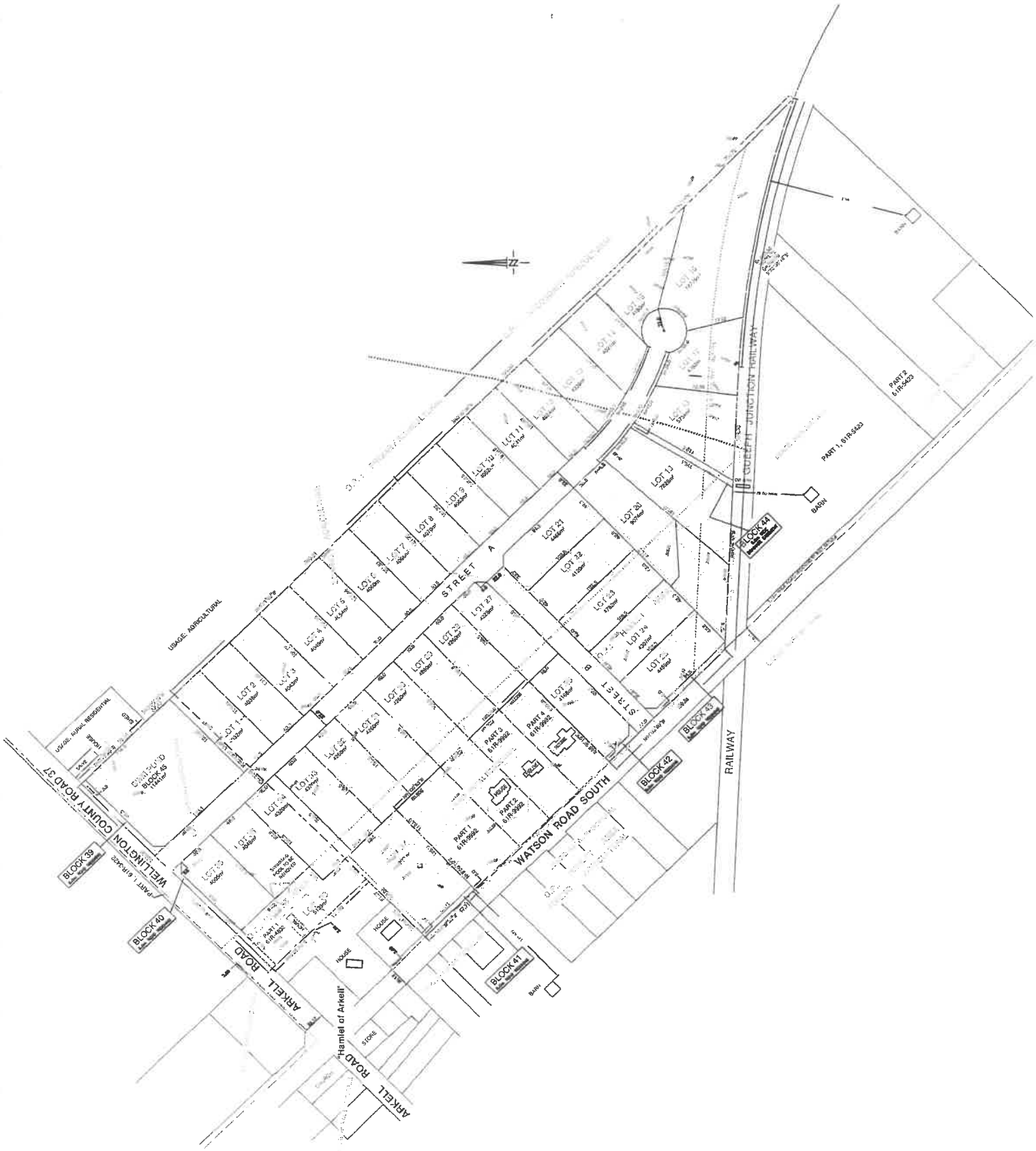


Figure 5b: Eastbound Freight Train, Passby 1 @ 40m
Acceleration Spectrum @ Peak Level (1 sec. Duration)



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Appendix A: Development Concept Plan



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Appendix B: Rail Volume Data

GUELPH
Junction Railway Company

RECEIVED
DATE: APR 0 1 2005
HGC ENGINEERING

March 29, 2005

H.C.G. Engineering
2000 Argentia Road Plaza
Suite 203
Mississauga, ON L5N 1P7

Attention: Kana A. Ganesh

Dear Sir:

Subject: Rail Traffic Data – Noise Study Watson Rd./Arkell Rd. area

Further to your correspondence of March 24th/05, please use the following rail traffic data in your noise study:

a) maximum of eight freight trains daily over 24 hours. No schedule – demand operation only.
b) maximum train size of 100 rail cars at a speed of 25 mph. four locomotives will be used.
c) jointed rail construction.
d) Watson Rd. crossing does not have a grade crossing warning system; consequently, locomotive bells and whistles are used.

I trust this information will allow you to complete your study but should you require any further information, please contact me at your convenience.

Yours truly,

[redacted]

Tom Sagaskie
General Manager

*TS*cp*

Guelph Junction Railway Company
c/o City Hall, 59 Carden Street
Guelph, Ontario, Canada N1H 3A1
Located at: Suite 301, 98 Macdonell Street
Tel: (519) 836-4848 Fax: (519) 837-5636

Appendix C: Sample STAMSON data

STAMSON 5.0 SUMMARY REPORT Date: 07-07-2006 07:53:23
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: lot17.te Time Period: Day/Night 16/8 hours
Description: **WHISTLE NOISE EXLUDED. USE DAYTIME NUMBERS ONLY**

Rail data, segment # 1: (day/night)

Train Type	Trains	Speed (km/h)	# loc /Train	# Cars /Train	Eng type	Cont weld
* 1.	6.4/3.8	40.0	4.0	100.0	Diesel	No

* The identified number of trains have been adjusted for future growth using the following parameters:

No	Train type: Name	Unadj. Trains	Annual % Increase	Years of Growth
1.		5.0/3.0	2.50	10.00

Data for Segment # 1: (day/night)

Angle1 Angle2	: -90.00 deg	90.00 deg
Wood depth	: 0	(No woods.)
No of house rows	: 0 / 0	
Surface	: 1	(Absorptive ground surface)
Receiver source distance	: 35.00 / 40.00	m
Receiver height	: 1.50 / 4.50	m
Topography	: 2	(Flat/gentle slope; with barrier)
No Whistle		
Barrier angle1	: -90.00 deg	Angle2 : 90.00 deg
Barrier height	: 4.00	m
Barrier receiver distance	: 20.00 / 20.00	m
Source elevation	: 350.50	m
Receiver elevation	: 348.50	m
Barrier elevation	: 348.50	m
Reference angle	: 0.00	

Result summary (day)

	Loc Leq (dBA)	Wheel Leq (dBA)	Whistle Left Leq (dBA)	Whistle Right Leq (dBA)	Total Leq (dBA)
1.	58.26	45.76	--	--	58.50 *
Total					58.50

dBA

```
* Bright Zone  !
```

Result summary (night)

	Loc Leq (dBA)	Wheel Leq (dBA)	Whistle Left Leq (dBA)	Whistle Right Leq (dBA)	Total Leq (dBA)
1.	58.63	49.90	--	--	59.18 *
Total dBA					59.18

* Bright Zone !

TOTAL Leq FROM ALL SOURCES (DAY): 58.50
(NIGHT): 59.18

STAMSON 5.0 SUMMARY REPORT Date: 07-07-2006 07:50:30
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: lot17.te Time Period: Day/Night 16/8 hours
Description: **WHISTLE NOISE INLCUDED. USE NIGHTTIME NUMBERS ONLY**

Rail data, segment # 1: (day/night)

Train Type	Trains (Left)	Trains (Right)	Speed (km/h)	# loc /Train	# Cars /Train	Eng type	Cont weld
1.	3.2/1.9	3.2/1.9	40.0	4.0	100.0	Diesel	No

Data for Segment # 1: (day/night)

Angle1 Angle2	: -90.00 deg	90.00 deg
Wood depth	: 0	(No woods.)
No of house rows	: 0 / 0	
Surface	: 1	(Absorptive ground surface)
Receiver source distance	: 40.00 / 40.00	m
Receiver height	: 1.50 / 4.50	m
Topography	: 2	(Flat/gentle slope; with barrier)
Whistle Angle	: -80 deg	Track 1
Barrier angle1	: -90.00 deg	Angle2 : 90.00 deg
Barrier height	: 4.00 m	
Barrier receiver distance	: 20.00 / 20.00	m
Source elevation	: 350.50 m	
Receiver elevation	: 348.50 m	
Barrier elevation	: 348.50 m	
Reference angle	: 0.00	

Result summary (day)

	Loc Leq (dBA)	Wheel Leq (dBA)	Whistle Left Leq (dBA)	Whistle Right Leq (dBA)	Total Leq (dBA)
1.	53.72	45.11	42.19	58.68	60.10 *
Total					60.10 dBA

* Bright Zone !

Result summary (night)

	Loc Leq (dBA)	Wheel Leq (dBA)	Whistle Left Leq (dBA)	Whistle Right Leq (dBA)	Total Leq (dBA)
1.	58.63	49.90	45.92	63.68	65.05 *
Total					65.05

dBA

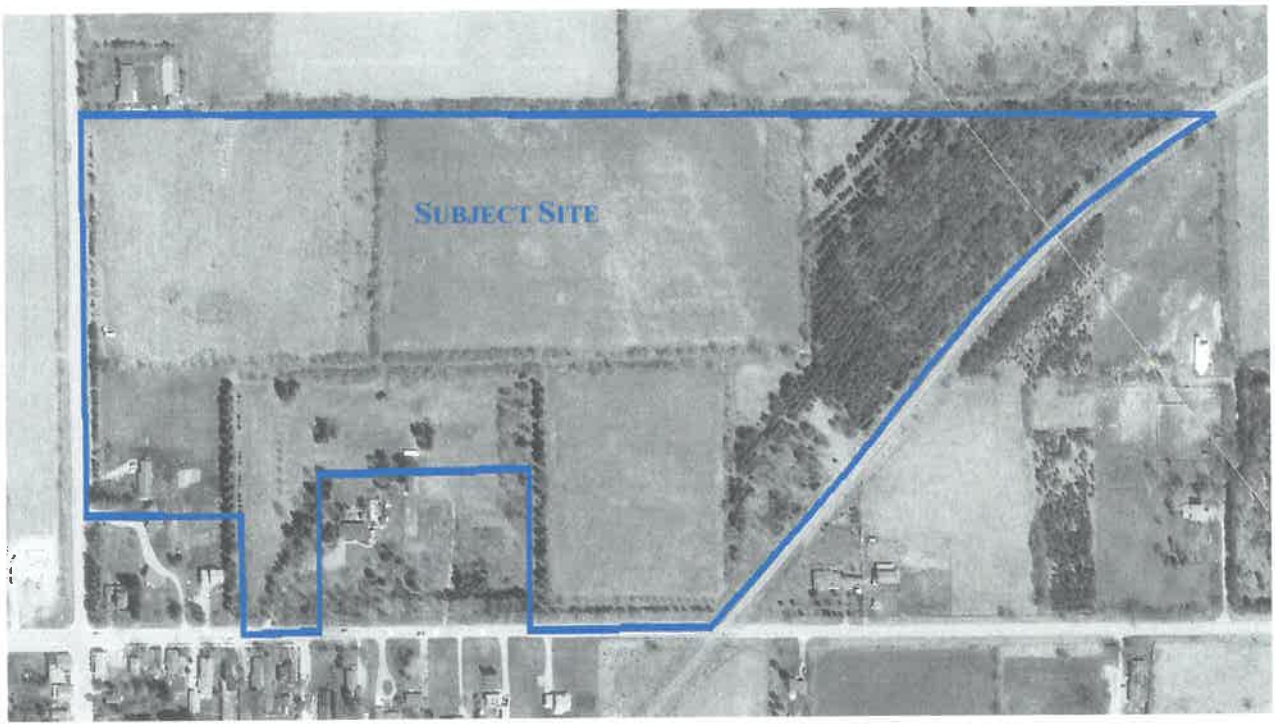
* Bright Zone

TOTAL Leq FROM ALL SOURCES (DAY): 60.10
(NIGHT): 65.05

P10/06

PRELIMINARY STORMWATER MANAGEMENT REPORT

KUKOVICA DEVELOPMENT
PART LOTS 7. 8 & 9, CONCESSION 10
TOWNSHIP OF PUSLINCH, WELLINGTON COUNTY



PREPARED FOR:
TOM KUKOVICA

OUR FILE NO: 1307
AUGUST 2006

PREPARED BY:

RICHARDSON FOSTER LTD.
CONSULTING ENGINEERS
PHONE: (705) 728-0009 TOLL FREE (1-877) 220-2461 FAX: (705) 727-7774
4 CEDAR POINTE DRIVE, UNIT L BARRIE, ONTARIO L4N 5R7

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1.0 INTRODUCTION

1.1 APPOINTMENT

Richardson Foster Ltd. has been retained by Tom Kukovica to provide engineering services for the development of a proposed 38 lot, low density, rural estate residential subdivision located in the Township of Puslinch. This Preliminary Stormwater Management Report is included within the scope of the appointment, as detailed in Section 1.2.

This report is prepared in support of the Draft Plan prepared by Van Harten Surveying in May 2006.

1.2 SCOPE OF WORK

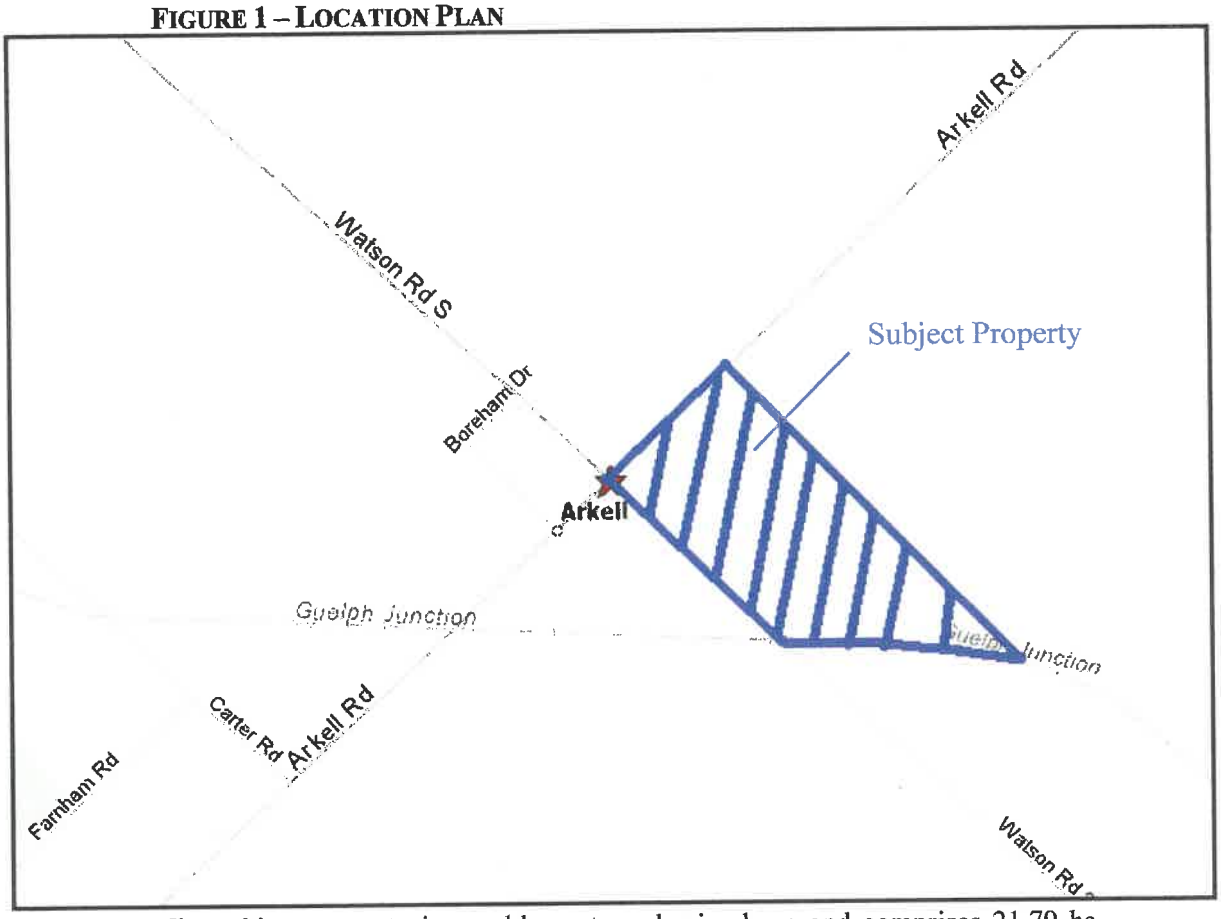
The Preliminary Stormwater Management Report was completed to address the stormwater management requirements for the proposed 38 lot, low density, rural estate residential subdivision. Included in this report is the preliminary design of a hybrid dry/infiltration stormwater management pond, which has been designed to satisfy the quantity and quality control requirements as well as the infiltration requirements.

This Preliminary Stormwater Management Report is submitted for approval of the stormwater management concept plan for the proposed rural estate residential subdivision.

1.3 SITE DESCRIPTION

The subject property is bounded to the north by Arkell Road (County Road 37) to the west by Watson Road (County Road 41) and existing residential lands, to the south by the Guelph Junction railway line and to the east by open undeveloped lands. Refer to Figure 1 for a location plan of the subject property.

FIGURE 1 – LOCATION PLAN



The subject property is roughly rectangular in shape and comprises 21.79 ha. The legal description of the property is Part Lots 7, 8, & 9, Concession 10, Township of Puslinch, Wellington County.

The topography of the land ranges from 352.7 m in the south east corner of the property to 339.0 m in the in the north corner. The pre-development land use consists entirely of pasture or unimproved land. The existing grades for the site are generally flat with an average grade of 1.7 %. All of the drainage for the site flows to the northern limit of the site where runoff flows through an existing 450mm diameter culvert that passes under Arkell Road.

The topographical information is derived from a topographic survey completed by Van Harten Surveying Inc.

1.4 APPROVING AGENCIES

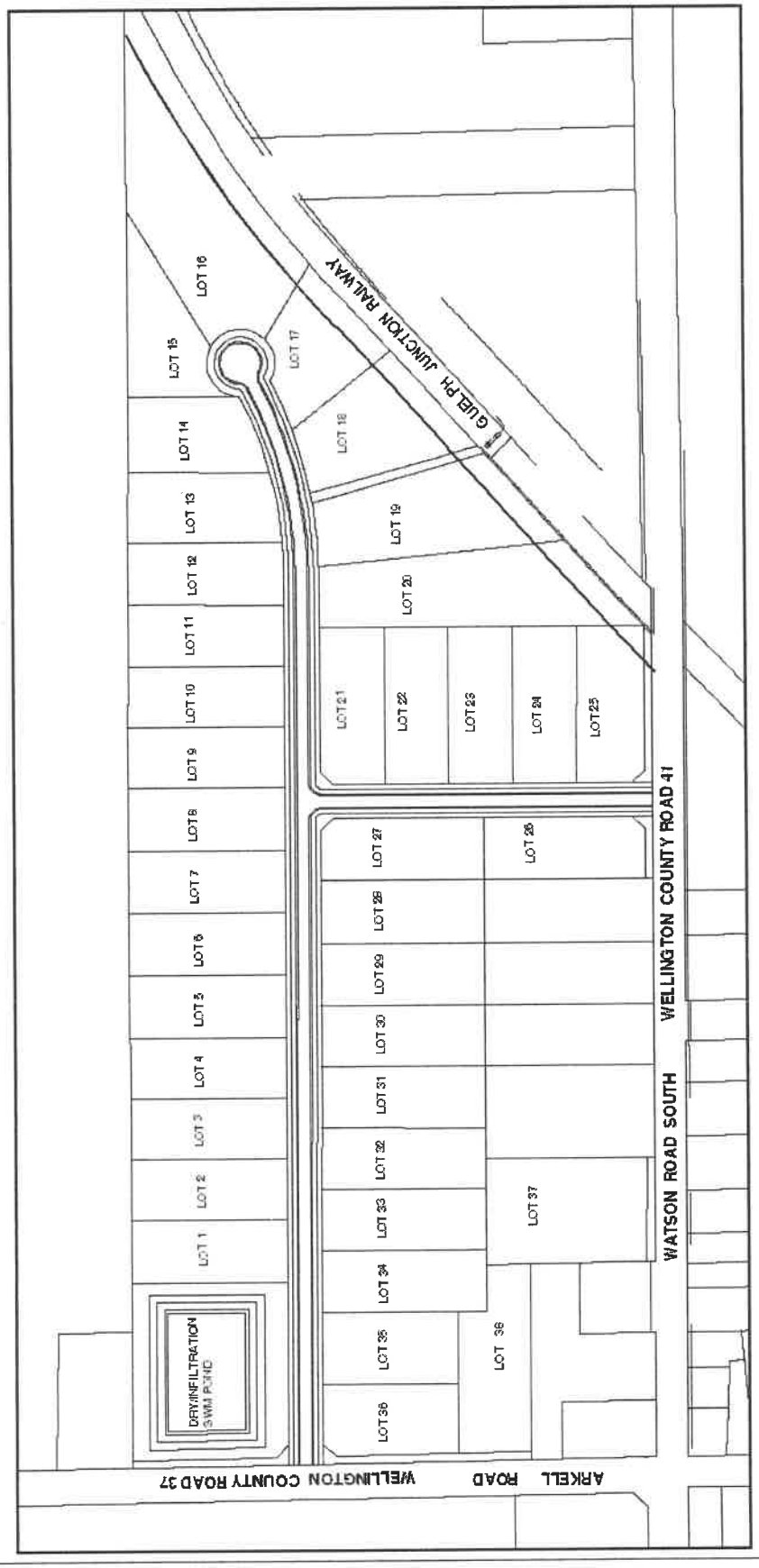
The subject property must conform to the policies and requirements of the Township of Puslinch and the Grand River Conservation Authority (GRCA). A submission will be made to the Ministry of Environment with respect to drainage and stormwater management at the detailed design phase.

2.0 DESIGN CRITERIA

2.1 BACKGROUND INFORMATION

This stormwater management report has been based on the proposed Draft Plan completed by Van Harten Surveying Inc. Figure 2 illustrates the proposed roadway and lot layout of the subject property.

FIGURE 2 – DRAFT PLAN



2.2 EXPECTED REQUIREMENTS OF APPROVAL AUTHORITIES

TOWNSHIP OF PUSLINCH

The stormwater drainage recommendations must conform to the Township of Puslinch Municipal Servicing Standards dated May 1997.

GRAND RIVER CONSERVATION AUTHORITY (GRCA)

The stormwater management plan must conform to the policies and standards of the GRCA. It is anticipated that the GRCA will also require the stormwater management plan to adhere to the standards and policies of the MOE Stormwater Management Planning and Design Manual, March 2003. These policies include providing water quality control to an Enhanced (Level 1) level of protection and providing water quantity control for all storm events up to and including the 100-year storm.

3.0 SITE PHYSIOGRAPHY

3.1 EXTERNAL DRAINAGE AREAS

There are three external areas that drain onto the site. Two of these areas are located on the west side of the property and the third area is located south of the property. The two external areas to the west consist of existing residential lots as well as undeveloped residential lots, and have a total area of 3.02 ha. The third external area to the south consists primarily of existing residential lands that drain through the subject site. The third external catchment area (catchment 102), has an area of 37.00 ha. The third external catchment area flows to the north towards the Guelph Junction Railway and flows under the railway through an existing concrete box culvert. Although this culvert may cause a backwater affect during major storm events, the external area has been modelled as if it drains to the site with no flow constraint.

3.2 EXISTING DRAINAGE CONDITIONS

The existing drainage conditions are based on the natural contours and land uses of the site. The subject property is relatively flat (average slope of 1.7 %) and drains via overland sheetflow to the northern limit of the property, where runoff

flows through an existing 450mm diameter culvert under Arkell Road. The stormwater then travels north east via the existing roadside ditches. Catchment 101, which consists of the subject site and two of the external drainage areas, has a drainage area of 24.83 ha, of which 20.68 ha consists of pasture or unimproved land and 4.15 ha consists of treed area. Catchment 102 (the external drainage area to the south), has a drainage area of 37.00 ha, of which 27.70 ha consists of pasture or unimproved land and 9.30 ha of treed area. These areas are based on the detailed topographic survey, as well as ortho-photography and site reconnaissance provided by the GRCA. Drawing 1307-PSWM1 illustrates the pre-development drainage pattern.

3.3 PROPOSED DRAINAGE CONDITIONS

Based on the May 2006 Draft Plan, the site is to be developed into a 38 lot, low density, rural estate residential subdivision, with lot sizes ranging from 0.41 ha to 1.2 ha, plus roadways covering 2.65 ha (total ROW area). The draft plan also includes a stormwater management block with an area of 1.14 ha.

The post-development flows for the subject site will drain via a combination of roadside ditches and overland flow to a hybrid dry/infiltration stormwater management pond to be located in the north east corner of the site. The hybrid dry/infiltration pond will provide quantity control for all storm events up to and including the 100-year storm and will provide quality control to an Enhanced (Level 1) level. The hybrid dry/infiltration pond will consist of an infiltration area, which will provide the necessary quality control and infiltration volumes, whereas the dry pond area will provide the necessary quantity control. The infiltration area has been designed with sufficient volume to infiltrate the 5-year storm. The dry pond area has been designed to provide quantity control for all storm events up to and including the 100-year storm. It should also be noted that the dry pond has been designed assuming that the infiltration area does not provide any storage volume, therefore, in the event the infiltration area fails or the soils are saturated, the dry pond will still provide sufficient quantity control.

The proposed hybrid dry/infiltration pond will outlet to the existing roadside ditches along Arkell Road. Since the post-development flow rates are

attenuated to the pre-development levels, there should be no adverse affects to the roadside ditches and no improvements will be needed.

In addition, in order to increase the amount of infiltration (to ensure adequate groundwater recharge), runoff from the rooftop of each house will be directed to a rear-yard soakaway pit. The rooftop drainage area is referred to as catchment 205 in the OTTHYMO model.

For further details regarding the stormwater management plan, please refer to Section 5.0. Drawing 1307-PSWM2 illustrates the post development drainage pattern.

4.0 HYDROLOGY

4.1 MODEL

The subdivision was hydrologically modeled using the Visual OTTHYMO (Version 2.0) computer program. This study makes use of subroutines in OTTHYMO for both undeveloped areas (natural hydrographs) and developed areas (urban hydrographs). Given a rainfall event, OTTHYMO calculates peak runoff flows and rainwater volumes for a predefined catchment area. This OTTHYMO model makes use of the NASHYD routine for calculating hydrographs for rural and urban areas.

4.2 DESIGN STORMS

The following rainfall events have been modeled (refer to Appendix B for OTTHYMO output files):

- 24 hour SCS (Soil Conservation Service) Type II rainfall distributions for the 2, 5, 25 and 100-year storms based on the City of Guelph IDF curve data;
- 4 hour Chicago rainfall distributions for the 2, 5, 25 and 100-year storms based on the City of Guelph IDF curve data;
- 25mm 4 hour Chicago rainfall distribution; and

- Regional (Hurricane Hazel) storm distribution.

4.3 SOIL TYPE AND TOPOGRAPHY

Based on the information provided in *the Preliminary Geotechnical Investigation Proposed Residential Development*, prepared by V. A. Wood (Guelph) Incorporated, the hydraulic soil group for the soils on site are classified as Group A. Introduction to Hydrology by Viessman and Lewis define type A soils as:

> *"Soils having high infiltration rates even if thoroughly wetted and consisting chiefly of deep well to excessively drained sands or gravels. They have a high rate of water transmission."*

In the pre-development condition, the land use of the site consists of a mixture of treed areas and pasture/unimproved areas. According to the MTO Drainage Management Manual, Design Chart 1.09, under soil type A, these land uses have a Curve Number (CN) of 58 (pasture) and 50 (treed).

The MTO charts used to confirm the above are appended (refer to Appendix A).

4.4 DISCRETIZATION

The internal storm areas have been divided into discrete storm catchment areas for the purpose of hydrologic modeling of the pre-development and post-development conditions for the subject lands. The pre and post development catchment areas are illustrated on drawings 1307-PSWM1, and 1307-PSWM2.

The proposed subdivision is considered to be a low density, rural estate residential development with an average percentage of imperviousness of 14.2%. This impervious area includes all hardened surfaces, such as driveways, roads, walkways and rooftops. Table 1 illustrates the average total imperviousness percentage (TIMP) for the subject property.

TABLE 1 - ESTIMATED PERCENTAGE OF IMPERMEABLE SURFACE TIMP

Feature	Area
Total Rooftop, Houses, Garages (Impermeable)	622 m^2 x 38 units
	23,636 m^2
Roadways	(928.21 m x 7.5 m)+(Pi x (11)^2)
	7,342 m^2
Total Impervious Area	30,978 m^2
Total Area	217,900 m^2
% Impervious (TIMP)	0.142 or 14.2%

The post-development catchments are based on the designs for road patterns and grading that provide a drainage network to the stormwater management facility.

The time to peak, t_p, was estimated by using the Upland Method for calculating time of concentration, t_c. This method is given by the following equation:

$$t_c = l / v$$

Where:

- t_c is the time to concentration for the hydrograph (sec)
- l is the overland flow distance (m)
- v is the estimated overland flow velocity of the stormwater as determined with the aid of the SCS Slope/Velocity Relationships

The time to peak, t_p, required in the OTTHYMO model is estimated as two thirds (2/3) of the time to concentration. The time to peak should not be less than the interval time of the hyetograph for the design storm. The OTTHYMO printouts are appended (refer to Appendix B). The SCS Slope / Velocity chart used in estimating the overland flow velocity is appended (refer to Appendix A).

Tables 2 through 6 illustrate the pre and post-development model parameters:

TABLE 2 - SUMMARY OF PRE-DEVELOPMENT HYDROLOGIC MODEL INPUT

Catchment	Area (ha)	L (m)	S (%)	v (m/s)	CN	IA (mm)	t_p (hr)	DT (min)
101	24.8	1012	1.5	0.22	56.7	8.3	0.83	10.0
102(EX.)	37.0	1000	1.9	0.24	56.0	8.5	0.77	9.2
Total Area	61.8							

TABLE 3 - WEIGHTED CALCULATIONS FOR CN & IA

Catchment	Pasture Area (ha)	Treed Area (ha)	Weighted	
			CN	IA (mm)
101	20.68	4.15	56.7	8.3
102(EX.)	27.70	9.30	56.0	8.5

TABLE 4 - SUMMARY OF POST-DEVELOPMENT HYDROLOGIC MODEL INPUT (NASHYD)

Catchment	Area (ha)	L (m)	S (%)	v (m/s)	CN	IA (mm)	t_p (hr)	DT (min)
201	20.9	648	0.5	0.17	63.9	8.2	0.68	8.2
202(EX.)	1.0	81	2.6	0.50	69.7	7.3	0.03	2.0
203(EX.)	2.0	110	3.8	0.62	70.0	7.2	0.03	2.0
204(EX.)	37.0	1000	1.9	0.30	62.0	8.5	0.60	7.2
Total Area	60.9							

TABLE 5 - WEIGHTED CALCULATIONS FOR CN & IA

Catchment	Improved Area (ha)	Impervious Area (ha)	Treed Area (ha)	Weighted	
				CN	IA (mm)
201	16.03	0.73	4.15	63.9	8.2
202(EX.)	0.91	0.12	0.00	69.7	7.3
203(EX.)	1.74	0.25	0.00	70.0	7.2
204(EX.)	27.70	0.00	9.30	62.0	8.5

TABLE 6 - SUMMARY OF POST DEVELOPMENT HYDROLOGIC INPUT - ROOFTOP AREA (STANDHYD)

Catchment	Area (ha)	XIMP (%)	TIMP (%)	SLPP (%)	LGP (m)	SLPI (%)	LGI (m)	DT (min)
205 (rooftops)	0.9	99.0	99.0	-	-	10.0	10	2.0
Total Area	0.9							

4.5 *MODEL RESULTS*

The results of the hydrological modeling are quantified in Table 7.

TABLE 7 - MODEL RESULTS

Storm Peak Event Flow (m^3/s) – Site Total					
	Area (ha)	Storm Distribution			
Return Period (years)		**2**	**5**	**25**	**100**
Pre-Development Condition					
SCS Storm Distribution	61.8	0.44	0.65	1.13	1.68
Chicago Storm Distribution	61.8	0.24	0.55	1.24	2.06
25 mm Chicago Storm	61.8	0.08			
Timmins Storm	61.8	4.69			
Post Development Condition (without attenuation)					
SCS Storm Distribution	61.8	0.63	0.93	1.59	2.33
Chicago Storm Distribution	61.8	0.35	0.79	1.74	2.84
25 mm Chicago Storm	61.8	0.11			
Timmins Storm	61.8	5.33			
Post Development Condition (with attenuation)					
SCS Storm Distribution	61.8	0.06	0.20	0.65	1.23
Chicago Storm Distribution	61.8	0.00	0.08	0.76	1.59
25 mm Chicago Storm	61.8	0.00			
Timmins Storm	61.8	5.33			

Table 7 illustrates that all storm events in the post-development scenario, up to and including the 100-year storm, are attenuated at or below the pre-

development level. For further details on the stormwater management plan refer to Section 5.

5.0 STORMWATER MANAGEMENT PLAN

5.1 INTRODUCTION

The stormwater management plan is intended to provide an environmentally sound approach to stormwater issues. The issues can be divided into two categories: stormwater quality control and stormwater quantity control.

An end-of-pipe stormwater management facility has been proposed to address quality and quantity control for stormwater drainage of the subject site. A hybrid dry/infiltration stormwater management pond is proposed as the primary treatment facility.

The hybrid dry/infiltration stormwater management pond has been designed according to the guidelines of the MOE Stormwater Management Planning and Design Manual, March 2003.

5.2 QUALITY CONTROL – HYBRID DRY/INFILTRATION STORMWATER MANAGEMENT POND

All of the impervious areas from the site (Catchment 201), will be treated for quality control within the infiltration portion of the proposed hybrid dry/infiltration stormwater management pond, located in the north east corner of the site. Enhanced (Level 1) water quality control is required for all runoff entering the stormwater management facility.

The site area draining to the stormwater management facility has an average imperviousness of approximately 14.2%. Based on the MOE requirements (Table 3.2), 19.1 m^3/ha of storage is required for quality control.

The required quality control volume, as per the MOE guidelines, is calculated as follows:

Enhanced (Level 1) Water Quality Protection

Total area draining to pond from site for quality control = 21.79 ha
(14.2 % Net Impervious area), (19.1 m^3/ha)

21.79 ha x 19.1 m^3/ha =	416 m^3 (quality control volume)
Applying a void ratio of 0.40	1040 m^3 (quality control volume)
Provided Volume	5,293 m^3

The quality control volume will be accommodated within the infiltration area within the hybrid dry/infiltration pond. The hybrid dry/infiltration pond will consist of an infiltration area which will provide the necessary quality control and infiltration volumes (as described in Section 5.4 below) and the dry pond area will provide the necessary quantity control (as described in Section 5.3 below). The cross-section and configuration of the infiltration area of the hybrid dry/infiltration pond is discussed in further detail in Section 5.4.

5.2.1 Pre-Treatment of Stormwater Runoff

The MOE manual states that pre-treatment should be provided before stormwater enters an infiltration trench to reduce the amount of suspended sediments that could clog the trench (MOE Manual, 4-28). Pre-treatment will be provided by the grassed roadside ditches. To help enhance pre-treatment the culverts will be raised above the bottom of the ditch, allowing sediment to settle before entering the culvert.

5.3 *QUANTITY CONTROL– DRY/INFILTRATION STORMWATER MANAGEMENT POND*

The dry portion of the hybrid dry/infiltration stormwater management pond is proposed to provide quantity control for the proposed development. The dry pond area has been modeled assuming that the infiltration trench is completely saturated and does not provide any additional storage. This is a conservative approach as the infiltration area has been sized to infiltrate all of the runoff from

the 5-year storm event. This approach was used to illustrate that sufficient space has been allocated for the stormwater management facility. The bottom elevation of the dry pond has been set at 337.60 m, which allows for a sufficient discharge to the roadside ditches along Arkell Road. Sideslopes of 5H:1V have been provided for all sideslopes within the dry pond. The top of pond elevation is 339.90 m, which provides a total active storage volume of 13,687 m^3.

For the preliminary design the 2, 5, 25, and 100-year storm events were used. The 100-year storm elevation is 339.32 m and the regional storm elevation is 339.56 m. This results in a free board of 0.58 m for the 100-year storm and 0.0.34 m for the regional storm. The total depth of water in the pond is 1.72 m for the 100-year storm and 1.96 m for the regional storm, taken from the bottom of the pond.

The weirs and orifices for the dry/infiltration pond will be designed during the detailed design phase of the project. All MOE and Township of Puslinch policies and standards will be followed during the design.

5.4 INFILTRATION

Infiltration is an acceptable method of stormwater management for development in areas where native soil conditions provide the required hydraulic conductivity. The following design for the infiltration trench is based on the criteria set out in the MOE Stormwater Management and Planning Design Manual, March 2003.

The infiltration trench will provide quality control for the stormwater runoff from the 2, 5, 25, and 100-year storm event. The area draining to the hybrid pond is 21.79 ha and this area has an imperviousness of approximately 14.2 %.

The required volume for *Enhanced* (Level 1) protection for a catchment with 14.2 % imperviousness is 19.1 m^3/ha.

Providing the above noted 19.1 m^3/ha corresponds to approximately 416 m^3 of required storage to provide *Enhanced* (Level 1) protection. The porosity of clear stone for 50 mm diameter is 0.40. To achieve this storage volume, approximately 1,040 m^3 of infiltration trenching is required.

The infiltration trench is to be constructed under the dry pond located in the north east corner of the site. The trench will be 76.0 m long, 52.0 m wide and 0.3 m deep (1,186 m^3) of clear stone, which will be lined with a geotextile filter fabric. Below the stone will be a sand filter (150mm to 300mm) thick, as per MOE standards.

Based on the proposed configuration, approximately 474 m^3 of storage will be provide by the infiltration trench, which when combined with the storage in the pond below the outlet (4,819 m^3) exceeds the MOE requirements for quality control.

The second function of the infiltration trench is to recharge the natural aquifer in the area. Based on OTHYMO modeling, the volume of runoff generated by the 5-year storm event is 3,225 m^3. Given the storage volume of the infiltration trench (474 m^3) plus the volume in the pond below the outlet (4,819 m^3) the volume of runoff that can be stored and infiltrated, exceeds the 5-year runoff volume. Infiltrating the 5-year storm event will have a significant impact on recharging the aquifer, as the 5-year storm is a frequently occurring storm.

Infiltration will also be used to address the stormwater runoff from each of the 38 houses on site. Soakaway pits will be constructed for each house to store and infiltrate runoff from the roof during storm events. Should a storm event produces a volume of stormwater larger than what the soakaway pit can accommodate, the excess stormwater will be discharged, by overland flow and the proposed ditches and swales, to the dry/infiltration stormwater management pond.

Based on the OTTHYMO modeling, the runoff from the rooftops of the houses during the 5-year storm event is 62.15 mm. This results in a total volume of

runoff of approximately 14.39 m^3, of required storage per house. The porosity of clear stone for 50 mm diameter is 0.40. This results in a storage volume of 36.0 m^3 per house. To achieve this storage volume the soakaway pit will have a footprint of 24.0 m^2 and a depth of 1.5 m. This will provide a total volume of 36.0 m^3, which will meet the required storage volume per house.

5.5 *EROSION AND SILTATION CONTROLS*

During construction, much of the topsoil of the subject site will be stripped. Exposed soil is susceptible to erosion. To minimize local and downstream impacts from erosion and sedimentation during construction, the following measures have been recommended:

1. Excess earth and topsoil is to be stockpiled away from established drainage areas.
2. Temporary rock check dams and silt fencing are to be installed as set out in the erosion and sediment control plan prior to construction and maintained throughout the construction period.
3. Boulevards should be stabilized with topsoil and seed or sod as soon as possible.
4. Silt fences are to be installed in appropriate locations to intercept stormwater runoff from construction areas.
5. All siltation control devices should be installed prior to the commencement of construction and maintained on a regular basis until completion of boulevard sodding.

At the detailed design stage, a Detailed Erosion Control Plan will be submitted for review to the Approval Authorities.

5.6 *OPERATION AND MAINTENANCE*

At the detailed design stage, a stand-alone operation and maintenance manual will be provided for the final dry/infiltration stormwater management pond design.

6.0 CONCLUSIONS AND RECOMMENDATIONS

1. The stormwater management plan for the subject site includes the use of a dry/infiltration stormwater management pond to provide quality and quantity control to the subject site. This preliminary pond design is detailed in Section 5.0.

2. Prior to construction, the erosion and sediment control measures outlined in Section 5.5 should be implemented. These controls are to be maintained throughout the construction period and removed once exposed areas have been stabilized with grass and topsoil.

3. The designs in this report are consistent with the Township of Puslinch, the Ministry of Environment stormwater management design guidelines and the GRCA development policies.

4. It is recommended that this report be accepted as demonstrating an acceptable stormwater management approach for the subject property.

5. **It is recommended that the Approval Authorities support the applied for Draft Plan Approval.**

Respectfully Submitted,

RICHARDSON FOSTER LTD

[redacted]

Chris Anders, E.I.T. Greg Gennrich, P.Eng.

[redacted]

7.0 REFERENCES

1. Ministry of the Environment, Stormwater Management Planning and Design Manual, Toronto, 2003.

2. Harris, J. D., MTO Drainage Manual, Ministry of Transportation, Downsview, 1997.

3. www.mapquest.com

4. "Preliminary Geotechnical Investigation Proposed Residential Development Part Lots 7, 8 & 9, Concession 10 Township of Puslinch (Arkell), Ontario". V.A. Woods Incorporated, February 2006

5. Viessman, Warren Jr. and Lewis, Gary, Introduction to Hydrology., 4th Edition, Addison Wesley Longman.

6. Township of Puslinch Municipal Servicing Standards, May 1997 (revised July 5, 1999), prepared by Gamsby and Mannerow Limited.

8.0 APPENDICES

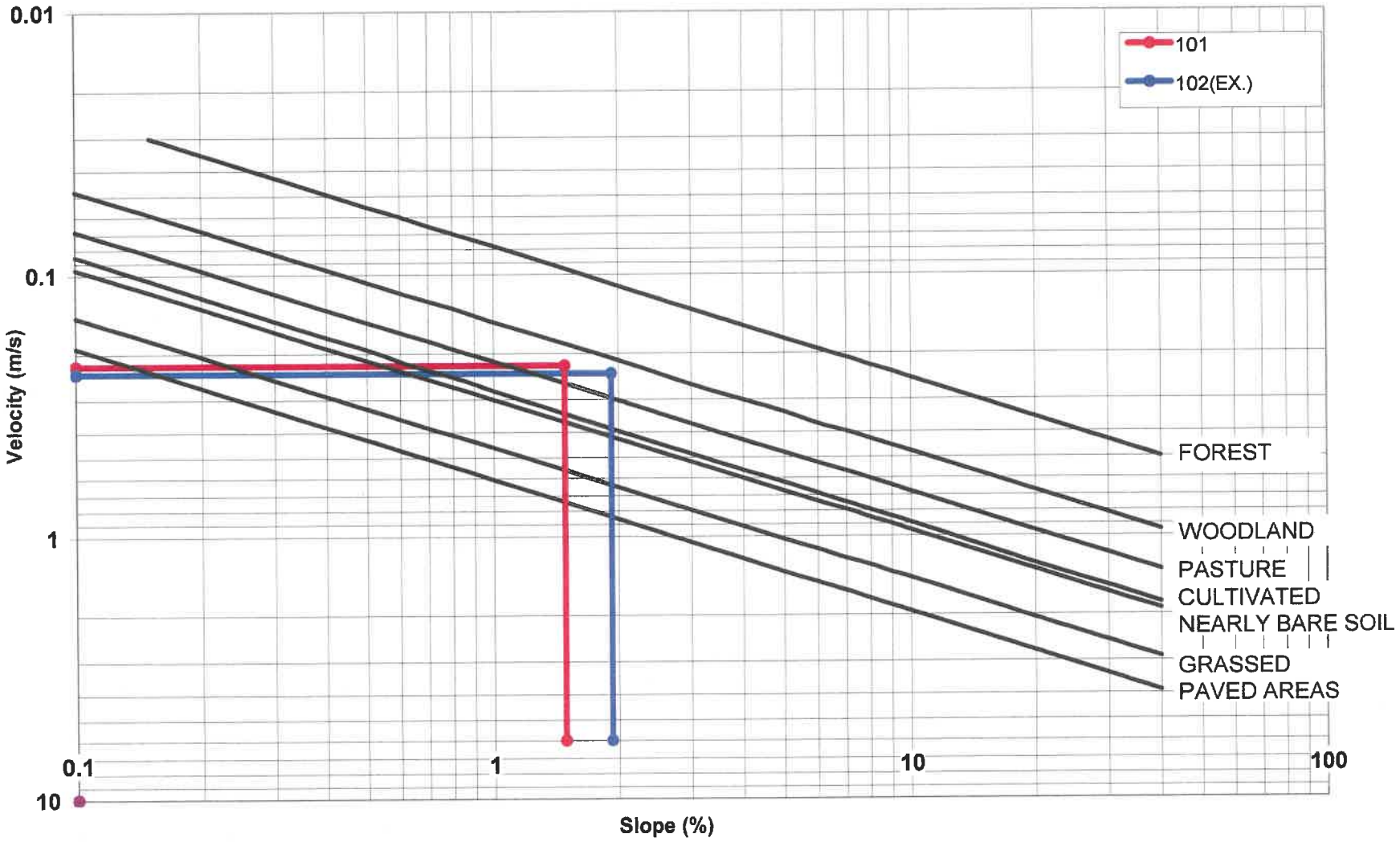
APPENDIX A - HYDROLOGIC MODEL PARAMETER SHEETS

APPENDIX B - OTTHYMO PRINTOUTS

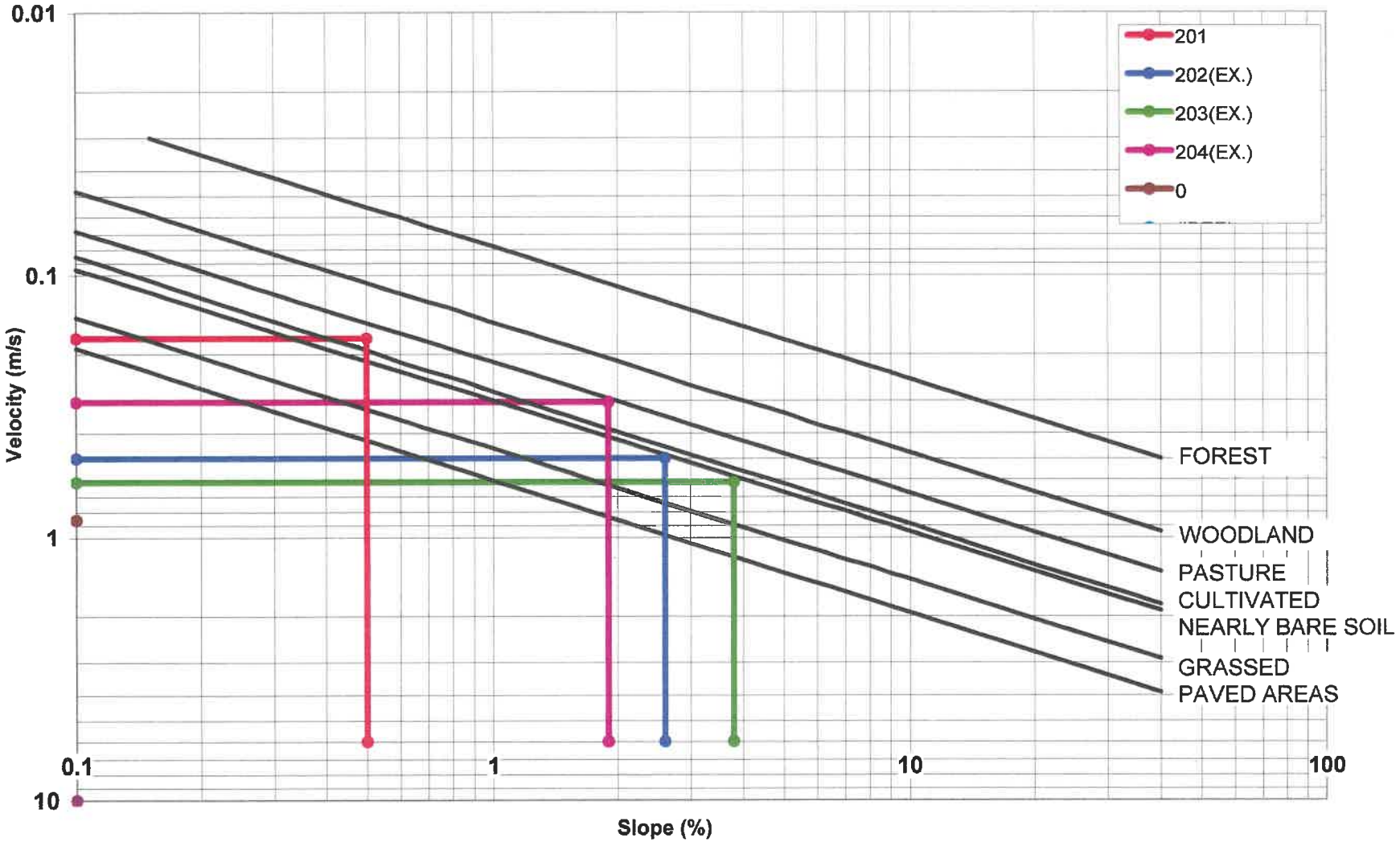
APPENDIX C – PRELIMINARY GEOTECHNICAL INVESTIGATION

APPENDIX A - HYDROLOGIC MODEL PARAMETER SHEETS

Uplands Method - Overland Flow



Uplands Method - Overland Flow



Design Chart 1.09: Soil Conservation Service Curve Numbers (Continued)

Land Use or Surface	Hydrologic Soil Group						
	A	AB	B	BC	C	CD	D
Fallow (special cases only)	77	82	86	89	91	93	94
Crop and other improved land	66** (62)	70** (68)	74	78	82	84	86 AMC I
Pasture & other unimproved land	58* (38)	62* (51)	65	71	76	79	81
Woodlots and forest	50* (30)	54* (44)	58	65	71	74	77
Impervious areas (paved)							98
Bare bedrock draining directly to stream by surface flow							98
Bare bedrock draining indirectly to stream as groundwater (usual case)							70
Lakes and wetlands							50

Group A Soils

Notes

(i) All values are based on AMC II except those marked by * (AMC III) or ** (mean of AMC II and AMC III).

(ii) Values in brackets are AMC II and are to be used only for special cases.

(iii) Table is not applicable to frozen soils or to periods in which snowmelt contributes to runoff.

APPENDIX B - OTTHYMO PRINTOUTS

```
V    V   I    SSSSS  U   U    A    L
V    V   I    SS     U   U   A A   L
 V  V    I     SS    U   U  AAAAA  L
 V  V    I      SS   U   U  A   A  L
  VV     I    SSSSS  UUUUU  A   A  LLLLL

 OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM, Version 2.0
O   O    T      T    H   H   Y Y   MM MM  O   O
O   O    T      T    H   H    Y    M   M  O   O   Licensed To: Richardson Foster Ltd.
 OOO     T      T    H   H    Y    M   M   OOO                  VO2-0066
```

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***** S U M M A R Y O U T P U T *****

Input filename: C:\Program Files\Visual OTTHYMO v2.0\voin.dat
Output filename: K:\1307-A~2\OTTHYMO\1307-F~1\Pre-Development.out
Summary filename: K:\1307-A~2\OTTHYMO\1307-F~1\Pre-Development.sum

DATE: 8/9/2006 TIME: 11:38:54 AM

USER:

COMMENTS: _____

****
** SIMULATION NUMBER: 1 **
****

W/E	COMMAND	HYD ID	DT min	AREA ha	Qpeak cms	Tpeak hrs	R.V. mm	R.C.	Qbase cms
	START @ .00 hrs								
	READ STORM		15.0						
	[Ptot= 53.22 mm]								
	fname : K:\1307-A~2\OTTHYMO\1307-F~1\SCS 2-yr Brant.stm								
	remark: 2-Year Brant County 24-hour SCS Storm								
*									
**	CALIB NASHYD	0102	1 9.0	37.00	.26	12.75	8.18	.15	.000
	[CN=56.0]								
	[N = 3.0:Tp .78]								
*									
**	CALIB NASHYD	0101	1 10.0	24.83	.18	12.83	8.44	.16	.000
	[CN=56.7]								
	[N = 3.0:Tp .83]								
*									
	ADD [0102 + 0101]	0103	3 9.0	61.83	.44	12.75	8.29	n/a	.000
*									

****
** SIMULATION NUMBER: 2 **
****

W/E	COMMAND	HYD ID	DT min	AREA ha	Qpeak cms	Tpeak hrs	R.V. mm	R.C.	Qbase cms
	START @ .00 hrs								
	READ STORM		15.0						
	[Ptot= 63.58 mm]								
	fname : K:\1307-A~2\OTTHYMO\1307-F~1\SCS 5-yr Brant.stm								
	remark: 5-Year Brant County 24-hour SCS Storm								
*									
**	CALIB NASHYD	0102	1 9.0	37.00	.39	12.75	11.91	.19	.000
	[CN=56.0]								
	[N = 3.0:Tp .78]								
*									
**	CALIB NASHYD	0101	1 10.0	24.83	.26	12.83	12.26	.19	.000
	[CN=56.7]								
	[N = 3.0:Tp .83]								
*									
	ADD [0102 + 0101]	0103	3 9.0	61.83	.65	12.75	12.05	n/a	.000
*									

****
** SIMULATION NUMBER: 3 **

```
**************************

W/E COMMAND              HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                 min     ha     cms   hrs     mm          cms

    START @   .00 hrs
    --------------------
    READ STORM                 15.0
    [ Ptot= 83.02 mm ]
    fname : K:\1307-A~2\OTTHYMO\1307-F~1\SCS 25-yr Brant.stm
    remark: 25-Year Brant County 24-hour SCS Storm
*
**  CALIB NASHYD       0102  1  9.0   37.00     .68 12.75  20.26  .24    .000
    [CN=56.0         ]
    [ N = 3.0:Tp  .78]
*
**  CALIB NASHYD       0101  1 10.0   24.83     .45 12.67  20.77  .25    .000
    [CN=56.7         ]
    [ N = 3.0:Tp  .83]
*
    ADD [0102 + 0101]  0103  3  9.0   61.83    1.13 12.75  20.46  n/a    .000
*
**************************
** SIMULATION NUMBER:   4 **
**************************

W/E COMMAND              HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                 min     ha     cms   hrs     mm          cms

    START @   .00 hrs
    --------------------
    READ STORM                 15.0
    [ Ptot=101.77 mm ]
    fname : K:\1307-A~2\OTTHYMO\1307-F~1\SCS 100-yr Brant.stm
    remark: 100-Year Brant County 24-hour SCS Storm
*
**  CALIB NASHYD       0102  1  9.0   37.00    1.01 12.75  29.71  .29    .000
    [CN=56.0         ]
    [ N = 3.0:Tp  .78]
*
**  CALIB NASHYD       0101  1 10.0   24.83     .67 12.67  30.39  .30    .000
    [CN=56.7         ]
    [ N = 3.0:Tp  .83]
*
    ADD [0102 + 0101]  0103  3  9.0   61.83    1.68 12.75  29.97  n/a    .000
*
**************************
** SIMULATION NUMBER:   5 **
**************************

W/E COMMAND              HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                 min     ha     cms   hrs     mm          cms

    START @   .00 hrs
    --------------------
    READ STORM                 10.0
    [ Ptot= 36.34 mm ]
    fname : K:\1307-A~2\OTTHYMO\1307-F~1\CHI 2-yr Brant.stm
    remark: 2-Year Brant County 4-hour Chicago Storm
*
**  CALIB NASHYD       0102  1  9.0   37.00     .15  2.40   3.41  .09    .000
    [CN=56.0         ]
    [ N = 3.0:Tp  .78]
*
**  CALIB NASHYD       0101  1 10.0   24.83     .10  2.50   3.46  .10    .000
    [CN=56.7         ]
    [ N = 3.0:Tp  .83]
*
    ADD [0102 + 0101]  0103  3  9.0   61.83     .24  2.40   3.43  n/a    .000
*
**************************
** SIMULATION NUMBER:   6 **
**************************

W/E COMMAND              HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                 min     ha     cms   hrs     mm          cms

    START @   .00 hrs
    --------------------
    READ STORM                 10.0
    [ Ptot= 49.52 mm ]
    fname : K:\1307-A~2\OTTHYMO\1307-F~1\CHI 5-yr Brant.stm
    remark: 5-Year Brant County 4-hour Chicago Storm
*
**  CALIB NASHYD       0102  1  9.0   37.00     .33  2.40   6.99  .14    .000
```

```
     [CN=56.0         ]
     [ N = 3.0:Tp  .78]
*
**  CALIB NASHYD       0101  1 10.0   24.83      .22  2.33   7.12  .14    .000
     [CN=56.7         ]
     [ N = 3.0:Tp  .83]
*
     ADD [0102 + 0101]  0103  3  9.0   61.83      .55  2.40   7.04  n/a    .000
*
*****************************
** SIMULATION NUMBER:   7 **
*****************************

W/E COMMAND              HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                  min     ha     cms   hrs     mm          cms

     START @   .00 hrs
     --------------------
     READ STORM                  10.0
     [ Ptot= 70.36 mm ]
     fname : K:\1307-A~2\OTTHYMO\1307-F~1\CHI 25-yr Brant.stm
     remark: 25-Year Brant County 4-hour Chicago Storm
*
**  CALIB NASHYD       0102  1  9.0   37.00      .75  2.25  14.64  .21    .000
     [CN=56.0         ]
     [ N = 3.0:Tp  .78]
*
**  CALIB NASHYD       0101  1 10.0   24.83      .50  2.33  14.90  .21    .000
     [CN=56.7         ]
     [ N = 3.0:Tp  .83]
*
     ADD [0102 + 0101]  0103  3  9.0   61.83     1.24  2.25  14.74  n/a    .000
*
*****************************
** SIMULATION NUMBER:   8 **
*****************************

W/E COMMAND              HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                  min     ha     cms   hrs     mm          cms

     START @   .00 hrs
     --------------------
     READ STORM                  10.0
     [ Ptot= 89.96 mm ]
     fname : K:\1307-A~2\OTTHYMO\1307-F~1\CHI 100-yr Brant.stm
     remark: 100-Year Brant County 4-hour Chicago Storm
*
**  CALIB NASHYD       0102  1  9.0   37.00     1.25  2.25  23.61  .26    .000
     [CN=56.0         ]
     [ N = 3.0:Tp  .78]
*
**  CALIB NASHYD       0101  1 10.0   24.83      .82  2.33  24.01  .27    .000
     [CN=56.7         ]
     [ N = 3.0:Tp  .83]
*
     ADD [0102 + 0101]  0103  3  9.0   61.83     2.06  2.25  23.76  n/a    .000
*
*****************************
** SIMULATION NUMBER:   9 **
*****************************

W/E COMMAND              HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                  min     ha     cms   hrs     mm          cms

     START @   .00 hrs
     --------------------
     READ STORM                  12.0
     [ Ptot=212.00 mm ]
     fname : K:\1307-A~2\OTTHYMO\1307-F~1\HAZEL.STM
     remark: * REGIONAL DESIGN STORM
*
**  CALIB NASHYD       0102  1  9.0   37.00     2.81 10.95 102.73  .48    .000
     [CN=56.0         ]
     [ N = 3.0:Tp  .78]
*
**  CALIB NASHYD       0101  1 10.0   24.83     1.88 11.00 104.33  .49    .000
     [CN=56.7         ]
     [ N = 3.0:Tp  .83]
*
     ADD [0102 + 0101]  0103  3  9.0   61.83     4.69 10.95 103.37  n/a    .000
*
*****************************
** SIMULATION NUMBER:  10 **
*****************************
```

```
W/L COMMAND                HYD ID   DT     AREA    Qpeak  Tpeak   R.V.  R.C.    Qbase
                                    min     ha      cms    hrs     mm             cms

     START @   .00 hrs
     --------------------
     READ STORM                     10.0
     [ Ptot= 25.00 mm ]
     fname : K:\1307-A~2\OTTHYMO\1307-F~1\25MM4HR.STM
     remark: Twenty-Five mm Four Hour Chicago Storm
*
  **  CALIB NASHYD       0102  1   9.0    37.00     .05   3.00   1.26  .05     .000
     [CN=56.0         ]
     [ N = 3.0:Tp  .78]
*
  **  CALIB NASHYD       0101  1  10.0    24.83     .03   3.00   1.27  .05     .000
     [CN=56.7         ]
     [ N = 3.0:Tp  .83]
*
     ADD [0102 + 0101]  0103  3   9.0    61.83     .08   3.00   1.26  n/a     .000
*
 FINISH
```

==========

```
V    V   I    SSSSS  U   U    A    L
V    V   I    SS     U   U   A A   L
 V  V    I     SS    U   U  AAAAA  L
 V  V    I      SS   U   U  A   A  L
  VV     I    SSSSS  UUUUU  A   A  LLLLL

 OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM, Version 2.0
O   O    T      T    H   H   Y Y   MM MM  O   O
O   O    T      T    H   H    Y    M   M  O   O   Licensed To: Richardson Foster Ltd.
 OOO     T      T    H   H    Y    M   M   OOO                  VO2-0066
```

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***** S U M M A R Y O U T P U T *****

Input filename: C:\Program Files\Visual OTTHYMO v2.0\voin.dat
Output filename: K:\1307-A~2\OTTHYMO\1307-F~1\Post Development.out
Summary filename: K:\1307-A~2\OTTHYMO\1307-F~1\Post Development.sum

DATE: 8/9/2006 TIME: 11:33:28 AM

USER:

COMMENTS: _____

****
** SIMULATION NUMBER: 1 **
****

W/E	COMMAND	HYD	ID	DT min	AREA ha	Qpeak cms	Tpeak hrs	R.V. mm	R.C.	Qbase cms
	START @ .00 hrs									
	READ STORM			15.0						
	[Ptot= 53.22 mm]									
	fname : K:\1307-A~2\OTTHYMO\1307-F~1\SCS 2-yr Brant.stm									
	remark: 2-Year Brant County 24-hour SCS Storm									
**	CALIB NASHYD	0204	1	7.0	37.00	.39	12.48	9.98	.19	.000
	[CN=62.0]									
	[N = 3.0:Tp .60]									
*	CALIB STANDHYD	0205	1	2.0	.88	.14	11.97	51.84	.97	.000
	[I%=99.0:S%= 2.00]									
	DUHYD	0001	1	2.0	.88	.14	11.97	51.84	n/a	.000
	MAJOR SYSTEM:	0001	2	2.0	.00	.00	.00	.00	n/a	.000
	MINOR SYSTEM:	0001	3	2.0	.88	.14	11.97	51.84	n/a	.000
**	CALIB NASHYD	0201	1	8.0	20.91	.22	12.67	10.75	.20	.000
	[CN=63.9]									
	[N = 3.0:Tp .68]									
	ADD [0001 + 0201]	0210	3	8.0	20.91	.22	12.67	10.75	n/a	.000
	ADD [0204 + 0210]	0211	3	7.0	57.91	.61	12.60	10.26	n/a	.000
**	CALIB NASHYD	0203	1	2.0	1.99	.11	12.00	12.71	.24	.000
	[CN=70.0]									
	[N = 3.0:Tp .03]									
**	CALIB NASHYD	0202	1	2.0	1.03	.05	12.00	7.45	.14	.000
	[CN=69.7]									
	[N = 3.0:Tp .03]									
	ADD [0203 + 0202]	0003	3	2.0	3.02	.16	12.00	10.92	n/a	.000
	ADD [0211 + 0003]	0002	3	2.0	60.93	.63	12.50	10.29	n/a	.000
	RESRVR [2 : 0002]	0500	1	2.0	60.93	.06	20.20	2.31	n/a	.000
	{ST= .51 ha.m }									

****
** SIMULATION NUMBER: 2 **

```
**************************

W/E COMMAND              HYD ID   DT     AREA    Qpeak Tpeak   R.V. R.C.   Qbase
                                 min      ha      cms   hrs      mm          cms

    START @   .00 hrs
    --------------------
    READ STORM                   15.0
    [ Ptot= 63.58 mm ]
    fname : K:\1307-A~2\OTTHYMO\1307-F~1\SCS 5-yr Brant.stm
    remark: 5-Year Brant County 24-hour SCS Storm
*
 **  CALIB NASHYD       0204  1  7.0   37.00     .58 12.48  14.39  .23    .000
    [CN=62.0         ]
    [ N = 3.0:Tp  .60]
*
 *   CALIB STANDHYD     0205  1  2.0     .88     .17 11.97  62.15  .98    .000
    [I%=99.0:S%= 2.00]
*
    DUHYD              0001  1  2.0     .88     .17 11.97  62.15  n/a    .000
       MAJOR SYSTEM:   0001  2  2.0     .00     .00 11.97  62.15  n/a    .000
       MINOR SYSTEM:   0001  3  2.0     .88     .17 11.83  62.15  n/a    .000
*
 **  CALIB NASHYD       0201  1  8.0   20.91     .32 12.67  15.42  .24    .000
    [CN=63.9         ]
    [ N = 3.0:Tp  .68]
*
    ADD [0001 + 0201]  0210  3  2.0   20.91     .32 12.67  15.42  n/a    .000
*
    ADD [0204 + 0210]  0211  3  2.0   57.91     .90 12.53  14.76  n/a    .000
*
 **  CALIB NASHYD       0203  1  2.0    1.99     .15 12.00  17.88  .28    .000
    [CN=70.0         ]
    [ N = 3.0:Tp  .03]
*
 **  CALIB NASHYD       0202  1  2.0    1.03     .08 12.00  10.80  .17    .000
    [CN=69.7         ]
    [ N = 3.0:Tp  .03]
*
    ADD [0203 + 0202]  0003  3  2.0    3.02     .22 12.00  15.47  n/a    .000
*
    ADD [0211 + 0003]  0002  3  2.0   60.93     .93 12.50  14.80  n/a    .000
*
    RESRVR [ 2 : 0002] 0500  1  2.0   60.93     .20 14.87   6.82  n/a    .000
    {ST=   .54 ha.m }
*
**************************
** SIMULATION NUMBER:   3 **
**************************

W/E COMMAND              HYD ID   DT     AREA    Qpeak Tpeak   R.V. R.C.   Qbase
                                 min      ha      cms   hrs      mm          cms

    START @   .00 hrs
    --------------------
    READ STORM                   15.0
    [ Ptot= 83.02 mm ]
    fname : K:\1307-A~2\OTTHYMO\1307-F~1\SCS 25-yr Brant.stm
    remark: 25-Year Brant County 24-hour SCS Storm
*
 **  CALIB NASHYD       0204  1  7.0   37.00    1.00 12.48  24.12  .29    .000
    [CN=62.0         ]
    [ N = 3.0:Tp  .60]
*
 *   CALIB STANDHYD     0205  1  2.0     .88     .22 11.97  81.48  .98    .000
    [I%=99.0:S%= 2.00]
*
    DUHYD              0001  1  2.0     .88     .22 11.97  81.48  n/a    .000
       MAJOR SYSTEM:   0001  2  2.0     .05     .05 11.97  81.48  n/a    .000
       MINOR SYSTEM:   0001  3  2.0     .83     .17 11.80  81.48  n/a    .000
*
 **  CALIB NASHYD       0201  1  8.0   20.91     .55 12.53  25.64  .31    .000
    [CN=63.9         ]
    [ N = 3.0:Tp  .68]
*
    ADD [0001 + 0201]  0210  3  2.0   20.96     .55 12.53  25.77  n/a    .000
*
    ADD [0204 + 0210]  0211  3  2.0   57.96    1.54 12.53  24.71  n/a    .000
*
 **  CALIB NASHYD       0203  1  2.0    1.99     .23 12.00  28.94  .35    .000
    [CN=70.0         ]
    [ N = 3.0:Tp  .03]
*
 **  CALIB NASHYD       0202  1  2.0    1.03     .12 12.00  18.14  .22    .000
    [CN=69.7         ]
```

```
     [ N = 3.0:Tp  .03]
*
     ADD [0203 + 0202]  0003  3  2.0    3.02     .35 12.00  25.25  n/a    .000
*
     ADD [0211 + 0003]  0002  3  2.0   60.98    1.59 12.50  24.74  n/a    .000
*
     RESRVR [ 2 : 0002] 0500  1  2.0   60.98     .65 13.60  16.77  n/a    .000
     {ST=   .68 ha.m }
*
  ****************************
  ** SIMULATION NUMBER:   4 **
  ****************************

  W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                   min     ha     cms   hrs     mm         cms

     START @   .00 hrs
     --------------------
     READ STORM                 15.0
     [ Ptot=101.77 mm ]
     fname : K:\1307-A~2\OTTHYMO\1307-F~1\SCS 100-yr Brant.stm
     remark: 100-Year Brant County 24-hour SCS Storm
*
  **  CALIB NASHYD       0204  1  7.0   37.00    1.47 12.48  34.94  .34    .000
     [CN=62.0          ]
     [ N = 3.0:Tp  .60]
*
  *   CALIB STANDHYD     0205  1  2.0     .88     .27 11.97 100.14  .98    .000
     [I%=99.0:S%= 2.00]
*
     DUHYD              0001  1  2.0     .88     .27 11.97 100.14  n/a    .000
        MAJOR SYSTEM:   0001  2  2.0     .08     .10 11.97 100.14  n/a    .000
        MINOR SYSTEM:   0001  3  2.0     .80     .17 11.80 100.14  n/a    .000
*
  **  CALIB NASHYD       0201  1  8.0   20.91     .80 12.53  36.93  .36    .000
     [CN=63.9          ]
     [ N = 3.0:Tp  .68]
*
     ADD [0001 + 0201]  0210  3  2.0   20.99     .80 12.53  37.18  n/a    .000
*
     ADD [0204 + 0210]  0211  3  2.0   57.99    2.26 12.53  35.75  n/a    .000
*
  **  CALIB NASHYD       0203  1  2.0    1.99     .33 12.00  40.88  .40    .000
     [CN=70.0          ]
     [ N = 3.0:Tp  .03]
*
  **  CALIB NASHYD       0202  1  2.0    1.03     .17 12.00  26.28  .26    .000
     [CN=69.7          ]
     [ N = 3.0:Tp  .03]
*
     ADD [0203 + 0202]  0003  3  2.0    3.02     .50 12.00  35.90  n/a    .000
*
     ADD [0211 + 0003]  0002  3  2.0   61.01    2.33 12.50  35.76  n/a    .000
*
     RESRVR [ 2 : 0002] 0500  1  2.0   61.01    1.23 13.37  27.79  n/a    .000
     {ST=   .85 ha.m }
*
  ****************************
  ** SIMULATION NUMBER:   5 **
  ****************************

  W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                   min     ha     cms   hrs     mm         cms

     START @   .00 hrs
     --------------------
     READ STORM                 10.0
     [ Ptot= 36.34 mm ]
     fname : K:\1307-A~2\OTTHYMO\1307-F~1\CHI 2-yr Brant.stm
     remark: 2-Year Brant County 4-hour Chicago Storm
*
  **  CALIB NASHYD       0204  1  7.0   37.00     .21  2.22   4.20  .12    .000
     [CN=62.0          ]
     [ N = 3.0:Tp  .60]
*
  *   CALIB STANDHYD     0205  1  2.0     .88     .20  1.33  35.05  .96    .000
     [I%=99.0:S%= 2.00]
*
     DUHYD              0001  1  2.0     .88     .20  1.33  35.05  n/a    .000
        MAJOR SYSTEM:   0001  2  2.0     .04     .03  1.33  35.05  n/a    .000
        MINOR SYSTEM:   0001  3  2.0     .84     .17  1.23  35.05  n/a    .000
*
  **  CALIB NASHYD       0201  1  8.0   20.91     .12  2.27   4.61  .13    .000
     [CN=63.9          ]
     [ N = 3.0:Tp  .68]
```

```
*
     ADD [0001 + 0201]  0210  3  2.0   20.95     .12  2.27   4.67  n/a    .000
*
     ADD [0204 + 0210]  0211  3  2.0   57.95     .33  2.20   4.37  n/a    .000
*
   **  CALIB NASHYD       0203  1  2.0    1.99     .07  1.33   5.72  .16    .000
     [CN=70.0         ]
     [ N = 3.0:Tp  .03]
*
   **  CALIB NASHYD       0202  1  2.0    1.03     .04  1.33   5.62  .15    .000
     [CN=69.7         ]
     [ N = 3.0:Tp  .03]
*
     ADD [0203 + 0202]  0003  3  2.0    3.02     .11  1.33   5.69  n/a    .000
*
     ADD [0211 + 0003]  0002  3  2.0   60.97     .35  2.17   4.44  n/a    .000
*
     RESRVR [ 2 : 0002] 0500  1  2.0   60.97     .00  6.87    .20  n/a    .000
     {ST=    .27 ha.m }
*
   ****************************
   ** SIMULATION NUMBER:   6 **
   ****************************

   W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                    min     ha     cms   hrs     mm          cms

     START @   .00 hrs
     --------------------
     READ STORM                  10.0
     [ Ptot= 49.52 mm ]
     fname : K:\1307-A~2\OTTHYMO\1307-F~1\CHI 5-yr Brant.stm
     remark: 5-Year Brant County 4-hour Chicago Storm
*
   **  CALIB NASHYD       0204  1  7.0   37.00     .49  2.10   8.53  .17    .000
     [CN=62.0         ]
     [ N = 3.0:Tp  .60]
*
   *   CALIB STANDHYD     0205  1  2.0     .88     .27  1.33  48.19  .97    .000
     [I%=99.0:S%= 2.00]
*
     DUHYD              0001  1  2.0     .88     .27  1.33  48.19  n/a    .000
        MAJOR SYSTEM:   0001  2  2.0     .11     .10  1.33  48.19  n/a    .000
        MINOR SYSTEM:   0001  3  2.0     .77     .17  1.23  48.19  n/a    .000
*
   **  CALIB NASHYD       0201  1  8.0   20.91     .28  2.13   9.24  .19    .000
     [CN=63.9         ]
     [ N = 3.0:Tp  .68]
*
     ADD [0001 + 0201]  0210  3  2.0   21.02     .28  2.13   9.44  n/a    .000
*
     ADD [0204 + 0210]  0211  3  2.0   58.02     .77  2.13   8.86  n/a    .000
*
   **  CALIB NASHYD       0203  1  2.0    1.99     .15  1.33  11.02  .22    .000
     [CN=70.0         ]
     [ N = 3.0:Tp  .03]
*
   **  CALIB NASHYD       0202  1  2.0    1.03     .07  1.33  10.86  .22    .000
     [CN=69.7         ]
     [ N = 3.0:Tp  .03]
*
     ADD [0203 + 0202]  0003  3  2.0    3.02     .22  1.33  10.96  n/a    .000
*
     ADD [0211 + 0003]  0002  3  2.0   61.04     .79  2.13   8.96  n/a    .000
*
     RESRVR [ 2 : 0002] 0500  1  2.0   61.04     .08  4.73   1.11  n/a    .000
     {ST=    .52 ha.m }
*
   ****************************
   ** SIMULATION NUMBER:   7 **
   ****************************

   W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                    min     ha     cms   hrs     mm          cms

     START @   .00 hrs
     --------------------
     READ STORM                  10.0
     [ Ptot= 70.36 mm ]
     fname : K:\1307-A~2\OTTHYMO\1307-F~1\CHI 25-yr Brant.stm
     remark: 25-Year Brant County 4-hour Chicago Storm
*
   **  CALIB NASHYD       0204  1  7.0   37.00    1.10  2.10  17.56  .25    .000
     [CN=62.0         ]
     [ N = 3.0:Tp  .60]
```

```
*   CALIB STANDHYD     0205  1  2.0      .88      .38  1.33  68.99  .98     .000
    [I%=99.0:S%= 2.00]
*
    DUHYD              0001  1  2.0      .88      .38  1.33  68.99  n/a     .000
       MAJOR SYSTEM:   0001  2  2.0      .17      .21  1.33  68.99  n/a     .000
       MINOR SYSTEM:   0001  3  2.0      .71      .17  1.20  68.99  n/a     .000
*
**  CALIB NASHYD       0201  1  8.0    20.91      .61  2.13  18.79  .27     .000
    [CN=63.9         ]
    [ N = 3.0:Tp  .68]
*
    ADD [0001 + 0201]  0210  3  2.0    21.08      .61  2.13  19.20  n/a     .000
*
    ADD [0204 + 0210]  0211  3  2.0    58.08     1.70  2.10  18.15  n/a     .000
*
**  CALIB NASHYD       0203  1  2.0     1.99      .29  1.33  21.56  .31     .000
    [CN=70.0         ]
    [ N = 3.0:Tp  .03]
*
**  CALIB NASHYD       0202  1  2.0     1.03      .15  1.33  21.31  .30     .000
    [CN=69.7         ]
    [ N = 3.0:Tp  .03]
*
    ADD [0203 + 0202]  0003  3  2.0     3.02      .44  1.33  21.48  n/a     .000
*
    ADD [0211 + 0003]  0002  3  2.0    61.10     1.74  2.10  18.32  n/a     .000
*
    RESRVR [ 2 : 0002] 0500  1  2.0    61.10      .76  3.20  10.47  n/a     .000
    {ST=    .71 ha.m }
*
*****************************
** SIMULATION NUMBER:   8 **
*****************************

W/E COMMAND            HYD ID   DT     AREA    Qpeak Tpeak   R.V. R.C.    Qbase
                                min      ha      cms   hrs      mm          cms

    START @   .00 hrs
    ---------------------
    READ STORM                10.0
    [ Ptot= 89.96 mm ]
    fname : K:\1307-A~2\OTTHYMO\1307-F~1\CHI 100-yr Brant.stm
    remark: 100-Year Brant County 4-hour Chicago Storm
*
**  CALIB NASHYD       0204  1  7.0    37.00     1.80  2.10  27.94  .31     .000
    [CN=62.0         ]
    [ N = 3.0:Tp  .60]
*
*   CALIB STANDHYD     0205  1  2.0      .88      .48  1.33  88.57  .98     .000
    [I%=99.0:S%= 2.00]
*
    DUHYD              0001  1  2.0      .88      .48  1.33  88.57  n/a     .000
       MAJOR SYSTEM:   0001  2  2.0      .23      .31  1.33  88.57  n/a     .000
       MINOR SYSTEM:   0001  3  2.0      .65      .17  1.20  88.57  n/a     .000
*
**  CALIB NASHYD       0201  1  8.0    20.91      .99  2.13  29.67  .33     .000
    [CN=63.9         ]
    [ N = 3.0:Tp  .68]
*
    ADD [0001 + 0201]  0210  3  2.0    21.14      .99  2.13  30.31  n/a     .000
*
    ADD [0204 + 0210]  0211  3  2.0    58.14     2.78  2.10  28.80  n/a     .000
*
**  CALIB NASHYD       0203  1  2.0     1.99      .45  1.33  33.23  .37     .000
    [CN=70.0         ]
    [ N = 3.0:Tp  .03]
*
**  CALIB NASHYD       0202  1  2.0     1.03      .23  1.33  32.90  .37     .000
    [CN=69.7         ]
    [ N = 3.0:Tp  .03]
*
    ADD [0203 + 0202]  0003  3  2.0     3.02      .69  1.33  33.12  n/a     .000
*
    ADD [0211 + 0003]  0002  3  2.0    61.16     2.84  2.10  29.01  n/a     .000
*
    RESRVR [ 2 : 0002] 0500  1  2.0    61.16     1.59  2.90  21.17  n/a     .000
    {ST=    .93 ha.m }
*
*****************************
** SIMULATION NUMBER:   9 **
*****************************

W/E COMMAND            HYD ID   DT     AREA    Qpeak Tpeak   R.V. R.C.    Qbase
                                min      ha      cms   hrs      mm          cms
```

```
      START @   .00 hrs
      ----------------------
      READ STORM                  12.0
      [ Ptot=212.00 mm ]
      fname : K:\1307-A~2\OTTHYMO\1307-F~1\HAZEL.STM
      remark: * REGIONAL DESIGN STORM
*
   **  CALIB NASHYD       0204  1  7.0   37.00    3.25 10.50 115.29  .54    .000
      [CN=62.0          ]
      [ N = 3.0:Tp  .60]
*
   *   CALIB STANDHYD     0205  1  2.0     .88     .13  9.97 210.09  .99    .000
      [I%=99.0:S%= 2.00]
*
      DUHYD              0001  1  2.0     .88     .13  9.97 210.09  n/a    .000
         MAJOR SYSTEM:   0001  2  2.0     .00     .00   .00    .00  n/a    .000
         MINOR SYSTEM:   0001  3  2.0     .88     .13  9.33 210.09  n/a    .000
*
   **  CALIB NASHYD       0201  1  8.0   20.91    1.84 10.80 119.58  .56    .000
      [CN=63.9          ]
      [ N = 3.0:Tp  .68]
*
      ADD [0001 + 0201]  0210  3  8.0   20.91    1.84 10.80 119.58  n/a    .000
*
      ADD [0204 + 0210]  0211  3  7.0   57.91    5.08 10.62 116.84  n/a    .000
*
   **  CALIB NASHYD       0203  1  2.0    1.99     .22 10.00 124.33  .59    .000
      [CN=70.0          ]
      [ N = 3.0:Tp  .03]
*
   **  CALIB NASHYD       0202  1  2.0    1.03     .12 10.00 123.63  .58    .000
      [CN=69.7          ]
      [ N = 3.0:Tp  .03]
*
      ADD [0203 + 0202]  0003  3  2.0    3.02     .34 10.00 124.09  n/a    .000
*
      ADD [0211 + 0003]  0002  3  2.0   60.93    5.33 10.63 117.20  n/a    .000
*
      RESRVR [ 2 : 0002] 0500  1  2.0   60.93    5.33 10.63 109.28  n/a    .000
      {ST=  1.10 ha.m }
*
   ****************************
   ** SIMULATION NUMBER:  10 **
   ****************************

   W/E COMMAND             HYD ID   DT     AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                    min      ha     cms   hrs     mm         cms

      START @   .00 hrs
      ----------------------
      READ STORM                  10.0
      [ Ptot= 25.00 mm ]
      fname : K:\1307-A~2\OTTHYMO\1307-F~1\25MM4HR.STM
      remark: Twenty-Five mm Four Hour Chicago Storm
*
   **  CALIB NASHYD       0204  1  7.0   37.00     .06  2.57   1.57  .06    .000
      [CN=62.0          ]
      [ N = 3.0:Tp  .60]
*
   *   CALIB STANDHYD     0205  1  2.0     .88     .12  1.50  23.76  .95    .000
      [I%=99.0:S%= 2.00]
*
      DUHYD              0001  1  2.0     .88     .12  1.50  23.76  n/a    .000
         MAJOR SYSTEM:   0001  2  2.0     .00     .00   .00    .00  n/a    .000
         MINOR SYSTEM:   0001  3  2.0     .88     .12  1.50  23.76  n/a    .000
*
   **  CALIB NASHYD       0201  1  8.0   20.91     .04  2.80   1.76  .07    .000
      [CN=63.9          ]
      [ N = 3.0:Tp  .68]
*
      ADD [0001 + 0201]  0210  3  8.0   20.91     .04  2.80   1.76  n/a    .000
*
      ADD [0204 + 0210]  0211  3  7.0   57.91     .10  2.68   1.64  n/a    .000
*
   **  CALIB NASHYD       0203  1  2.0    1.99     .02  1.50   2.32  .09    .000
      [CN=70.0          ]
      [ N = 3.0:Tp  .03]
*
   **  CALIB NASHYD       0202  1  2.0    1.03     .01  1.50   2.27  .09    .000
      [CN=69.7          ]
      [ N = 3.0:Tp  .03]
*
      ADD [0203 + 0202]  0003  3  2.0    3.02     .03  1.50   2.31  n/a    .000
*
```

```
      ADD [0211 + 0003]  0002  3  2.0   60.93     .11  2.67   1.67  n/a    .000
*
      RESRVR [ 2 : 0002] 0500  1  2.0   60.93     .00  7.10    .01  n/a    .000
      {ST=    .10 ha.m }
*
 FINISH
```

==========

```
V    V   I    SSSSS  U   U    A    L
V    V   I    SS     U   U   A A   L
 V  V    I     SS    U   U  AAAAA  L
 V  V    I      SS   U   U  A   A  L
  VV     I    SSSSS  UUUUU  A   A  LLLLL

 OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM, Version 2.0
O   O    T      T    H   H   Y Y   MM MM  O   O
O   O    T      T    H   H    Y    M   M  O   O   Licensed To: Richardson Foster Ltd.
 OOO     T      T    H   H    Y    M   M   OOO                 VO2-0066
```

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files\Visual OTTHYMO v2.0\voin.dat
Output filename: K:\1307-A~2\OTTHYMO\1307-F~1\Post Development.out
Summary filename: K:\1307-A~2\OTTHYMO\1307-F~1\Post Development.sum

DATE: 8/9/2006 TIME: 11:34:43 AM

USER:

COMMENTS: _____

****
** SIMULATION NUMBER: 4 **
****

| READ STORM | Ptotal=101.77 mm | Filename: K:\1307-A~2\OTTHYMO\1307-F~1\SCS 100-yr Brant.stm
Comments: 100-Year Brant County 24-hour SCS Storm

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.25	1.14	6.25	.00	12.25	14.66	18.25	1.83
.50	1.10	6.50	.00	12.50	14.66	18.50	1.83
.75	1.14	6.75	.00	12.75	7.53	18.75	1.83
1.00	1.10	7.00	.00	13.00	7.53	19.00	1.83
1.25	1.14	7.25	4.07	13.25	1.43	19.25	1.83
1.50	1.10	7.50	4.07	13.50	1.43	19.50	1.83
1.75	1.14	7.75	4.07	13.75	8.35	19.75	1.83
2.00	1.10	8.00	4.07	14.00	8.35	20.00	1.83
2.25	1.34	8.25	.00	14.25	3.05	20.25	1.22
2.50	1.30	8.50	.00	14.50	3.05	20.50	1.22
2.75	1.34	8.75	5.50	14.75	3.05	20.75	1.22
3.00	1.30	9.00	5.50	15.00	3.05	21.00	1.22
3.25	1.34	9.25	3.26	15.25	3.05	21.25	1.22
3.50	1.30	9.50	3.26	15.50	3.05	21.50	1.22
3.75	1.34	9.75	.00	15.75	3.05	21.75	1.22
4.00	1.30	10.00	7.33	16.00	3.05	22.00	1.22
4.25	1.63	10.25	4.68	16.25	1.83	22.25	1.22
4.50	1.63	10.50	4.68	16.50	1.83	22.50	1.22
4.75	1.63	10.75	6.31	16.75	1.83	22.75	1.22
5.00	1.63	11.00	6.31	17.00	1.83	23.00	1.22
5.25	1.63	11.25	9.77	17.25	1.83	23.25	1.22
5.50	1.63	11.50	9.77	17.50	1.83	23.50	1.22
5.75	1.63	11.75	42.35	17.75	1.83	23.75	1.22
6.00	1.63	12.00	112.39	18.00	1.83	24.00	1.22

| CALIB | NASHYD (0204) | ID= 1 DT= 7.0 min | Area (ha)= 37.00 Curve Number (CN)= 62.0
Ia (mm)= 8.50 # of Linear Res.(N)= 3.00
U.H. Tp(hrs)= .60

NOTE: RAINFALL WAS TRANSFORMED TO 7.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.117	1.14	6.183	.00	12.250	14.66	18.32	1.83
.233	1.14	6.300	.00	12.367	14.66	18.43	1.83
.350	1.11	6.417	.00	12.483	14.66	18.55	1.83
.467	1.10	6.533	.00	12.600	8.55	18.67	1.83
.583	1.13	6.650	.00	12.717	7.53	18.78	1.83
.700	1.14	6.767	.00	12.833	7.53	18.90	1.83
.817	1.12	6.883	.00	12.950	7.53	19.02	1.83
.933	1.10	7.000	.00	13.067	4.04	19.13	1.83
1.050	1.12	7.117	4.07	13.183	1.43	19.25	1.83
1.167	1.14	7.233	4.07	13.300	1.43	19.37	1.83
1.283	1.13	7.350	4.07	13.417	1.43	19.48	1.83
1.400	1.10	7.467	4.07	13.533	3.41	19.60	1.83
1.517	1.11	7.583	4.07	13.650	8.35	19.72	1.83
1.633	1.14	7.700	4.07	13.767	8.35	19.83	1.83
1.750	1.14	7.817	4.07	13.883	8.35	19.95	1.83
1.867	1.10	7.933	4.07	14.000	8.35	20.07	1.48
1.983	1.10	8.050	2.33	14.117	3.05	20.18	1.22
2.100	1.31	8.167	.00	14.233	3.05	20.30	1.22
2.217	1.34	8.283	.00	14.350	3.05	20.42	1.22
2.333	1.31	8.400	.00	14.467	3.05	20.53	1.22
2.450	1.30	8.517	.79	14.583	3.05	20.65	1.22
2.567	1.32	8.633	5.50	14.700	3.05	20.77	1.22
2.683	1.34	8.750	5.50	14.817	3.05	20.88	1.22
2.800	1.32	8.867	5.50	14.933	3.05	21.00	1.22
2.917	1.30	8.983	5.50	15.050	3.05	21.12	1.22
3.033	1.31	9.100	3.58	15.167	3.05	21.23	1.22
3.150	1.34	9.217	3.26	15.283	3.05	21.35	1.22
3.267	1.33	9.333	3.26	15.400	3.05	21.47	1.22
3.383	1.30	9.450	3.26	15.517	3.05	21.58	1.22
3.500	1.30	9.567	1.40	15.633	3.05	21.70	1.22
3.617	1.34	9.683	.00	15.750	3.05	21.82	1.22
3.733	1.34	9.800	3.14	15.867	3.05	21.93	1.22
3.850	1.31	9.917	7.33	15.983	3.05	22.05	1.22
3.967	1.30	10.033	6.57	16.100	2.00	22.17	1.22
4.083	1.54	10.150	4.68	16.217	1.83	22.28	1.22
4.200	1.63	10.267	4.68	16.333	1.83	22.40	1.22
4.317	1.63	10.383	4.68	16.450	1.83	22.52	1.22
4.433	1.63	10.500	4.68	16.567	1.83	22.63	1.22
4.550	1.63	10.617	6.31	16.683	1.83	22.75	1.22
4.667	1.63	10.733	6.31	16.800	1.83	22.87	1.22
4.783	1.63	10.850	6.31	16.917	1.83	22.98	1.22
4.900	1.63	10.967	6.31	17.033	1.83	23.10	1.22
5.017	1.63	11.083	8.78	17.150	1.83	23.22	1.22
5.133	1.63	11.200	9.77	17.267	1.83	23.33	1.22
5.250	1.63	11.317	9.77	17.383	1.83	23.45	1.22
5.367	1.63	11.433	9.77	17.500	1.83	23.57	1.22
5.483	1.63	11.550	23.73	17.617	1.83	23.68	1.22
5.600	1.63	11.667	42.35	17.733	1.83	23.80	1.22
5.717	1.63	11.783	62.37	17.850	1.83	23.92	1.22
5.833	1.63	11.900	112.39	17.967	1.83	24.03	.87
5.950	1.63	12.017	98.42	18.083	1.83		
6.067	.70	12.133	14.66	18.200	1.83		

Unit Hyd Qpeak (cms)= 2.355

PEAK FLOW (cms)= 1.467 (i)
TIME TO PEAK (hrs)= 12.483
RUNOFF VOLUME (mm)= 34.942
TOTAL RAINFALL (mm)= 101.772
RUNOFF COEFFICIENT = .343

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB	Area (ha)= .88
STANDHYD (0205)	Total Imp(%)= 99.00 Dir. Conn.(%)= 99.00
ID= 1 DT= 2.0 min	

		IMPERVIOUS	PERVIOUS (i)
Surface Area	(ha)=	.87	.01
Dep. Storage	(mm)=	1.00	1.50
Average Slope	(%)=	10.00	2.00
Length	(m)=	10.00	40.00
Mannings n	=	.013	.250

NOTE: RAINFALL WAS TRANSFORMED TO 2.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.033	1.14	6.033	.00	12.033	14.66	18.03	1.83

.067	1.14	6.067	.00	12.067	14.66	18.07	1.83
.100	1.14	6.100	.00	12.100	14.66	18.10	1.83
.133	1.14	6.133	.00	12.133	14.66	18.13	1.83
.167	1.14	6.167	.00	12.167	14.66	18.17	1.83
.200	1.14	6.200	.00	12.200	14.66	18.20	1.83
.233	1.14	6.233	.00	12.233	14.66	18.23	1.83
.267	1.12	6.267	.00	12.267	14.66	18.27	1.83
.300	1.10	6.300	.00	12.300	14.66	18.30	1.83
.333	1.10	6.333	.00	12.333	14.66	18.33	1.83
.367	1.10	6.367	.00	12.367	14.66	18.37	1.83
.400	1.10	6.400	.00	12.400	14.66	18.40	1.83
.433	1.10	6.433	.00	12.433	14.66	18.43	1.83
.467	1.10	6.467	.00	12.467	14.66	18.47	1.83
.500	1.10	6.500	.00	12.500	14.65	18.50	1.83
.533	1.14	6.533	.00	12.533	7.53	18.53	1.83
.567	1.14	6.567	.00	12.567	7.53	18.57	1.83
.600	1.14	6.600	.00	12.600	7.53	18.60	1.83
.633	1.14	6.633	.00	12.633	7.53	18.63	1.83
.667	1.14	6.667	.00	12.667	7.53	18.67	1.83
.700	1.14	6.700	.00	12.700	7.53	18.70	1.83
.733	1.14	6.733	.00	12.733	7.53	18.73	1.83
.767	1.12	6.767	.00	12.767	7.53	18.77	1.83
.800	1.10	6.800	.00	12.800	7.53	18.80	1.83
.833	1.10	6.833	.00	12.833	7.53	18.83	1.83
.867	1.10	6.867	.00	12.867	7.53	18.87	1.83
.900	1.10	6.900	.00	12.900	7.53	18.90	1.83
.933	1.10	6.933	.00	12.933	7.53	18.93	1.83
.967	1.10	6.967	.00	12.967	7.53	18.97	1.83
1.000	1.10	7.000	.00	13.000	7.52	19.00	1.83
1.033	1.14	7.033	4.07	13.033	1.43	19.03	1.83
1.067	1.14	7.067	4.07	13.067	1.43	19.07	1.83
1.100	1.14	7.100	4.07	13.100	1.43	19.10	1.83
1.133	1.14	7.133	4.07	13.133	1.43	19.13	1.83
1.167	1.14	7.167	4.07	13.167	1.43	19.17	1.83
1.200	1.14	7.200	4.07	13.200	1.43	19.20	1.83
1.233	1.14	7.233	4.07	13.233	1.43	19.23	1.83
1.267	1.12	7.267	4.07	13.267	1.43	19.27	1.83
1.300	1.10	7.300	4.07	13.300	1.43	19.30	1.83
1.333	1.10	7.333	4.07	13.333	1.43	19.33	1.83
1.367	1.10	7.367	4.07	13.367	1.43	19.37	1.83
1.400	1.10	7.400	4.07	13.400	1.43	19.40	1.83
1.433	1.10	7.433	4.07	13.433	1.43	19.43	1.83
1.467	1.10	7.467	4.07	13.467	1.43	19.47	1.83
1.500	1.10	7.500	4.07	13.500	1.44	19.50	1.83
1.533	1.14	7.533	4.07	13.533	8.35	19.53	1.83
1.567	1.14	7.567	4.07	13.567	8.35	19.57	1.83
1.600	1.14	7.600	4.07	13.600	8.35	19.60	1.83
1.633	1.14	7.633	4.07	13.633	8.35	19.63	1.83
1.667	1.14	7.667	4.07	13.667	8.35	19.67	1.83
1.700	1.14	7.700	4.07	13.700	8.35	19.70	1.83
1.733	1.14	7.733	4.07	13.733	8.35	19.73	1.83
1.767	1.12	7.767	4.07	13.767	8.35	19.77	1.83
1.800	1.10	7.800	4.07	13.800	8.35	19.80	1.83
1.833	1.10	7.833	4.07	13.833	8.35	19.83	1.83
1.867	1.10	7.867	4.07	13.867	8.35	19.87	1.83
1.900	1.10	7.900	4.07	13.900	8.35	19.90	1.83
1.933	1.10	7.933	4.07	13.933	8.35	19.93	1.83
1.967	1.10	7.967	4.07	13.967	8.35	19.97	1.83
2.000	1.10	8.000	4.07	14.000	8.34	20.00	1.83
2.033	1.34	8.033	.00	14.033	3.05	20.03	1.22
2.067	1.34	8.067	.00	14.067	3.05	20.07	1.22
2.100	1.34	8.100	.00	14.100	3.05	20.10	1.22
2.133	1.34	8.133	.00	14.133	3.05	20.13	1.22
2.167	1.34	8.167	.00	14.167	3.05	20.17	1.22
2.200	1.34	8.200	.00	14.200	3.05	20.20	1.22
2.233	1.34	8.233	.00	14.233	3.05	20.23	1.22
2.267	1.32	8.267	.00	14.267	3.05	20.27	1.22
2.300	1.30	8.300	.00	14.300	3.05	20.30	1.22
2.333	1.30	8.333	.00	14.333	3.05	20.33	1.22
2.367	1.30	8.367	.00	14.367	3.05	20.37	1.22
2.400	1.30	8.400	.00	14.400	3.05	20.40	1.22
2.433	1.30	8.433	.00	14.433	3.05	20.43	1.22
2.467	1.30	8.467	.00	14.467	3.05	20.47	1.22
2.500	1.30	8.500	.00	14.500	3.05	20.50	1.22
2.533	1.34	8.533	5.50	14.533	3.05	20.53	1.22
2.567	1.34	8.567	5.50	14.567	3.05	20.57	1.22
2.600	1.34	8.600	5.50	14.600	3.05	20.60	1.22
2.633	1.34	8.633	5.50	14.633	3.05	20.63	1.22
2.667	1.34	8.667	5.50	14.667	3.05	20.67	1.22
2.700	1.34	8.700	5.50	14.700	3.05	20.70	1.22
2.733	1.34	8.733	5.50	14.733	3.05	20.73	1.22
2.767	1.32	8.767	5.50	14.767	3.05	20.77	1.22
2.800	1.30	8.800	5.50	14.800	3.05	20.80	1.22
2.833	1.30	8.833	5.50	14.833	3.05	20.83	1.22
2.867	1.30	8.867	5.50	14.867	3.05	20.87	1.22

2.900	1.30	8.900	5.50	14.900	3.05	20.90	1.22
2.933	1.30	8.933	5.50	14.933	3.05	20.93	1.22
2.967	1.30	8.967	5.50	14.967	3.05	20.97	1.22
3.000	1.30	9.000	5.50	15.000	3.05	21.00	1.22
3.033	1.34	9.033	3.26	15.033	3.05	21.03	1.22
3.067	1.34	9.067	3.26	15.067	3.05	21.07	1.22
3.100	1.34	9.100	3.26	15.100	3.05	21.10	1.22
3.133	1.34	9.133	3.26	15.133	3.05	21.13	1.22
3.167	1.34	9.167	3.26	15.167	3.05	21.17	1.22
3.200	1.34	9.200	3.26	15.200	3.05	21.20	1.22
3.233	1.34	9.233	3.26	15.233	3.05	21.23	1.22
3.267	1.32	9.267	3.26	15.267	3.05	21.27	1.22
3.300	1.30	9.300	3.26	15.300	3.05	21.30	1.22
3.333	1.30	9.333	3.26	15.333	3.05	21.33	1.22
3.367	1.30	9.367	3.26	15.367	3.05	21.37	1.22
3.400	1.30	9.400	3.26	15.400	3.05	21.40	1.22
3.433	1.30	9.433	3.26	15.433	3.05	21.43	1.22
3.467	1.30	9.467	3.26	15.467	3.05	21.47	1.22
3.500	1.30	9.500	3.26	15.500	3.05	21.50	1.22
3.533	1.34	9.533	.00	15.533	3.05	21.53	1.22
3.567	1.34	9.567	.00	15.567	3.05	21.57	1.22
3.600	1.34	9.600	.00	15.600	3.05	21.60	1.22
3.633	1.34	9.633	.00	15.633	3.05	21.63	1.22
3.667	1.34	9.667	.00	15.667	3.05	21.67	1.22
3.700	1.34	9.700	.00	15.700	3.05	21.70	1.22
3.733	1.34	9.733	.00	15.733	3.05	21.73	1.22
3.767	1.32	9.767	3.67	15.767	3.05	21.77	1.22
3.800	1.30	9.800	7.33	15.800	3.05	21.80	1.22
3.833	1.30	9.833	7.33	15.833	3.05	21.83	1.22
3.867	1.30	9.867	7.33	15.867	3.05	21.87	1.22
3.900	1.30	9.900	7.33	15.900	3.05	21.90	1.22
3.933	1.30	9.933	7.33	15.933	3.05	21.93	1.22
3.967	1.30	9.967	7.33	15.967	3.05	21.97	1.22
4.000	1.30	10.000	7.33	16.000	3.05	22.00	1.22
4.033	1.63	10.033	4.68	16.033	1.83	22.03	1.22
4.067	1.63	10.067	4.68	16.067	1.83	22.07	1.22
4.100	1.63	10.100	4.68	16.100	1.83	22.10	1.22
4.133	1.63	10.133	4.68	16.133	1.83	22.13	1.22
4.167	1.63	10.167	4.68	16.167	1.83	22.17	1.22
4.200	1.63	10.200	4.68	16.200	1.83	22.20	1.22
4.233	1.63	10.233	4.68	16.233	1.83	22.23	1.22
4.267	1.63	10.267	4.68	16.267	1.83	22.27	1.22
4.300	1.63	10.300	4.68	16.300	1.83	22.30	1.22
4.333	1.63	10.333	4.68	16.333	1.83	22.33	1.22
4.367	1.63	10.367	4.68	16.367	1.83	22.37	1.22
4.400	1.63	10.400	4.68	16.400	1.83	22.40	1.22
4.433	1.63	10.433	4.68	16.433	1.83	22.43	1.22
4.467	1.63	10.467	4.68	16.467	1.83	22.47	1.22
4.500	1.63	10.500	4.68	16.500	1.83	22.50	1.22
4.533	1.63	10.533	6.31	16.533	1.83	22.53	1.22
4.567	1.63	10.567	6.31	16.567	1.83	22.57	1.22
4.600	1.63	10.600	6.31	16.600	1.83	22.60	1.22
4.633	1.63	10.633	6.31	16.633	1.83	22.63	1.22
4.667	1.63	10.667	6.31	16.667	1.83	22.67	1.22
4.700	1.63	10.700	6.31	16.700	1.83	22.70	1.22
4.733	1.63	10.733	6.31	16.733	1.83	22.73	1.22
4.767	1.63	10.767	6.31	16.767	1.83	22.77	1.22
4.800	1.63	10.800	6.31	16.800	1.83	22.80	1.22
4.833	1.63	10.833	6.31	16.833	1.83	22.83	1.22
4.867	1.63	10.867	6.31	16.867	1.83	22.87	1.22
4.900	1.63	10.900	6.31	16.900	1.83	22.90	1.22
4.933	1.63	10.933	6.31	16.933	1.83	22.93	1.22
4.967	1.63	10.967	6.31	16.967	1.83	22.97	1.22
5.000	1.63	11.000	6.31	17.000	1.83	23.00	1.22
5.033	1.63	11.033	9.77	17.033	1.83	23.03	1.22
5.067	1.63	11.067	9.77	17.067	1.83	23.07	1.22
5.100	1.63	11.100	9.77	17.100	1.83	23.10	1.22
5.133	1.63	11.133	9.77	17.133	1.83	23.13	1.22
5.167	1.63	11.167	9.77	17.167	1.83	23.17	1.22
5.200	1.63	11.200	9.77	17.200	1.83	23.20	1.22
5.233	1.63	11.233	9.77	17.233	1.83	23.23	1.22
5.267	1.63	11.267	9.77	17.267	1.83	23.27	1.22
5.300	1.63	11.300	9.77	17.300	1.83	23.30	1.22
5.333	1.63	11.333	9.77	17.333	1.83	23.33	1.22
5.367	1.63	11.367	9.77	17.367	1.83	23.37	1.22
5.400	1.63	11.400	9.77	17.400	1.83	23.40	1.22
5.433	1.63	11.433	9.77	17.433	1.83	23.43	1.22
5.467	1.63	11.467	9.77	17.467	1.83	23.47	1.22
5.500	1.63	11.500	9.81	17.500	1.83	23.50	1.22
5.533	1.63	11.533	42.35	17.533	1.83	23.53	1.22
5.567	1.63	11.567	42.35	17.567	1.83	23.57	1.22
5.600	1.63	11.600	42.35	17.600	1.83	23.60	1.22
5.633	1.63	11.633	42.35	17.633	1.83	23.63	1.22
5.667	1.63	11.667	42.35	17.667	1.83	23.67	1.22
5.700	1.63	11.700	42.35	17.700	1.83	23.70	1.22

5.733	1.63	11.733	42.35	17.733	1.83	23.73	1.22
5.767	1.63	11.767	77.46	17.767	1.83	23.77	1.22
5.800	1.63	11.800	112.39	17.800	1.83	23.80	1.22
5.833	1.63	11.833	112.39	17.833	1.83	23.83	1.22
5.867	1.63	11.867	112.39	17.867	1.83	23.87	1.22
5.900	1.63	11.900	112.39	17.900	1.83	23.90	1.22
5.933	1.63	11.933	112.39	17.933	1.83	23.93	1.22
5.967	1.63	11.967	112.39	17.967	1.83	23.97	1.22
6.000	1.63	12.000	112.25	18.000	1.83	24.00	1.22

Max.Eff.Inten.(mm/hr)=	112.39	104.87	
over (min)	5.00	2.00	
Storage Coeff. (min)=	.31 (ii)	1.38 (ii)	
Unit Hyd. Tpeak (min)=	4.00	2.00	
Unit Hyd. peak (cms)=	.57	.65	
			TOTALS
PEAK FLOW (cms)=	.27	.00	.275 (iii)
TIME TO PEAK (hrs)=	11.90	11.97	11.97
RUNOFF VOLUME (mm)=	100.77	38.10	100.14
TOTAL RAINFALL (mm)=	101.77	101.77	101.77
RUNOFF COEFFICIENT =	.99	.37	.98

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

(i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
Fo (mm/hr)= 50.00 K (1/hr)= 2.00
Fc (mm/hr)= 7.50 Cum.Inf. (mm)= .00
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

DUHYD (0001)
Inlet Cap.= .170
#of Inlets= 1
Total(cms)= .2

	AREA (ha)	QPEAK (cms)	TPEAK (hrs)	R.V. (mm)
TOTAL HYD.(ID= 1):	.88	.27	11.97	100.14
MAJOR SYS.(ID= 2):	.08	.10	11.97	100.14
MINOR SYS.(ID= 3):	.80	.17	11.80	100.14

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

CALIB
NASHYD (0201)
ID= 1 DT= 8.0 min

Area (ha)= 20.91 Curve Number (CN)= 63.9
Ia (mm)= 8.20 # of Linear Res.(N)= 3.00
U.H. Tp(hrs)= .68

NOTE: RAINFALL WAS TRANSFORMED TO 8.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.133	1.14	6.133	.00	12.133	14.66	18.13	1.83
.267	1.13	6.267	.00	12.267	14.66	18.27	1.83
.400	1.10	6.400	.00	12.400	14.66	18.40	1.83
.533	1.11	6.533	.00	12.533	12.88	18.53	1.83
.667	1.14	6.667	.00	12.667	7.53	18.67	1.83
.800	1.13	6.800	.00	12.800	7.53	18.80	1.83
.933	1.10	6.933	.00	12.933	7.53	18.93	1.83
1.067	1.12	7.067	2.03	13.067	4.48	19.07	1.83
1.200	1.14	7.200	4.07	13.200	1.43	19.20	1.83
1.333	1.12	7.333	4.07	13.333	1.43	19.33	1.83
1.467	1.10	7.467	4.07	13.467	1.43	19.47	1.83
1.600	1.13	7.600	4.07	13.600	6.62	19.60	1.83
1.733	1.14	7.733	4.07	13.733	8.35	19.73	1.83
1.867	1.11	7.867	4.07	13.867	8.35	19.87	1.83
2.000	1.10	8.000	4.07	14.000	8.35	20.00	1.83
2.133	1.34	8.133	.00	14.133	3.05	20.13	1.22
2.267	1.33	8.267	.00	14.267	3.05	20.27	1.22
2.400	1.30	8.400	.00	14.400	3.05	20.40	1.22
2.533	1.31	8.533	1.37	14.533	3.05	20.53	1.22
2.667	1.34	8.667	5.50	14.667	3.05	20.67	1.22
2.800	1.32	8.800	5.50	14.800	3.05	20.80	1.22
2.933	1.30	8.933	5.50	14.933	3.05	20.93	1.22
3.067	1.32	9.067	4.38	15.067	3.05	21.07	1.22
3.200	1.34	9.200	3.26	15.200	3.05	21.20	1.22
3.333	1.31	9.333	3.26	15.333	3.05	21.33	1.22
3.467	1.30	9.467	3.26	15.467	3.05	21.47	1.22
3.600	1.33	9.600	.82	15.600	3.05	21.60	1.22

3.733	1.34	9.733	.00	15.733	3.05	21.73	1.22
3.867	1.30	9.867	6.41	15.867	3.05	21.87	1.22
4.000	1.30	10.000	7.33	16.000	3.05	22.00	1.22
4.133	1.63	10.133	4.68	16.133	1.83	22.13	1.22
4.267	1.63	10.267	4.68	16.267	1.83	22.27	1.22
4.400	1.63	10.400	4.68	16.400	1.83	22.40	1.22
4.533	1.63	10.533	5.09	16.533	1.83	22.53	1.22
4.667	1.63	10.667	6.31	16.667	1.83	22.67	1.22
4.800	1.63	10.800	6.31	16.800	1.83	22.80	1.22
4.933	1.63	10.933	6.31	16.933	1.83	22.93	1.22
5.067	1.63	11.067	8.04	17.067	1.83	23.07	1.22
5.200	1.63	11.200	9.77	17.200	1.83	23.20	1.22
5.333	1.63	11.333	9.77	17.333	1.83	23.33	1.22
5.467	1.63	11.467	9.77	17.467	1.83	23.47	1.22
5.600	1.63	11.600	34.20	17.600	1.83	23.60	1.22
5.733	1.63	11.733	42.35	17.733	1.83	23.73	1.22
5.867	1.63	11.867	103.63	17.867	1.83	23.87	1.22
6.000	1.63	12.000	112.39	18.000	1.83	24.00	1.22

Unit Hyd Qpeak (cms)= 1.174

PEAK FLOW (cms)= .804 (i)
TIME TO PEAK (hrs)= 12.533
RUNOFF VOLUME (mm)= 36.930
TOTAL RAINFALL (mm)= 101.773
RUNOFF COEFFICIENT = .363

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

ADD HYD (0210)		AREA	QPEAK	TPEAK	R.V.
1 + 2 = 3		(ha)	(cms)	(hrs)	(mm)
	ID1= 1 (0001):	.08	.105	11.97	100.14
+	ID2= 2 (0201):	20.91	.804	12.53	36.93
	ID = 3 (0210):	20.99	.804	12.53	37.18

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

ADD HYD (0211)		AREA	QPEAK	TPEAK	R.V.
1 + 2 = 3		(ha)	(cms)	(hrs)	(mm)
	ID1= 1 (0204):	37.00	1.467	12.48	34.94
+	ID2= 2 (0210):	20.99	.804	12.53	37.18
	ID = 3 (0211):	57.99	2.261	12.53	35.75

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

CALIB					
NASHYD (0203)	Area	(ha)=	1.99	Curve Number	(CN)= 70.0
ID= 1 DT= 2.0 min	Ia	(mm)=	7.20	# of Linear Res.	(N)= 3.00
	U.H. Tp	(hrs)=	.03		

NOTE: RAINFALL WAS TRANSFORMED TO 2.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.033	1.14	6.033	.00	12.033	14.66	18.03	1.83
.067	1.14	6.067	.00	12.067	14.66	18.07	1.83
.100	1.14	6.100	.00	12.100	14.66	18.10	1.83
.133	1.14	6.133	.00	12.133	14.66	18.13	1.83
.167	1.14	6.167	.00	12.167	14.66	18.17	1.83
.200	1.14	6.200	.00	12.200	14.66	18.20	1.83
.233	1.14	6.233	.00	12.233	14.66	18.23	1.83
.267	1.12	6.267	.00	12.267	14.66	18.27	1.83
.300	1.10	6.300	.00	12.300	14.66	18.30	1.83
.333	1.10	6.333	.00	12.333	14.66	18.33	1.83
.367	1.10	6.367	.00	12.367	14.66	18.37	1.83
.400	1.10	6.400	.00	12.400	14.66	18.40	1.83
.433	1.10	6.433	.00	12.433	14.66	18.43	1.83
.467	1.10	6.467	.00	12.467	14.66	18.47	1.83
.500	1.10	6.500	.00	12.500	14.65	18.50	1.83
.533	1.14	6.533	.00	12.533	7.53	18.53	1.83
.567	1.14	6.567	.00	12.567	7.53	18.57	1.83

.600	1.14	6.600	.00	12.600	7.53	18.60	1.83
.633	1.14	6.633	.00	12.633	7.53	18.63	1.83
.667	1.14	6.667	.00	12.667	7.53	18.67	1.83
.700	1.14	6.700	.00	12.700	7.53	18.70	1.83
.733	1.14	6.733	.00	12.733	7.53	18.73	1.83
.767	1.12	6.767	.00	12.767	7.53	18.77	1.83
.800	1.10	6.800	.00	12.800	7.53	18.80	1.83
.833	1.10	6.833	.00	12.833	7.53	18.83	1.83
.867	1.10	6.867	.00	12.867	7.53	18.87	1.83
.900	1.10	6.900	.00	12.900	7.53	18.90	1.83
.933	1.10	6.933	.00	12.933	7.53	18.93	1.83
.967	1.10	6.967	.00	12.967	7.53	18.97	1.83
1.000	1.10	7.000	.00	13.000	7.52	19.00	1.83
1.033	1.14	7.033	4.07	13.033	1.43	19.03	1.83
1.067	1.14	7.067	4.07	13.067	1.43	19.07	1.83
1.100	1.14	7.100	4.07	13.100	1.43	19.10	1.83
1.133	1.14	7.133	4.07	13.133	1.43	19.13	1.83
1.167	1.14	7.167	4.07	13.167	1.43	19.17	1.83
1.200	1.14	7.200	4.07	13.200	1.43	19.20	1.83
1.233	1.14	7.233	4.07	13.233	1.43	19.23	1.83
1.267	1.12	7.267	4.07	13.267	1.43	19.27	1.83
1.300	1.10	7.300	4.07	13.300	1.43	19.30	1.83
1.333	1.10	7.333	4.07	13.333	1.43	19.33	1.83
1.367	1.10	7.367	4.07	13.367	1.43	19.37	1.83
1.400	1.10	7.400	4.07	13.400	1.43	19.40	1.83
1.433	1.10	7.433	4.07	13.433	1.43	19.43	1.83
1.467	1.10	7.467	4.07	13.467	1.43	19.47	1.83
1.500	1.10	7.500	4.07	13.500	1.44	19.50	1.83
1.533	1.14	7.533	4.07	13.533	8.35	19.53	1.83
1.567	1.14	7.567	4.07	13.567	8.35	19.57	1.83
1.600	1.14	7.600	4.07	13.600	8.35	19.60	1.83
1.633	1.14	7.633	4.07	13.633	8.35	19.63	1.83
1.667	1.14	7.667	4.07	13.667	8.35	19.67	1.83
1.700	1.14	7.700	4.07	13.700	8.35	19.70	1.83
1.733	1.14	7.733	4.07	13.733	8.35	19.73	1.83
1.767	1.12	7.767	4.07	13.767	8.35	19.77	1.83
1.800	1.10	7.800	4.07	13.800	8.35	19.80	1.83
1.833	1.10	7.833	4.07	13.833	8.35	19.83	1.83
1.867	1.10	7.867	4.07	13.867	8.35	19.87	1.83
1.900	1.10	7.900	4.07	13.900	8.35	19.90	1.83
1.933	1.10	7.933	4.07	13.933	8.35	19.93	1.83
1.967	1.10	7.967	4.07	13.967	8.35	19.97	1.83
2.000	1.10	8.000	4.07	14.000	8.34	20.00	1.83
2.033	1.34	8.033	.00	14.033	3.05	20.03	1.22
2.067	1.34	8.067	.00	14.067	3.05	20.07	1.22
2.100	1.34	8.100	.00	14.100	3.05	20.10	1.22
2.133	1.34	8.133	.00	14.133	3.05	20.13	1.22
2.167	1.34	8.167	.00	14.167	3.05	20.17	1.22
2.200	1.34	8.200	.00	14.200	3.05	20.20	1.22
2.233	1.34	8.233	.00	14.233	3.05	20.23	1.22
2.267	1.32	8.267	.00	14.267	3.05	20.27	1.22
2.300	1.30	8.300	.00	14.300	3.05	20.30	1.22
2.333	1.30	8.333	.00	14.333	3.05	20.33	1.22
2.367	1.30	8.367	.00	14.367	3.05	20.37	1.22
2.400	1.30	8.400	.00	14.400	3.05	20.40	1.22
2.433	1.30	8.433	.00	14.433	3.05	20.43	1.22
2.467	1.30	8.467	.00	14.467	3.05	20.47	1.22
2.500	1.30	8.500	.00	14.500	3.05	20.50	1.22
2.533	1.34	8.533	5.50	14.533	3.05	20.53	1.22
2.567	1.34	8.567	5.50	14.567	3.05	20.57	1.22
2.600	1.34	8.600	5.50	14.600	3.05	20.60	1.22
2.633	1.34	8.633	5.50	14.633	3.05	20.63	1.22
2.667	1.34	8.667	5.50	14.667	3.05	20.67	1.22
2.700	1.34	8.700	5.50	14.700	3.05	20.70	1.22
2.733	1.34	8.733	5.50	14.733	3.05	20.73	1.22
2.767	1.32	8.767	5.50	14.767	3.05	20.77	1.22
2.800	1.30	8.800	5.50	14.800	3.05	20.80	1.22
2.833	1.30	8.833	5.50	14.833	3.05	20.83	1.22
2.867	1.30	8.867	5.50	14.867	3.05	20.87	1.22
2.900	1.30	8.900	5.50	14.900	3.05	20.90	1.22
2.933	1.30	8.933	5.50	14.933	3.05	20.93	1.22
2.967	1.30	8.967	5.50	14.967	3.05	20.97	1.22
3.000	1.30	9.000	5.50	15.000	3.05	21.00	1.22
3.033	1.34	9.033	3.26	15.033	3.05	21.03	1.22
3.067	1.34	9.067	3.26	15.067	3.05	21.07	1.22
3.100	1.34	9.100	3.26	15.100	3.05	21.10	1.22
3.133	1.34	9.133	3.26	15.133	3.05	21.13	1.22
3.167	1.34	9.167	3.26	15.167	3.05	21.17	1.22
3.200	1.34	9.200	3.26	15.200	3.05	21.20	1.22
3.233	1.34	9.233	3.26	15.233	3.05	21.23	1.22
3.267	1.32	9.267	3.26	15.267	3.05	21.27	1.22
3.300	1.30	9.300	3.26	15.300	3.05	21.30	1.22
3.333	1.30	9.333	3.26	15.333	3.05	21.33	1.22
3.367	1.30	9.367	3.26	15.367	3.05	21.37	1.22
3.400	1.30	9.400	3.26	15.400	3.05	21.40	1.22

3.433	1.30	9.433	3.26	15.433	3.05	21.43	1.22
3.467	1.30	9.467	3.26	15.467	3.05	21.47	1.22
3.500	1.30	9.500	3.26	15.500	3.05	21.50	1.22
3.533	1.34	9.533	.00	15.533	3.05	21.53	1.22
3.567	1.34	9.567	.00	15.567	3.05	21.57	1.22
3.600	1.34	9.600	.00	15.600	3.05	21.60	1.22
3.633	1.34	9.633	.00	15.633	3.05	21.63	1.22
3.667	1.34	9.667	.00	15.667	3.05	21.67	1.22
3.700	1.34	9.700	.00	15.700	3.05	21.70	1.22
3.733	1.34	9.733	.00	15.733	3.05	21.73	1.22
3.767	1.32	9.767	3.67	15.767	3.05	21.77	1.22
3.800	1.30	9.800	7.33	15.800	3.05	21.80	1.22
3.833	1.30	9.833	7.33	15.833	3.05	21.83	1.22
3.867	1.30	9.867	7.33	15.867	3.05	21.87	1.22
3.900	1.30	9.900	7.33	15.900	3.05	21.90	1.22
3.933	1.30	9.933	7.33	15.933	3.05	21.93	1.22
3.967	1.30	9.967	7.33	15.967	3.05	21.97	1.22
4.000	1.30	10.000	7.33	16.000	3.05	22.00	1.22
4.033	1.63	10.033	4.68	16.033	1.83	22.03	1.22
4.067	1.63	10.067	4.68	16.067	1.83	22.07	1.22
4.100	1.63	10.100	4.68	16.100	1.83	22.10	1.22
4.133	1.63	10.133	4.68	16.133	1.83	22.13	1.22
4.167	1.63	10.167	4.68	16.167	1.83	22.17	1.22
4.200	1.63	10.200	4.68	16.200	1.83	22.20	1.22
4.233	1.63	10.233	4.68	16.233	1.83	22.23	1.22
4.267	1.63	10.267	4.68	16.267	1.83	22.27	1.22
4.300	1.63	10.300	4.68	16.300	1.83	22.30	1.22
4.333	1.63	10.333	4.68	16.333	1.83	22.33	1.22
4.367	1.63	10.367	4.68	16.367	1.83	22.37	1.22
4.400	1.63	10.400	4.68	16.400	1.83	22.40	1.22
4.433	1.63	10.433	4.68	16.433	1.83	22.43	1.22
4.467	1.63	10.467	4.68	16.467	1.83	22.47	1.22
4.500	1.63	10.500	4.68	16.500	1.83	22.50	1.22
4.533	1.63	10.533	6.31	16.533	1.83	22.53	1.22
4.567	1.63	10.567	6.31	16.567	1.83	22.57	1.22
4.600	1.63	10.600	6.31	16.600	1.83	22.60	1.22
4.633	1.63	10.633	6.31	16.633	1.83	22.63	1.22
4.667	1.63	10.667	6.31	16.667	1.83	22.67	1.22
4.700	1.63	10.700	6.31	16.700	1.83	22.70	1.22
4.733	1.63	10.733	6.31	16.733	1.83	22.73	1.22
4.767	1.63	10.767	6.31	16.767	1.83	22.77	1.22
4.800	1.63	10.800	6.31	16.800	1.83	22.80	1.22
4.833	1.63	10.833	6.31	16.833	1.83	22.83	1.22
4.867	1.63	10.867	6.31	16.867	1.83	22.87	1.22
4.900	1.63	10.900	6.31	16.900	1.83	22.90	1.22
4.933	1.63	10.933	6.31	16.933	1.83	22.93	1.22
4.967	1.63	10.967	6.31	16.967	1.83	22.97	1.22
5.000	1.63	11.000	6.31	17.000	1.83	23.00	1.22
5.033	1.63	11.033	9.77	17.033	1.83	23.03	1.22
5.067	1.63	11.067	9.77	17.067	1.83	23.07	1.22
5.100	1.63	11.100	9.77	17.100	1.83	23.10	1.22
5.133	1.63	11.133	9.77	17.133	1.83	23.13	1.22
5.167	1.63	11.167	9.77	17.167	1.83	23.17	1.22
5.200	1.63	11.200	9.77	17.200	1.83	23.20	1.22
5.233	1.63	11.233	9.77	17.233	1.83	23.23	1.22
5.267	1.63	11.267	9.77	17.267	1.83	23.27	1.22
5.300	1.63	11.300	9.77	17.300	1.83	23.30	1.22
5.333	1.63	11.333	9.77	17.333	1.83	23.33	1.22
5.367	1.63	11.367	9.77	17.367	1.83	23.37	1.22
5.400	1.63	11.400	9.77	17.400	1.83	23.40	1.22
5.433	1.63	11.433	9.77	17.433	1.83	23.43	1.22
5.467	1.63	11.467	9.77	17.467	1.83	23.47	1.22
5.500	1.63	11.500	9.81	17.500	1.83	23.50	1.22
5.533	1.63	11.533	42.35	17.533	1.83	23.53	1.22
5.567	1.63	11.567	42.35	17.567	1.83	23.57	1.22
5.600	1.63	11.600	42.35	17.600	1.83	23.60	1.22
5.633	1.63	11.633	42.35	17.633	1.83	23.63	1.22
5.667	1.63	11.667	42.35	17.667	1.83	23.67	1.22
5.700	1.63	11.700	42.35	17.700	1.83	23.70	1.22
5.733	1.63	11.733	42.35	17.733	1.83	23.73	1.22
5.767	1.63	11.767	77.46	17.767	1.83	23.77	1.22
5.800	1.63	11.800	112.39	17.800	1.83	23.80	1.22
5.833	1.63	11.833	112.39	17.833	1.83	23.83	1.22
5.867	1.63	11.867	112.39	17.867	1.83	23.87	1.22
5.900	1.63	11.900	112.39	17.900	1.83	23.90	1.22
5.933	1.63	11.933	112.39	17.933	1.83	23.93	1.22
5.967	1.63	11.967	112.39	17.967	1.83	23.97	1.22
6.000	1.63	12.000	112.25	18.000	1.83	24.00	1.22

Unit Hyd Qpeak (cms)= 2.534

PEAK FLOW (cms)= .327 (i)
TIME TO PEAK (hrs)= 12.000
RUNOFF VOLUME (mm)= 40.876
TOTAL RAINFALL (mm)= 101.772

RUNOFF COEFFICIENT = .402

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB			
NASHYD (0202)	Area (ha)= 1.03	Curve Number (CN)= 69.7	
ID= 1 DT= 2.0 min	Ia (mm)= 7.30	# of Linear Res.(N)= 3.00	
	U.H. Tp(hrs)= .03		

Unit Hyd Qpeak (cms)= 1.311

PEAK FLOW (cms)= .168 (i)
TIME TO PEAK (hrs)= 12.000
RUNOFF VOLUME (mm)= 26.279
TOTAL RAINFALL (mm)= 101.772
RUNOFF COEFFICIENT = .258

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

ADD HYD (0003)
1 + 2 = 3

	AREA (ha)	QPEAK (cms)	TPEAK (hrs)	R.V. (mm)
ID1= 1 (0203):	1.99	.327	12.00	40.88
+ ID2= 2 (0202):	1.03	.168	12.00	26.28
ID = 3 (0003):	3.02	.495	12.00	35.90

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

ADD HYD (0002)
1 + 2 = 3

	AREA (ha)	QPEAK (cms)	TPEAK (hrs)	R.V. (mm)
ID1= 1 (0211):	57.99	2.261	12.53	35.75
+ ID2= 2 (0003):	3.02	.495	12.00	35.90
ID = 3 (0002):	61.01	2.329	12.50	35.76

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

RESERVOIR (0500)
IN= 2---> OUT= 1
DT= 2.0 min

OUTFLOW (cms)	STORAGE (ha.m.)	OUTFLOW (cms)	STORAGE (ha.m.)
.0000	.0000	1.2400	.8500
.0010	.5000	2.0600	1.0500
.2400	.5500	5.0000	1.1000
.5500	.6500	10.0000	1.1500

	AREA (ha)	QPEAK (cms)	TPEAK (hrs)	R.V. (mm)
INFLOW : ID= 2 (0002)	61.01	2.33	12.50	35.76
OUTFLOW: ID= 1 (0500)	61.01	1.23	13.37	27.79

PEAK FLOW REDUCTION [Qout/Qin](%)= 52.85
TIME SHIFT OF PEAK FLOW (min)= 52.00
MAXIMUM STORAGE USED (ha.m.)= .8476

****
** SIMULATION NUMBER: 8 **
****

READ STORM | Ptotal= 89.96 mm

Filename: K:\1307-A~2\OTTHYMO\
1307-F~1\CHI 100-yr Brant.stm
Comments: 100-Year Brant County 4-hour Chicago Sto

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.17	2.83	1.17	62.45	2.17	12.47	3.17	3.85
.33	3.61	1.33	196.78	2.33	9.56	3.33	3.38
.50	4.83	1.50	83.53	2.50	7.61	3.50	2.99
.67	6.91	1.67	41.46	2.67	6.23	3.67	2.68
.83	10.99	1.83	25.16	2.83	5.22	3.83	2.41

1.00	21.09	2.00	17.09	3.00	4.45	4.00	2.19

CALIB
NASHYD (0204)
ID= 1 DT= 7.0 min

Area (ha)= 37.00 Curve Number (CN)= 62.0
Ia (mm)= 8.50 # of Linear Res.(N)= 3.00
U.H. Tp(hrs)= .60

NOTE: RAINFALL WAS TRANSFORMED TO 7.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.117	2.83	1.167	62.45	2.217	11.22	3.27	3.45
.233	3.28	1.283	196.78	2.333	9.56	3.38	3.21
.350	3.78	1.400	132.07	2.450	7.61	3.50	2.99
.467	4.83	1.517	77.52	2.567	6.82	3.62	2.68
.583	6.32	1.633	41.46	2.683	6.09	3.73	2.53
.700	8.08	1.750	29.82	2.800	5.22	3.85	2.38
.817	10.99	1.867	22.85	2.917	4.67	3.97	2.19
.933	19.65	1.983	17.09	3.033	4.28		
1.050	38.82	2.100	13.13	3.150	3.85		

Unit Hyd Qpeak (cms)= 2.355

PEAK FLOW (cms)= 1.796 (i)
TIME TO PEAK (hrs)= 2.100
RUNOFF VOLUME (mm)= 27.939
TOTAL RAINFALL (mm)= 89.889
RUNOFF COEFFICIENT = .311

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB
STANDHYD (0205)
ID= 1 DT= 2.0 min

Area (ha)= .88
Total Imp(%)= 99.00 Dir. Conn.(%)= 99.00

		IMPERVIOUS	PERVIOUS (i)
Surface Area	(ha)=	.87	.01
Dep. Storage	(mm)=	1.00	1.50
Average Slope	(%)=	10.00	2.00
Length	(m)=	10.00	40.00
Mannings n	=	.013	.250

NOTE: RAINFALL WAS TRANSFORMED TO 2.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.033	2.83	1.033	62.45	2.033	12.47	3.03	3.85
.067	2.83	1.067	62.45	2.067	12.47	3.07	3.85
.100	2.83	1.100	62.45	2.100	12.47	3.10	3.85
.133	2.83	1.133	62.45	2.133	12.47	3.13	3.85
.167	2.83	1.167	62.45	2.167	12.47	3.17	3.85
.200	3.61	1.200	196.78	2.200	9.56	3.20	3.38
.233	3.61	1.233	196.78	2.233	9.56	3.23	3.38
.267	3.61	1.267	196.78	2.267	9.56	3.27	3.38
.300	3.61	1.300	196.78	2.300	9.56	3.30	3.38
.333	3.61	1.333	196.78	2.333	9.56	3.33	3.38
.367	4.83	1.367	83.53	2.367	7.61	3.37	2.99
.400	4.83	1.400	83.53	2.400	7.61	3.40	2.99
.433	4.83	1.433	83.53	2.433	7.61	3.43	2.99
.467	4.83	1.467	83.53	2.467	7.61	3.47	2.99
.500	4.83	1.500	83.53	2.500	7.61	3.50	2.99
.533	6.91	1.533	41.46	2.533	6.23	3.53	2.68
.567	6.91	1.567	41.46	2.567	6.23	3.57	2.68
.600	6.91	1.600	41.46	2.600	6.23	3.60	2.68
.633	6.91	1.633	41.46	2.633	6.23	3.63	2.68
.667	6.91	1.667	41.46	2.667	6.23	3.67	2.68
.700	10.99	1.700	25.16	2.700	5.22	3.70	2.41
.733	10.99	1.733	25.16	2.733	5.22	3.73	2.41
.767	10.99	1.767	25.16	2.767	5.22	3.77	2.41
.800	10.99	1.800	25.16	2.800	5.22	3.80	2.41
.833	10.99	1.833	25.16	2.833	5.22	3.83	2.41
.867	21.09	1.867	17.09	2.867	4.45	3.87	2.19
.900	21.09	1.900	17.09	2.900	4.45	3.90	2.19
.933	21.09	1.933	17.09	2.933	4.45	3.93	2.19
.967	21.09	1.967	17.09	2.967	4.45	3.97	2.19
1.000	21.09	2.000	17.09	3.000	4.45	4.00	2.19

Max.Eff.Inten.(mm/hr)=	196.78	171.80	
over (min)	5.00	2.00	
Storage Coeff. (min)=	.25 (ii)	1.10 (ii)	
Unit Hyd. Tpeak (min)=	4.00	2.00	
Unit Hyd. peak (cms)=	.57	.71	
			TOTALS
PEAK FLOW (cms)=	.48	.00	.480 (iii)
TIME TO PEAK (hrs)=	1.27	1.33	1.33
RUNOFF VOLUME (mm)=	88.96	49.95	88.57
TOTAL RAINFALL (mm)=	89.96	89.96	89.96
RUNOFF COEFFICIENT =	.99	.56	.98

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

(i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
Fo (mm/hr)= 50.00 K (1/hr)= 2.00
Fc (mm/hr)= 7.50 Cum.Inf. (mm)= .00
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

DUHYD (0001)
Inlet Cap.= .170
#of Inlets= 1
Total(cms)= .2

	AREA (ha)	QPEAK (cms)	TPEAK (hrs)	R.V. (mm)
TOTAL HYD.(ID= 1):	.88	.48	1.33	88.57
MAJOR SYS.(ID= 2):	.23	.31	1.33	88.57
MINOR SYS.(ID= 3):	.65	.17	1.20	88.57

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

CALIB
NASHYD (0201)
ID= 1 DT= 8.0 min

Area (ha)= 20.91 Curve Number (CN)= 63.9
Ia (mm)= 8.20 # of Linear Res.(N)= 3.00
U.H. Tp(hrs)= .68

NOTE: RAINFALL WAS TRANSFORMED TO 8.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.133	2.83	1.200	96.03	2.267	10.29	3.33	3.38
.267	3.42	1.333	196.78	2.400	8.58	3.47	2.99
.400	4.22	1.467	83.53	2.533	7.26	3.60	2.76
.533	5.35	1.600	51.98	2.667	6.23	3.73	2.54
.667	6.91	1.733	33.31	2.800	5.22	3.87	2.35
.800	10.99	1.867	23.14	2.933	4.64	4.00	2.19
.933	18.56	2.000	17.09	3.067	4.15		
1.067	41.77	2.133	12.47	3.200	3.73		

Unit Hyd Qpeak (cms)= 1.174

PEAK FLOW (cms)= .987 (i)
TIME TO PEAK (hrs)= 2.133
RUNOFF VOLUME (mm)= 29.674
TOTAL RAINFALL (mm)= 89.962
RUNOFF COEFFICIENT = .330

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

ADD HYD (0210)
1 + 2 = 3

	AREA (ha)	QPEAK (cms)	TPEAK (hrs)	R.V. (mm)
ID1= 1 (0001):	.23	.310	1.33	88.57
+ ID2= 2 (0201):	20.91	.987	2.13	29.67
ID = 3 (0210):	21.14	.987	2.13	30.31

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

ADD HYD (0211)

1 + 2 = 3	AREA (ha)	QPEAK (cms)	TPEAK (hrs)	R.V. (mm)
ID1= 1 (0204):	37.00	1.796	2.10	27.94
+ ID2= 2 (0210):	21.14	.987	2.13	30.31
ID = 3 (0211):	58.14	2.776	2.10	28.80

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

CALIB NASHYD (0203) ID= 1 DT= 2.0 min				
	Area (ha)=	1.99	Curve Number (CN)=	70.0
	Ia (mm)=	7.20	# of Linear Res.(N)=	3.00
	U.H. Tp(hrs)=	.03		

NOTE: RAINFALL WAS TRANSFORMED TO 2.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.033	2.83	1.033	62.45	2.033	12.47	3.03	3.85
.067	2.83	1.067	62.45	2.067	12.47	3.07	3.85
.100	2.83	1.100	62.45	2.100	12.47	3.10	3.85
.133	2.83	1.133	62.45	2.133	12.47	3.13	3.85
.167	2.83	1.167	62.45	2.167	12.47	3.17	3.85
.200	3.61	1.200	196.78	2.200	9.56	3.20	3.38
.233	3.61	1.233	196.78	2.233	9.56	3.23	3.38
.267	3.61	1.267	196.78	2.267	9.56	3.27	3.38
.300	3.61	1.300	196.78	2.300	9.56	3.30	3.38
.333	3.61	1.333	196.78	2.333	9.56	3.33	3.38
.367	4.83	1.367	83.53	2.367	7.61	3.37	2.99
.400	4.83	1.400	83.53	2.400	7.61	3.40	2.99
.433	4.83	1.433	83.53	2.433	7.61	3.43	2.99
.467	4.83	1.467	83.53	2.467	7.61	3.47	2.99
.500	4.83	1.500	83.53	2.500	7.61	3.50	2.99
.533	6.91	1.533	41.46	2.533	6.23	3.53	2.68
.567	6.91	1.567	41.46	2.567	6.23	3.57	2.68
.600	6.91	1.600	41.46	2.600	6.23	3.60	2.68
.633	6.91	1.633	41.46	2.633	6.23	3.63	2.68
.667	6.91	1.667	41.46	2.667	6.23	3.67	2.68
.700	10.99	1.700	25.16	2.700	5.22	3.70	2.41
.733	10.99	1.733	25.16	2.733	5.22	3.73	2.41
.767	10.99	1.767	25.16	2.767	5.22	3.77	2.41
.800	10.99	1.800	25.16	2.800	5.22	3.80	2.41
.833	10.99	1.833	25.16	2.833	5.22	3.83	2.41
.867	21.09	1.867	17.09	2.867	4.45	3.87	2.19
.900	21.09	1.900	17.09	2.900	4.45	3.90	2.19
.933	21.09	1.933	17.09	2.933	4.45	3.93	2.19
.967	21.09	1.967	17.09	2.967	4.45	3.97	2.19
1.000	21.09	2.000	17.09	3.000	4.45	4.00	2.19

Unit Hyd Qpeak (cms)= 2.534

PEAK FLOW (cms)= .454 (i)
TIME TO PEAK (hrs)= 1.333
RUNOFF VOLUME (mm)= 33.234
TOTAL RAINFALL (mm)= 89.962
RUNOFF COEFFICIENT = .369

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB NASHYD (0202) ID= 1 DT= 2.0 min				
	Area (ha)=	1.03	Curve Number (CN)=	69.7
	Ia (mm)=	7.30	# of Linear Res.(N)=	3.00
	U.H. Tp(hrs)=	.03		

Unit Hyd Qpeak (cms)= 1.311

PEAK FLOW (cms)= .233 (i)
TIME TO PEAK (hrs)= 1.333
RUNOFF VOLUME (mm)= 32.903
TOTAL RAINFALL (mm)= 89.962
RUNOFF COEFFICIENT = .366

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

ADD HYD (0003)					
1 + 2 = 3	AREA	QPEAK	TPEAK	R.V.	

	(ha)	(cms)	(hrs)	(mm)
ID1= 1 (0203):	1.99	.454	1.33	33.23
+ ID2= 2 (0202):	1.03	.233	1.33	32.90
ID = 3 (0003):	3.02	.687	1.33	33.12

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

ADD HYD (0002)
1 + 2 = 3

	AREA (ha)	QPEAK (cms)	TPEAK (hrs)	R.V. (mm)
ID1= 1 (0211):	58.14	2.776	2.10	28.80
+ ID2= 2 (0003):	3.02	.687	1.33	33.12
ID = 3 (0002):	61.16	2.839	2.10	29.01

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

RESERVOIR (0500)
IN= 2---> OUT= 1
DT= 2.0 min

OUTFLOW (cms)	STORAGE (ha.m.)	OUTFLOW (cms)	STORAGE (ha.m.)
.0000	.0000	1.2400	.8500
.0010	.5000	2.0600	1.0500
.2400	.5500	5.0000	1.1000
.5500	.6500	10.0000	1.1500

	AREA (ha)	QPEAK (cms)	TPEAK (hrs)	R.V. (mm)
INFLOW : ID= 2 (0002)	61.16	2.84	2.10	29.01
OUTFLOW: ID= 1 (0500)	61.16	1.59	2.90	21.17

PEAK FLOW REDUCTION [Qout/Qin](%)= 55.95
TIME SHIFT OF PEAK FLOW (min)= 48.00
MAXIMUM STORAGE USED (ha.m.)= .9350

FINISH

APPENDIX C – PRELIMINARY GEOTECHNICAL INVESTIGATION

V. A. WOOD (GUELPH) INCORPORATED
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
TELEPHONE: (519) 763-3101

PRELIMINARY GEOTECHNICAL INVESTIGATION

PROPOSED RESIDENTIAL DEVELOPMENT

PART LOTS 7, 8 & 9, CONCESSION 10

TOWNSHIP OF PUSLINCH (ARKELL), ONTARIO

Ref. No. G2547-6-2
February, 2006

Prepared for:

1648253 Ontario Inc.
c/o Mr. Tom Kukovica
794 Watson Road South
RR #1
Puslinch, Ontario

Distribution:

(4) Copies – 1648253 Ontario Inc.
(1) Copy – Van Harten Surveying Inc.
(1) Copies – R.J. Burnside & Associates Ltd.
(2) Copies – V.A. Wood (Guelph) Inc.

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3.0	SUBSURFACE CONDITIONS	3
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APPENDIX

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ENCLOSURES

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1.0 INTRODUCTION:

V.A. Wood (Guelph) Inc. was retained by 1648253 Ontario Inc. to carry out a preliminary geotechnical investigation for the proposed residential development on Part Lots 7, 8 & 9, Concession 10 in the Village of Arkell in the Township of Puslinch, Ontario.

The purpose of the investigation was to reveal the subsurface conditions and to determine the relevant soil properties for preliminary recommendations for the design and construction of the site services, residences, pavement areas and storm water management systems.

2.0 FIELD WORK:

The fieldwork was carried out on January 12, 13 and 16, and consisted of ten (10) boreholes at the locations shown on Enclosure 1. The boreholes were advanced to the sampling depths by means of a track-mounted, power auger machine, equipped for soil sampling. Standard Penetration tests were carried out at frequent intervals of depth and the results are shown on the Borehole Logs as N-values.

Engineering staff from V.A. Wood (Guelph) Inc. supervised the fieldwork. Geodetic ground elevations at Boreholes 1 to 8, inclusive were provided by Van Harten Surveying Inc. Elevations at Boreholes 9 and 10 were extrapolated from the Van Harten Surveying Inc. topographic survey.

3.0 SUBSURFACE CONDITIONS:

Full details of the soils encountered in each borehole are given on the Borehole Logs, Enclosures 2 to 11, inclusive and the following notes are intended to summarize this data.

*A surficial deposit of **topsoil** was encountered at all the boreholes. The thickness varied from 200 to 1500mm in thickness. A Standard Penetration test in the topsoil at Borehole 7 gave an N-value of 6 blows/300mm and the natural moisture content was found to be about 18%.*

*The topsoil at Boreholes 1 to 5, inclusive and 8 was underlain by a deposit of brown **sandy gravel**, which extended to a depth of 7.7 metres below grade and to the full depth of the investigation (i.e. 5.2 to 6.6 metres below grade). This material generally consisted of a sandy gravel matrix with a trace of silt and occasional cobble and boulder. Standard Penetration tests in this material gave N-values ranging between 17 and greater than 100 blows/300mm and the natural moisture content was found to range from 2 to 5%. Typical grain size distribution curves for this material can be found on Enclosures 12 and 13.*

Based on the test results, the deposit of sandy gravel is considered to be in a generally compact to very dense condition. It should be noted that the presence of gravel, cobble and boulder in the deposits may have resulted in high N-values and these may not accurately represent the relative density of the soils.

*The topsoil at Boreholes 6, 7, 9 and 10 was underlain by a deposit of brown **gravel and sand**, which extended to depths ranging between 6.9 and 7.2 metres below grade and to the full depth of the investigation (i.e. 3.3 to 6.2 metres below grade). This material generally consisted of a gravel and sand matrix with some silt and occasional cobble and boulder. Standard Penetration tests in this material gave N-values ranging between 18 and greater than 100 blows/300mm and the natural moisture content was found to range from 2 to 8%. Typical grain size distribution curves for this material can be found on Enclosures 14 and 15.*

Based on the test results, the deposit of gravel and sand is considered to be in a generally compact to very dense condition. It should be noted that the presence of gravel, cobble and boulder in the deposits may have resulted in high N-values and these may not accurately represent the relative density of the soils.

*A deposit of brown **silt** was encountered below the sandy gravel at Borehole 1 to a depth of 9.4 metres below grade. This material generally consisted of a silt matrix with some clay and sand, a trace of gravel and occasional cobble and boulder. A Standard Penetration test in this material gave an N-value of 79 blows/300mm and the natural moisture content was found to be about 15%. A typical grain size distribution curve for this material can be found on Enclosure 16.*

Based on the test results, the deposit of silt is considered to be in a generally very dense condition.

The gravel and sand at Borehole 10 was underlain by a deposit of brown, ***gravelly, silty sand till****, which extended to a depth of 10.1 metres below grade. This material generally consisted of a gravelly, silty sand matrix. Standard Penetration tests in this material gave N-values ranging between 74 and 91 blows/300mm and the natural moisture content was found to be about 6%. A typical grain size distribution curve for this material can be found on Enclosure 17.*

Based on the test results, the deposit of gravelly, silty sand till is considered to be in a generally very dense condition. It should be noted that the presence of gravel in the deposits may have resulted in high N-values and these may not accurately represent the relative density of the soils.

A deposit of brown ***sand and silt*** *was encountered below the gravelly, silty sand till at Borehole 10 to a depth of 11.0 metres below grade. This material generally consisted of a sand and silt matrix with a trace of clay and gravel. The natural moisture content was found to be about 16%. A typical grain size distribution curve for this material can be found on Enclosure 18.*

Based on the test results, the deposit of sand and silt is considered to be in a generally very dense condition.

The sand and silt at Borehole 10 was underlain by a deposit of brown, ***gravelly, silty sand till****, which extended to a depth of 11.7 metres below grade. This material generally consisted of a gravelly, silty sand matrix. A Standard Penetration test in this material gave an N-value of 68 blows/300mm. It should be noted that the presence of gravel in the deposits may have resulted in high N-values and these may not accurately represent the relative density of the soils.*

Based on the test results, the deposit of gravelly, silty sand till is considered to be in a generally very dense condition.

A deposit of brown ***sand*** *was encountered below the gravelly, silty sand till at Borehole 10. This deposit extended to the full depth of the investigation (i.e. 12.6 metres below grade) and generally consisted of a sand matrix with some silt and a trace of gravel. A Standard Penetration test in this material gave an N-value of greater than 100 blows/300mm. A typical grain size distribution curve for this material can be found on Enclosure 19.*

Based on the test results, the deposit of sand is considered to be in a generally very dense condition.

The silt at Borehole 1 and the gravel and sand at Borehole 7 were underlain by grey ***dolostone rock fragments****, which extended to the full depth of the investigaton (i.e. 7.3 to 9.5 metres below grade). Standard Penetration tests in this material gave N-values of 100 blows/300mm and the natural moisture content was found to be about 1%.*

Auger refusal on probable boulder or bedrock was encountered at Boreholes 1, 6, 7 and 8 at depths of 9.5, 3.3, 7.3 and 9.5 metres below grade, respectively.

4.0 GROUNDWATER CONDITIONS:

Boreholes 2 to 9, inclusive were dry to the full depth of the investigation on completion of the fieldwork programs on January 12, 13 and 16, 2004, respectively. Dry cave-ins were encountered at Boreholes 2, 4, 5, 8 and 9 at depths ranging between 4.0 and 5.0 metres below grade (i.e. El. 335.4m± to 340.3m±). Boreholes 1 and 10 encountered a free water surface at depths ranging between 9.1 and 10.1 metres below grade (El. 331.4m± to 334.8m±) on completion of the fieldwork program on January 12 and 16, 2006 respectively.

Monitoring wells were installed in Boreholes 1 and 10 on January 12 and 16, 2006, respectively for future groundwater level monitoring. A free water surface was encountered in Boreholes 1 and 10 at depths of 7.2 and 10.0 metres below grade (i.e. El. 333.3m± and 334.9m±), respectively on February 2, 2006.

An examination of the soil samples indicated that they were generally dry to saturated.

It is noted that no sub-artesian water pressures were encountered in any of the boreholes.

Based on the foregoing, the groundwater table is considered to be located at elevations between El. 333.3m± and 334.9m±.

5.0 DISCUSSION AND RECOMMENDATIONS:

5.1 General:

The boreholes encountered surficial deposits of topsoil underlain by compact to very dense sandy gravel or gravel and sand on very dense silt or gravelly, silty sand till on very dense sand and silt on very dense gravelly, silty sand till on very dense sand or probable boulder or bedrock.

The groundwater table is considered to be located at elevations ranging between El. 333.3m± and 334.9m±.

Details concerning the proposed development were not available at the time of this report and therefore the following discussion should be considered preliminary and should be reviewed when more details are available.

5.2 Sewers:

If storm sewer inverts are located at typical depths of between 3 and 4 metres below grade, excavations will encounter compact to very dense sandy gravel or gravel and sand. These deposits will generally provide adequate support for the pipes and allow the use of normal Class 'B' bedding using Granular 'A' material. Clear crushed stone should not be used as bedding unless it is wrapped with geotextile to prevent undesirable settlements caused from fines migrating into the voids of the stone. Where the exposed subgrade is less competent, the bedding thickness may have to be increased and it may be necessary to protect the excavation with a skim coat of concrete immediately after it has been exposed.

The excavated materials will be generally suitable for use as trench backfill provided that they are free of topsoil and boulders. If the on-site materials are or become wet, they should be air dried prior to re-use as trench backfill. The trench backfill should be placed in 150 to 200mm thick layers and uniformly compacted to at least 95% of its Standard Proctor maximum dry density. The backfill around manholes should consist of well-graded and well-compacted granular material.

To minimize potential problems and wetting of the subgrade material, backfilling operations should follow closely after excavations, so that only a minimal length of trench is exposed at a time. Should construction be carried out in the winter season, particular attention should be given to make sure no frozen material is used for backfill.

5.3 Foundations:

The deposits of topsoil are not considered to be a suitable bearing stratum. The foundations for the proposed residential dwellings should therefore be extended into the native sandy gravel or gravel and sand which will be suitable for supporting footings designed to an allowable bearing pressure of up to 200 kPa (4 ksf).

All exterior footings or footings in unheated areas should be located at least 1.2 metres below finished grade for adequate frost protection.

Elevation differences between adjacent footings should not be more than a half of the horizontal distance between them.

It is estimated that the total and differential settlements of footings designed to these bearing pressures will be less than 25 and 20mm respectively, which are normally considered acceptable for the proposed residential structures.

It is recommended that all foundation excavations be inspected by geotechnical personnel from V.A. Wood (Guelph) Inc. to ensure the founding materials are similar to those identified in the boreholes and that they are capable of supporting the design loads.

5.4 Excavation and Groundwater Control:

No major construction problems due to water are anticipated in excavations above El. 334.9m±. However, provision should be made for control of surface water run-off and minor seepage by pumping from local sumps on an as and where required basis.

The sides of the excavation to a depth of more than 1.2 metres (and above the water table) should either be cut back at a side slope of 1 to 1 or supported using adequately braced closed sheeting.

5.5 Floor Slabs:

All topsoil and any deleterious fill encountered should be stripped from the building areas and the proposed subgrade should be re-compacted from the surface to at least 95% of its Standard Proctor maximum dry density. Any loose/wet material encountered should be sub-excavated and replaced with approved fill.

The fill may consist of approved on-site materials free of cobbles/boulders or approved imported fill. All fill should be placed in 150 to 200mm thick lifts and compacted to at least 95% Standard Proctor maximum dry density. It is recommended the underfloor fill be placed at least one month prior to floor construction in order to minimize settlement.

A layer of well-graded, free-draining material, at least 150mm thick and compacted to at least 98% Standard Proctor maximum density, should be placed under the floor slabs to provide a uniform bearing surface and act as a vapour barrier.

Frequent inspections by geotechnical personnel from V.A. Wood (Guelph) Inc. should be carried out during construction to verify compaction of the subgrade and base courses by in-situ density testing using nuclear gauges.

5.6 Pavement Designs:

All topsoil and any deleterious materials encountered should be stripped from the proposed pavement area(s). The underlying subgrade should then be re-compacted from the surface to at least 95% of its Standard Proctor maximum dry density prior to construction of the pavement. Any loose areas which are detected should be sub-excavated and replaced with suitable approved on-site material or approved imported fill. All fill materials should be placed in 150 to 200mm thick lifts and compacted to at least 95% Standard Proctor maximum dry density.

Considering the probable traffic requirements and subsoil conditions, the following pavement designs are recommended:

Material	Passenger Car Parking (Light Duty) (mm)	Access Road (Medium Duty) (mm)
Asphaltic Concrete	50	90
Granular 'A' Base Course	150	150
Granular 'B' Sub-base Course	200	300

The base and sub-base granular materials should be compacted to at least 100% Standard Proctor maximum dry density. The asphalt should be compacted to OPS Specifications.

Frequent inspections by geotechnical personnel from V.A. Wood (Guelph) Inc. should be carried out during construction to verify the compaction of the subgrade, base courses and asphaltic concrete by in-situ density testing using nuclear gauges.

5.7 Storm Water Management:

The grain size distribution curves prepared for the samples obtained from the boreholes were compared to the family of curves presented in the Supplementary Guidelines to the Ontario Building Code 1997. Based on the Unified Soils Classification System, the soils are considered to have the following properties:

Material	Unified Soils Classification Group	Estimated Co-efficient of Permeability (k) (cm/sec)
Sandy Gravel, trace silt	(GW-GM)	10^{-1} to 10^{-4}
Sandy Gravel, trace silt	(GP-GM)	10^{-1} to 10^{-3}
Gravel and Sand, some silt	(GM)	10^{-2} to 10^{-4}
Silt, some clay, some sand, trace gravel	(ML)	10^{-5} to 10^{-6}
Gravelly, Silty Sand Till	(SM)	10^{-3} to 10^{-5}
Sand and Silt, trace clay, trace gravel	(SM)	10^{-3} to 10^{-5}
Sand, some silt, trace gravel	(SM)	10^{-3} to 10^{-5}

6.0 STATEMENT OF LIMITATIONS:

The Statement of Limitations presented on Appendix 'A' is an integral part of this report.

V.A. WOOD (GUELPH) INC.

[redacted]

Mikko Nyyssonen, M.Eng., P.Eng.
Senior Engineer

PROVINCE OF ONTARIO

[redacted]

J. Broad, BA
General Manager

MN:sm

Encls.

4 copies

APPENDIX

STATEMENT OF LIMITATIONS:

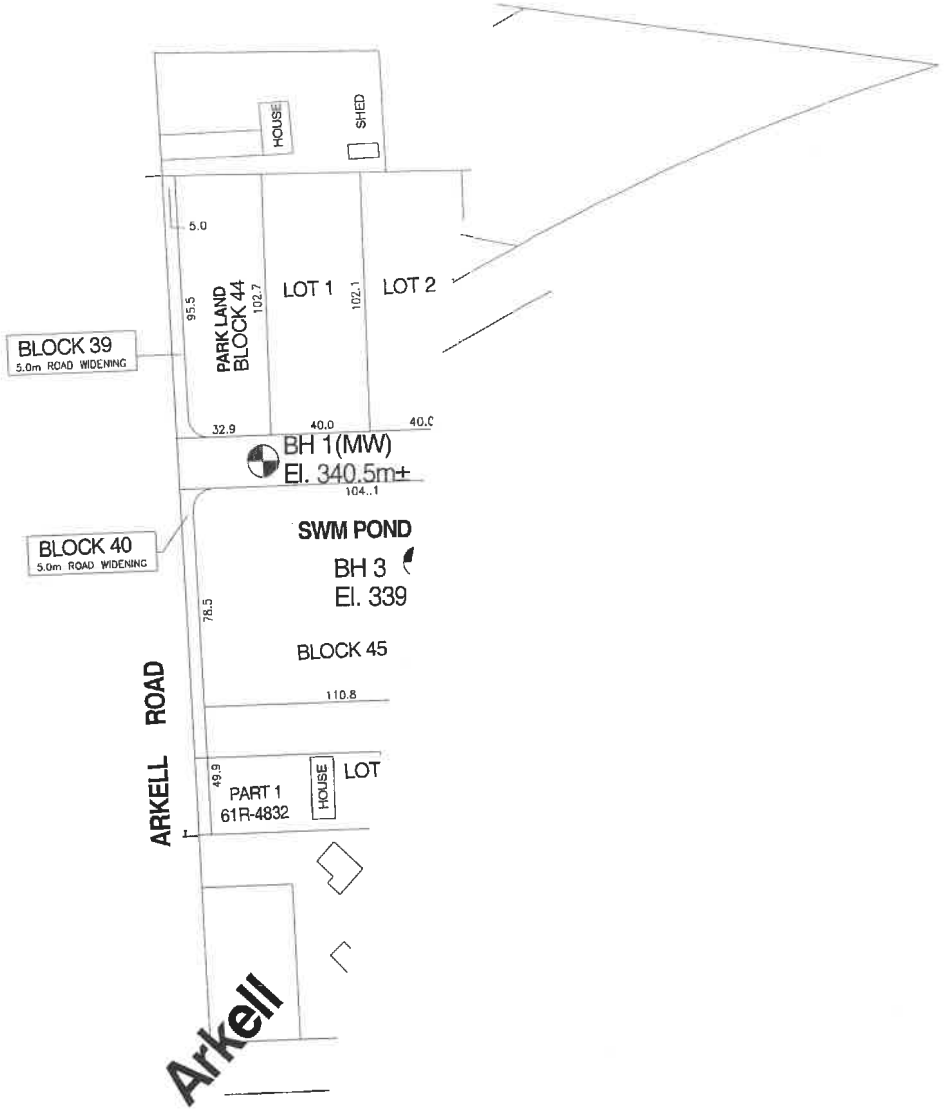
The conclusions and recommendations in this report are based on information determined at the borehole locations and on geological data of a general nature, which may be available, for the area investigated. Soil and groundwater conditions between and beyond the boreholes may differ from those encountered at the borehole locations and conditions may become apparent during construction, which would not be detected or anticipated at the time of the soil investigation.

We recommend that we be retained to ensure that all necessary stripping, subgrade preparation and compaction requirements are met, and to confirm that the soil conditions do not deviate materially from those encountered in the boreholes. ***In cases where this recommendation is not followed the company's responsibility is limited to interpreting accurately the information encountered at the boreholes.***

This report is applicable only to the project described in the introduction, constructed substantially in accordance with details of alignment and elevations quoted in the text.

V.A. Wood (Guelph) Inc. prepared this report for 1648253 Ontario Inc. The material in it reflects V.A. Wood (Guelph) Inc. judgement in light of the information available to it at the time of preparation. Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, is the responsibility of such Third Parties. V.A. Wood (Guelph) Inc. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

ENCLOSURES



V.A. WOOD (GUELPH) INC.
Consulting Geotechnical Engineers

405 York Road, Guelph, Ontario N1E 3H3
Ph. (519) 763-3101 Fax. (519) 763-5912

Borehole Location Plan
Proposed Residential Development
Part Lots 7, 8 & 9, Concession 10
Township of Puslinch (Arkell), Ontario

Scale: 1:3000	Ref. No. G2547-6-2
Date: February 2, 2006	Enclosure 1

REFERENCE No: G2547-6-2

BOREHOLE No: 1

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 2

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: B.R.F.

DEPTH (m)	DESCRIPTION	ELEVATION	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	340.5			
0.3	300mm Topsoil	340.2			
	brown, compact to very dense SANDY GRAVEL trace silt, occasional cobble, moist to dry		1	SS	17
			2	SS	61
			3	SS	45
			4	SS	52
			5	SS	57
			6	SS	42
7.7		332.8			
	brown, very dense SILT some clay, some sand, trace gravel, occasional cobble & boulder, moist		7	SS	79
8.4		331.1	8	SS	50
	grey Dolostone Rock Fragments wet				
	Auger Refusal/Boulder/Bedrock				

Bentonite Hole Plug
51mm OD Trilock Pipe
W.L. @ 333.3m (February 2, 2006)
Industrial Sand
Screen

PENETRATION RESISTANCE BLOWS/0.3m
20 40 60 80
150mm
100mm

WATER CONTENT %
5 10 15 20 25

UNIT WEIGHT

DRILLED BY: Aardvark Drilling Inc.

DRILL METHOD: Hollow-Stem Auger

DRILL DATE: January 12, 2006

HOLE DIAMETER: 210mm

DATUM: Geodetic

SHEET: 1 of 1

REFERENCE No: G2547-6-2

BOREHOLE No: 2

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 3

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: B.R.F.

SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	340.1								
0.4	400mm Topsoil	339.7								
	brown, dense to very dense SANDY GRAVEL trace silt, occasional cobble, moist to dry			▽ DRY CAVE-IN @ 335.4m (January 12, 2006)	1	SS	48			
					2	SS	63			
					3	SS	49			
	occasional boulder @ 4.3m				4	SS	61			
					5	SS	50	50mm		
6.6		333.5			6	SS	81			
	End of Borehole									

DRILLED BY: Aardvark Drilling Inc.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow-Stem Auger

DATUM: Geodetic

DRILL DATE: January 12, 2006

SHEET: 1 of 1

REFERENCE No: G2547-6-2

BOREHOLE No: 3

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 4

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: B.R.F.

SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	339.9								
0.2	200mm Topsoil	339.7								
	brown, very dense SANDY GRAVEL trace silt, occasional cobble, dry			DRY (January 12, 2006)	1	SS	36			
					2	SS	50	125mm		
	occasional boulder @ 3.6m				3	SS	45			
					4	SS	50			
					5	SS	40			
6.6		333.3			6	SS	43			
	End of Borehole									

DRILLED BY: Aardvark Drilling Inc.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow-Stem Auger

DATUM: Geodetic

DRILL DATE: January 12, 2006

SHEET: 1 of 1

REFERENCE No: G2547-6-2

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

BOREHOLE No: 4

ENCLOSURE No: 5

SUPERVISOR: B.R.F.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	340.9								
0.2	200mm Topsoil	340.7								
	brown, dense to very dense SANDY GRAVEL some silt, occasional cobble, moist to dry			DRY CAVE-IN @ 336.1m (January 13, 2006)	1	SS	41			
					2	SS	46			
					3	SS	48			
					4	SS	61			
					5	SS	54	125mm		
6.3		334.6			6	SS	50	75mm		
	End of Borehole									

DRILLED BY: Aardvark Drilling Inc.

DRILL METHOD: Hollow-Stem Auger

DRILL DATE: January 13, 2006

HOLE DIAMETER: 210mm

DATUM: Geodetic

SHEET: 1 of 1

REFERENCE No: G2547-6-2

BOREHOLE No: 5

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 6

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: B.R.F.

SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	341.9								
0.2	200mm Topsoil	341.7								
	brown, very dense to compact SANDY GRAVEL trace silt, occasional cobble, moist to dry			DRY CAVE-IN @ 336.9m (January 13, 2006)	1	SS	67	275mm		
					2	SS	26			
					3	SS	26			
					4	SS	30			
					5	SS	37			
6.6		335.3			6	SS	24			
	End of Borehole									

DRILLED BY: Aardvark Drilling Inc.

DRILL METHOD: Hollow-Stem Auger

DRILL DATE: January 13, 2006

HOLE DIAMETER: 210mm

DATUM: Geodetic

SHEET: 1 of 1

REFERENCE No: G2547-6-2

BOREHOLE No: 6

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 7

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: B.R.F.

SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	342.9								
0.3	250mm Topsoil	342.6								
	brown, compact to very dense GRAVEL AND SAND some silt, occasional cobble & boulder, moist			DRY (January 13, 2006)	1	SS	18			
					2	SS	73			
					3	SS	99			
3.3		339.6			4	SS	50	125mm		
	Refusal on Probable Boulder/Bedrock									

DRILLED BY: Aardvark Drilling Inc.

DRILL METHOD: Hollow-Stem Auger

DRILL DATE: January 13, 2006

HOLE DIAMETER: 210mm

DATUM: Geodetic

SHEET: 1 of 1

REFERENCE No: G2547-6-2

BOREHOLE No: 7

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 8

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: MN

SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	344.4								
	1500mm Topsoil				1	SS	6			
1.5		342.9								
	brown, compact to very dense GRAVEL AND SAND some silt, occasional cobble, dry				2	SS	20			
					3	SS	27			
					4	SS	30			
	occasional boulder @ 4.5m			DRY (January 16, 2006)						
					5	SS	19			
					6	SS	53			
7.2		337.2			7	SS	50	100mm		
7.3	grey Dolostone Rock Fragments	337.1								
	Refusal on Probable Boulder/Bedrock									

DRILLED BY: Aardvark Drilling Inc.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow-Stem Auger

DATUM: Geodetic

DRILL DATE: January 16, 2006

SHEET: 1 of 1

REFERENCE No: G2547-6-2

BOREHOLE No: 8

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 9

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: B.R.F.

SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	344.3								
0.2	200mm Topsoil	344.1								
	brown, compact to very dense SANDY GRAVEL some silt, occasional cobble, moist to dry			DRY CAVE-IN @ 340.3m (January 13, 2006)	1	SS	28			
					2	SS	53			
					3	SS	40			
					4	SS	78			
					5	SS	50	100mm		
5.2		339.1			6	SS	50	25mm		
	Refusal on Probable Boulder/Bedrock									

DRILLED BY: Aardvark Drilling Inc.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow-Stem Auger

DATUM: Geodetic

DRILL DATE: January 13, 2006

SHEET: 1 of 1

REFERENCE No: G2547-6-2

BOREHOLE No: 9

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 10

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: B.R.F.

SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	343.3								
0.3	250mm Topsoil	343.1								
	brown, dense to very dense GRAVEL AND SAND some silt, occasional cobble, moist to dry			DRY CAVE-IN @ 338.7m (January 13, 2006)	1	SS	31			
					2	SS	53	150mm		
					3	SS	45			
					4	SS	55	150mm		
					5	SS	50	25mm		
6.2		337.1			6	SS	50	100mm		
	End of Borehole									

DRILLED BY: Aardvark Drilling Inc.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow-Stem Auger

DATUM: Geodetic

DRILL DATE: January 13, 2006

SHEET: 1 of 1

REFERENCE No: G2547-6-2

BOREHOLE No: 10

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 11

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: MN

SUBSURFACE PROFILE					SAMPLE					
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	MONITORING WELL	NUMBER	TYPE	'N' BLOWS/0.3m	PENETRATION RESISTANCE BLOWS/0.3m (20 40 60 80)	WATER CONTENT % (5 10 15 20 25)	UNIT WEIGHT
0.0	Ground Surface	344.9								
0.8	800mm Topsoil	344.1								
	brown, very dense GRAVEL AND SAND some silt, occasional cobble, dry				1	SS	65			
					2	SS	64			
					3	SS	50	50mm		
					4	SS	40			
					5	SS	76	275mm		
6.9		338.0			6	SS	52			
	brown, very dense GRAVELLY, SILTY SAND TILL dry				7	SS	91			
10.1		334.8			8	SS	74			
11.0	brown, very dense SAND AND SILT trace clay, trace gravel, saturated	333.9			9	SS	68			
11.7	brown, very dense GRAVELLY, SILTY SAND TILL moist	333.2								
12.6	brown, very dense SAND some silt, trace gravel, wet	332.3			10	SS	86	250mm		
	End of Borehole									

Bentonite Hole Plug
Industrial Sand
Auger Cuttings
W.L. @ 334.9m (February 2, 2006)
51mm OD Trilock Pipe
Screen

DRILLED BY: Aardvark Drilling Inc.

DRILL METHOD: Hollow-Stem Auger

DRILL DATE: January 16, 2006

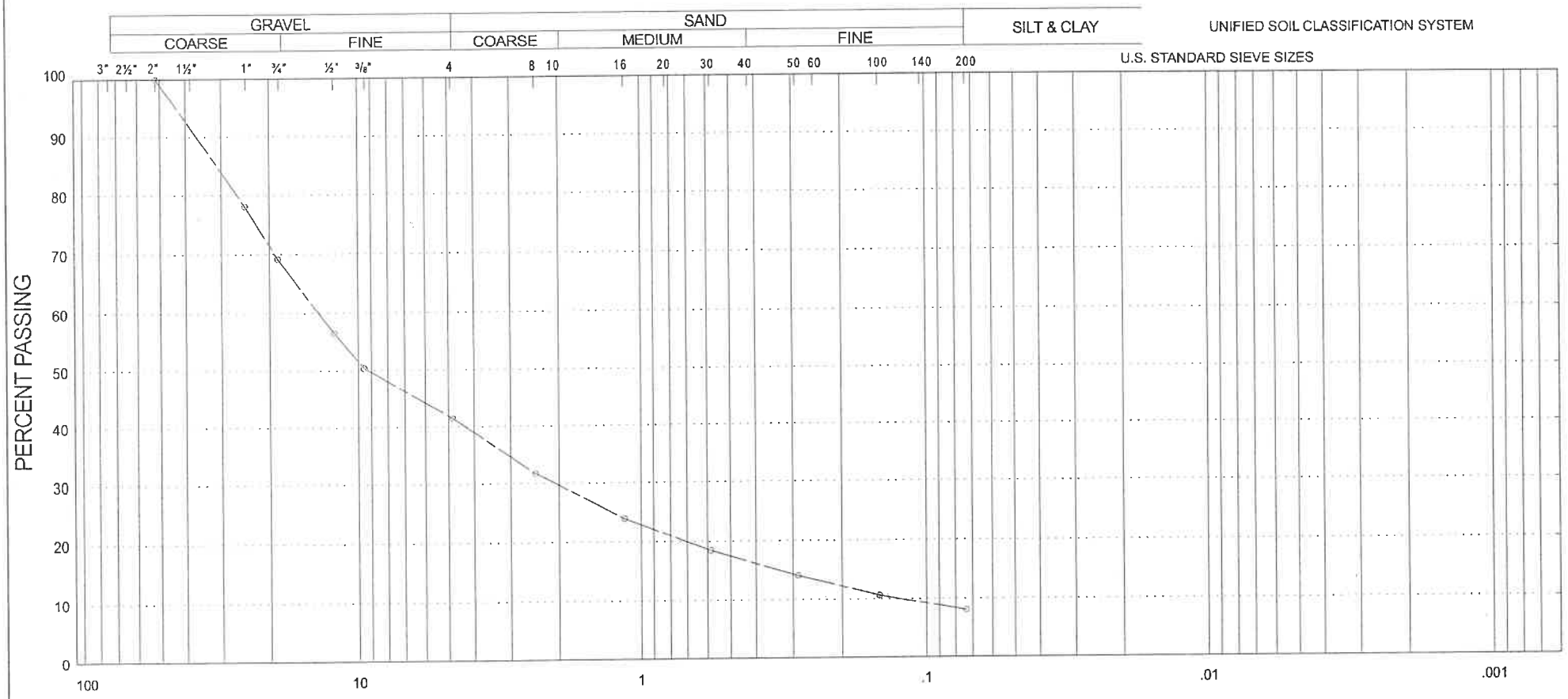
HOLE DIAMETER: 210mm

DATUM: Geodetic

SHEET: 1 of 1

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G2547-6-2



PROJECT: Proposed Residential Subdivision

LOCATION: Pt Lots 7, 8 & 9, Con 10, Puslinch, ON

BOREHOLE N°: 5

SAMPLE N°: 4

DEPTH: 3.0 - 3.5m±

ELEVATION: 338.9.0 - 338.4m±

COEFFICIENT OF UNIFORMITY: 6.4

COEFFICIENT OF CURVATURE: 2.5

Classification of Sample and Group Symbol:

SANDY GRAVEL, trace silt (GW-GM)

PLASTIC PROPERTIES

LIQUID LIMIT % =

PLASTIC LIMIT % =

PLASTICITY INDEX % =

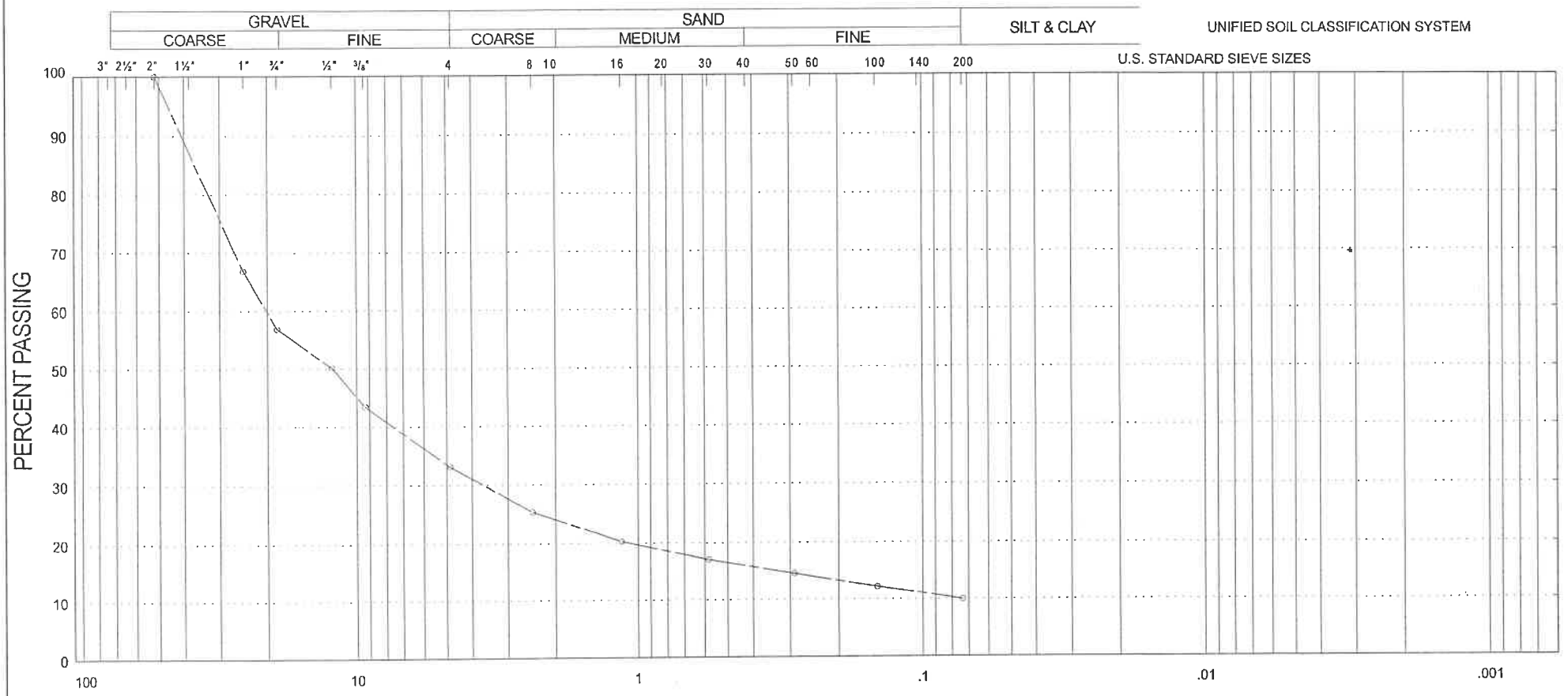
MOISTURE CONTENT % = 2.8

ENCLOSURE N° 12

V. A. WOOD (GUELPH) INCORPORATED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G2547-6-2



PROJECT: Proposed Residential Subdivision

LOCATION: Pt Lots 7, 8 & 9, Con 10, Puslinch, ON

BOREHOLE N°: 8

SAMPLE N°: 2

DEPTH: 1.5 - 2.0m±

ELEVATION: 342.8.0 - 342.3m±

COEFFICIENT OF UNIFORMITY: 273.9

COEFFICIENT OF CURVATURE: 8.9

Classification of Sample and Group Symbol:

SANDY GRAVEL, trace silt (GP-GM)

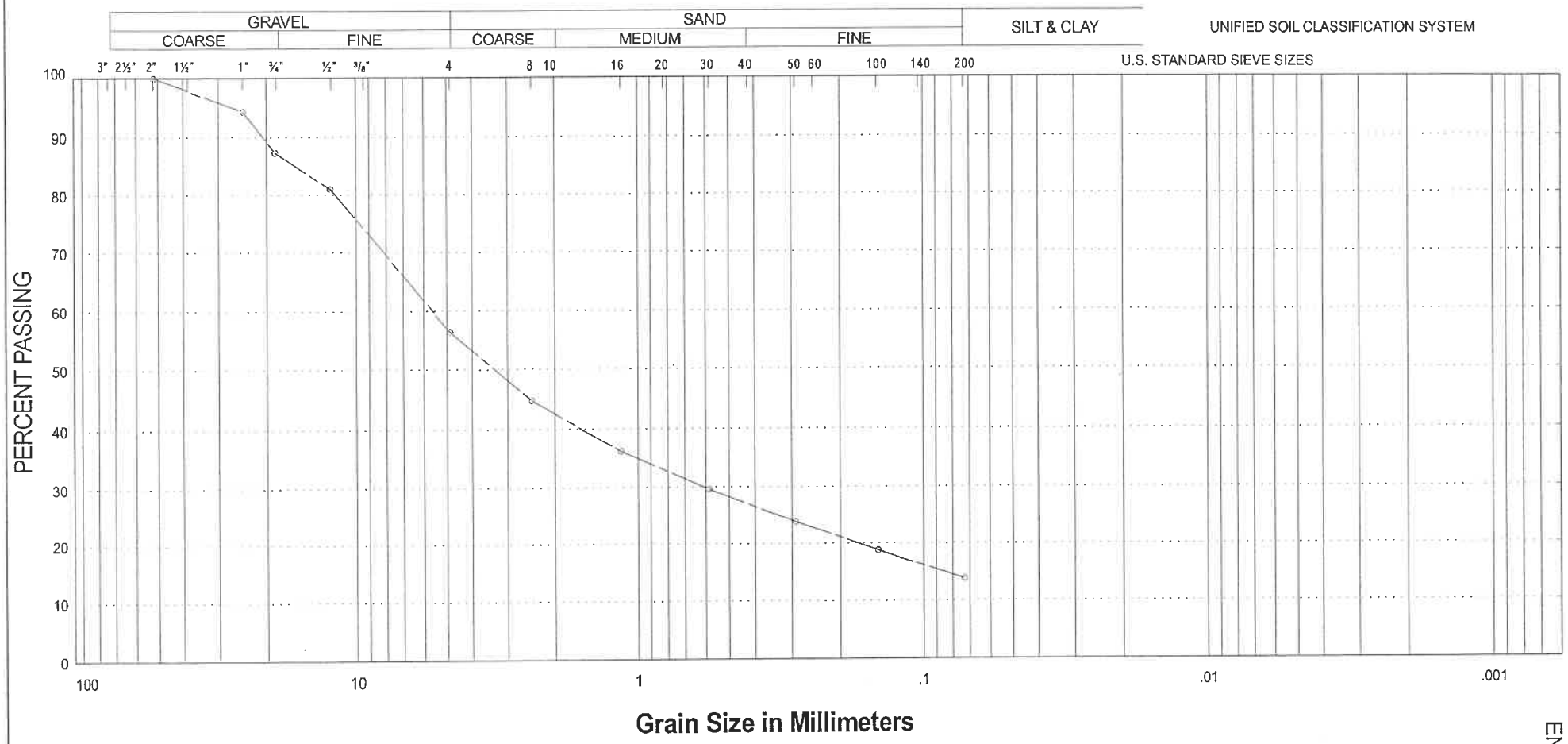
PLASTIC PROPERTIES

LIQUID LIMIT	% =
PLASTIC LIMIT	% =
PLASTICITY INDEX	% =
MOISTURE CONTENT	% = 2.6

ENCLOSURE N° 13

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G2547-6-2



PROJECT: Proposed Residential Subdivision

LOCATION: Pt Lots 7, 8 & 9, Con 10, Puslinch, ON

BOREHOLE N°: 6

SAMPLE N°: 2

DEPTH: 1.5 - 2.0m±

ELEVATION: 341.4.0 - 340.9m±

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

GRAVEL AND SAND, some silt (GM)

PLASTIC PROPERTIES

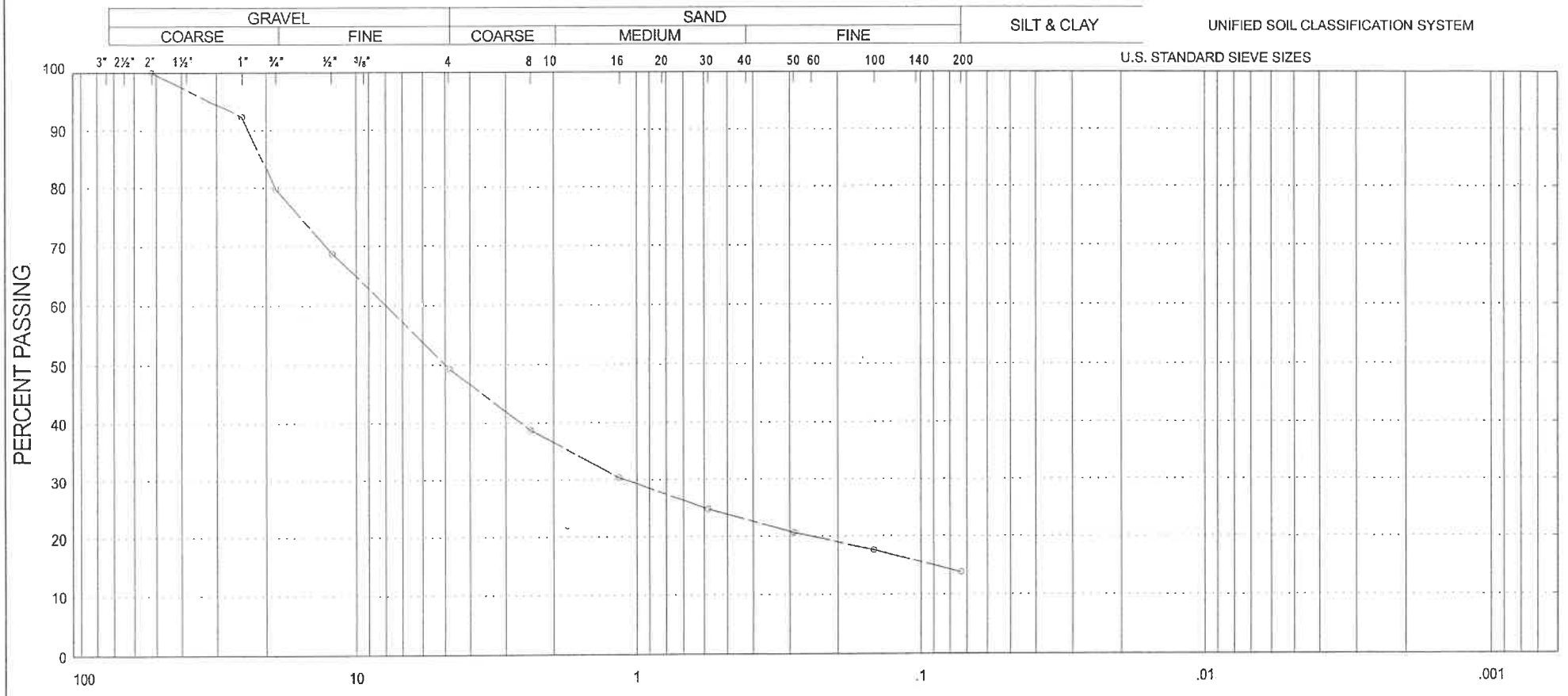
LIQUID LIMIT	% =
PLASTIC LIMIT	% =
PLASTICITY INDEX	% =
MOISTURE CONTENT	% = 3.7

ENCLOSURE N° 14

V. A. WOOD (GUELPH) INCORPORATED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G2547-6-2



PROJECT: Proposed Residential Subdivision

LOCATION: Pt Lots 7, 8 & 9, Con 10, Puslinch, ON

BOREHOLE N°: 9

SAMPLE N°: 3

DEPTH: 2.3 - 2.7m±

ELEVATION: 341.0 - 340.6m±

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

GRAVEL AND SAND, some silt (GM)

PLASTIC PROPERTIES

LIQUID LIMIT % =

PLASTIC LIMIT % =

PLASTICITY INDEX % =

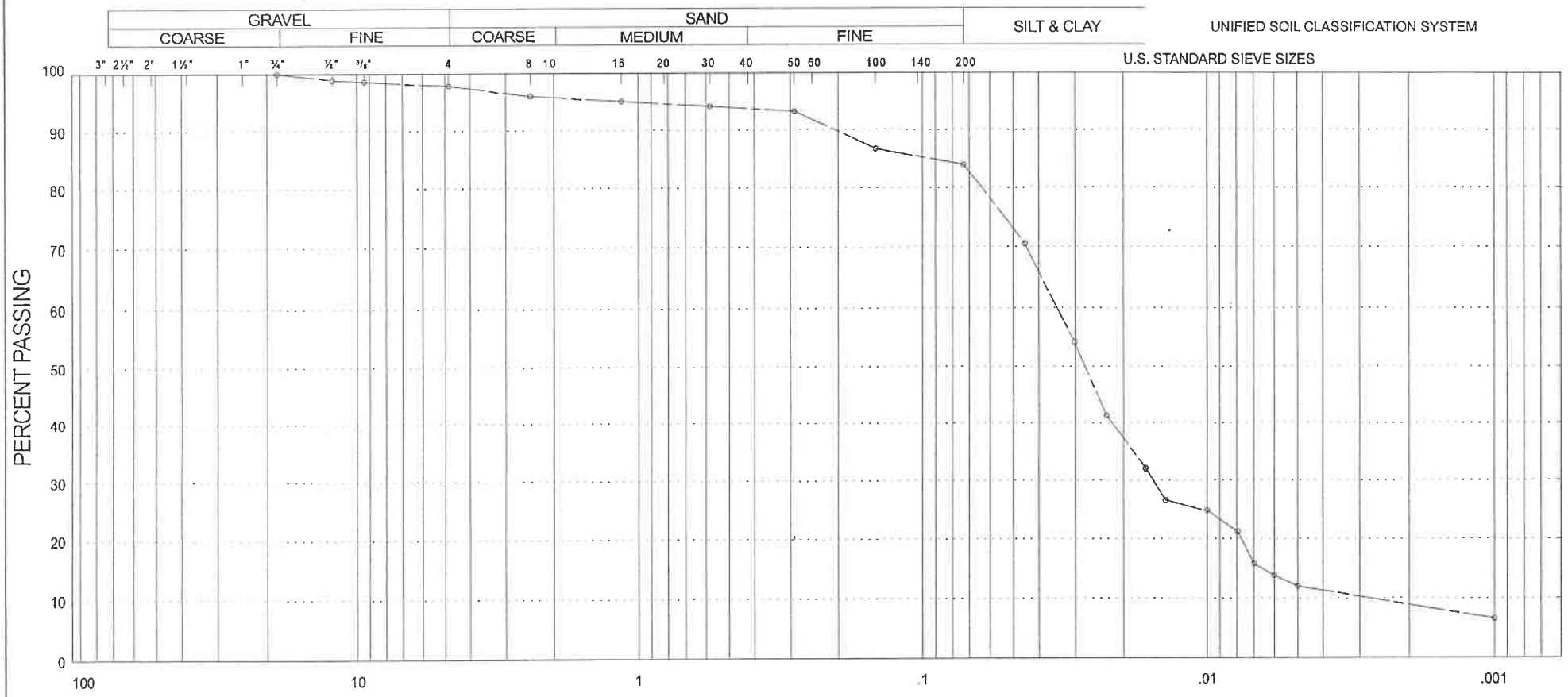
MOISTURE CONTENT % = 3.6

ENCLOSURE N° 15

V. A. WOOD (GUELPH) INCORPORATED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G2547-6-2



PROJECT: Proposed Residential Subdivision
LOCATION: Pt Lots 7, 8 & 9, Con. 10, Puslinch,ON
BOREHOLE N°: 1
SAMPLE N°: 7
DEPTH: 7.6 - 8.1m±
ELEVATION: 332.9 - 332.4m±

COEFFICIENT OF UNIFORMITY:
COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SILT, some clay, some sand, trace gravel (ML)

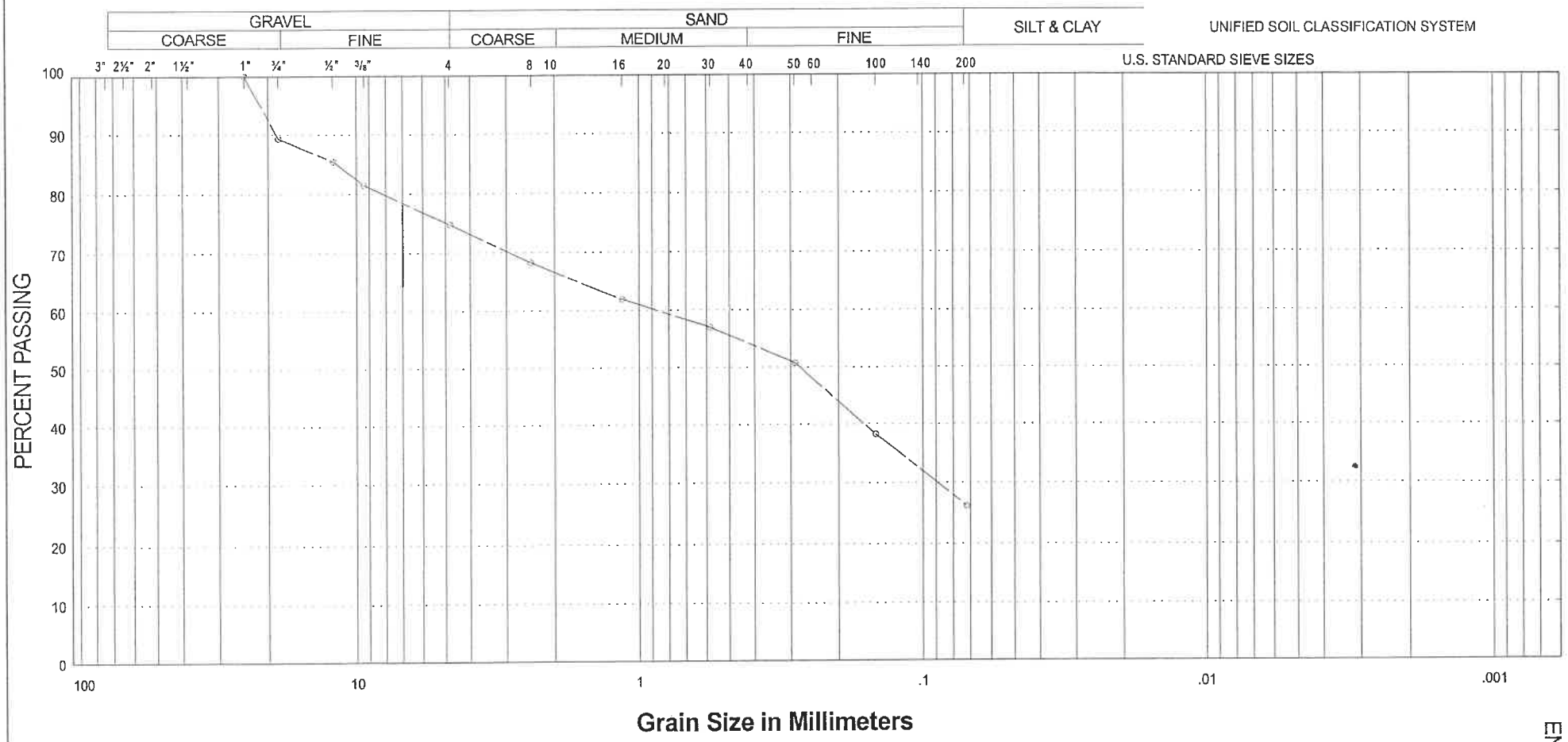
PLASTIC PROPERTIES
LIQUID LIMIT % =
PLASTIC LIMIT % =
PLASTICITY INDEX % =
MOISTURE CONTENT % = 14.8

ENCLOSURE N° 16

V. A. WOOD (GUELPH) INCORPORATED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G2547-6-2



PROJECT: Proposed Residential Subdivision

LOCATION: Pt Lots 7, 8 & 9, Con 10, Puslinch, ON

BOREHOLE N°: 10

SAMPLE N°: 8

DEPTH: 9.1 - 9.6m±

ELEVATION: 331.4 - 330.9m±

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

GRAVELLY, SILTY SAND TILL (SM)

PLASTIC PROPERTIES

LIQUID LIMIT % =

PLASTIC LIMIT % =

PLASTICITY INDEX % =

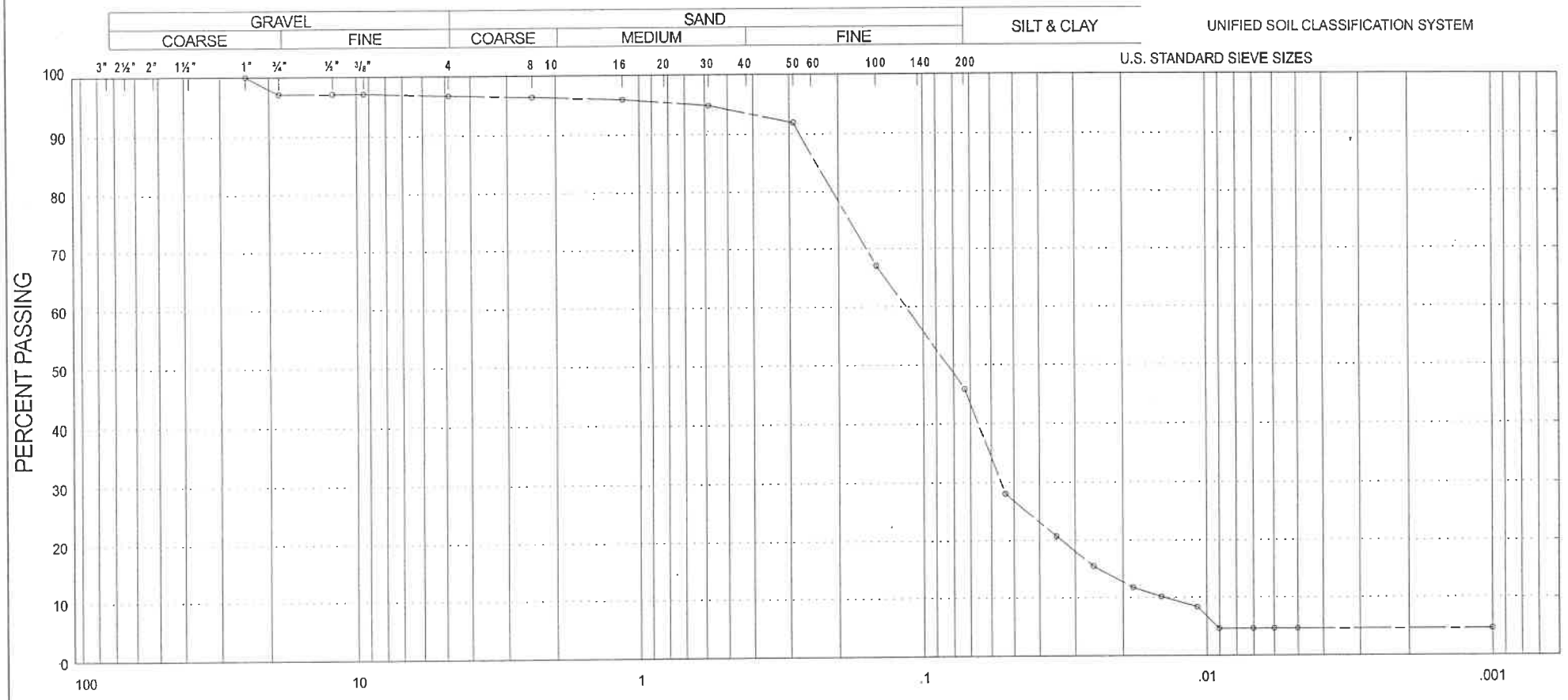
MOISTURE CONTENT % =

ENCLOSURE N° 17

V. A. WOOD (GUELPH) INCORPORATED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G2547-6-2



PROJECT: Proposed Residential Subdivision
LOCATION: Pt Lots 7, 8 & 9, Con 10, Puslinch,ON
BOREHOLE N°: 10
SAMPLE N°: 9
DEPTH: 10.7 - 11.1m±
ELEVATION: 334.2.0 - 333.8m±

COEFFICIENT OF UNIFORMITY:
COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SAND AND SILT, trace clay, trace gravel (SM)

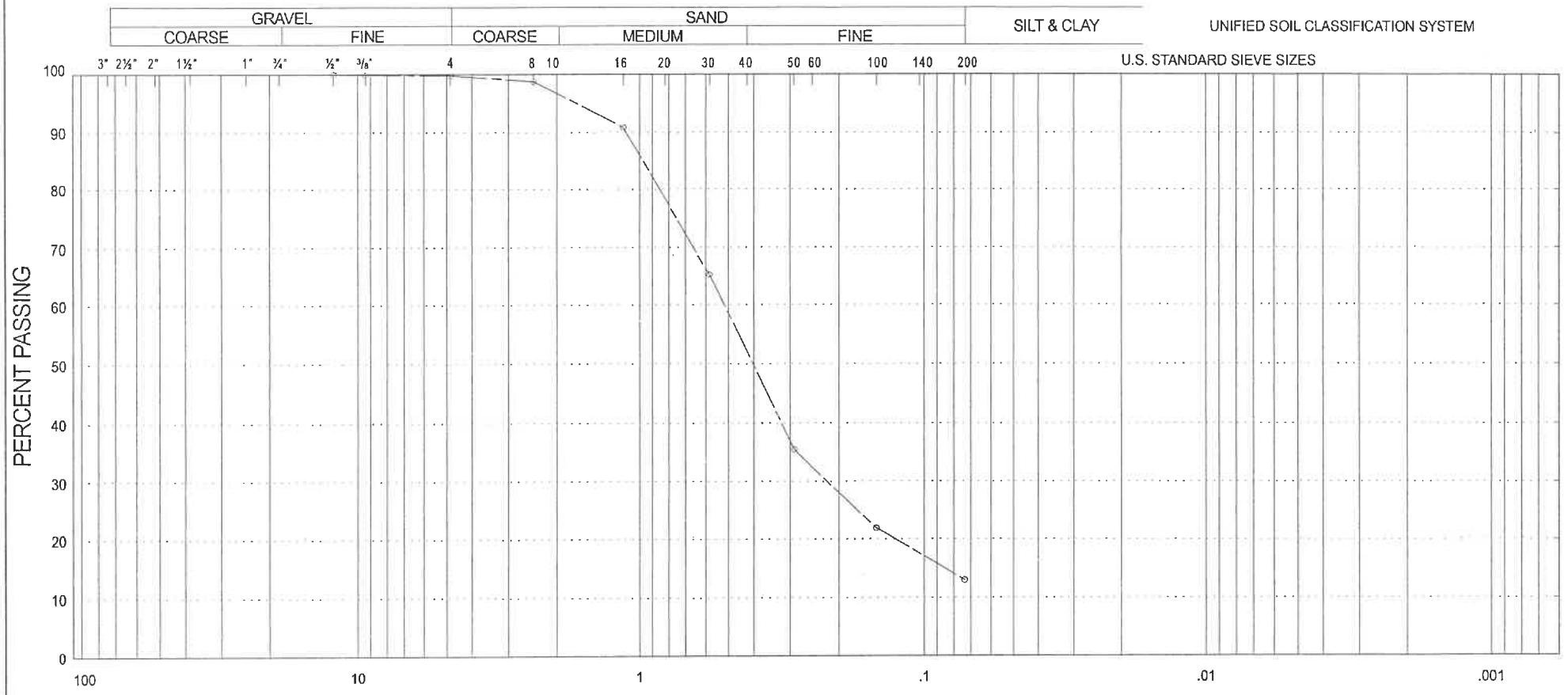
PLASTIC PROPERTIES
LIQUID LIMIT % =
PLASTIC LIMIT % =
PLASTICITY INDEX % =
MOISTURE CONTENT % = 15.7

ENCLOSURE N° 18

V. A. WOOD (GUELPH) INCORPORATED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G2547-6-2



PROJECT: Proposed Residential Subdivision

LOCATION: Pt Lots 7, 8 & 9, Con 10, Puslinch, ON

BOREHOLE N°: 10

SAMPLE N°: 10

DEPTH: 12.2 - 12.6m±

ELEVATION: 332.7 - 332.3m±

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SAND, some silt, trace gravel (SM)

PLASTIC PROPERTIES

LIQUID LIMIT % =

PLASTIC LIMIT % =

PLASTICITY INDEX % =

MOISTURE CONTENT % =

ENCLOSURE N° 19

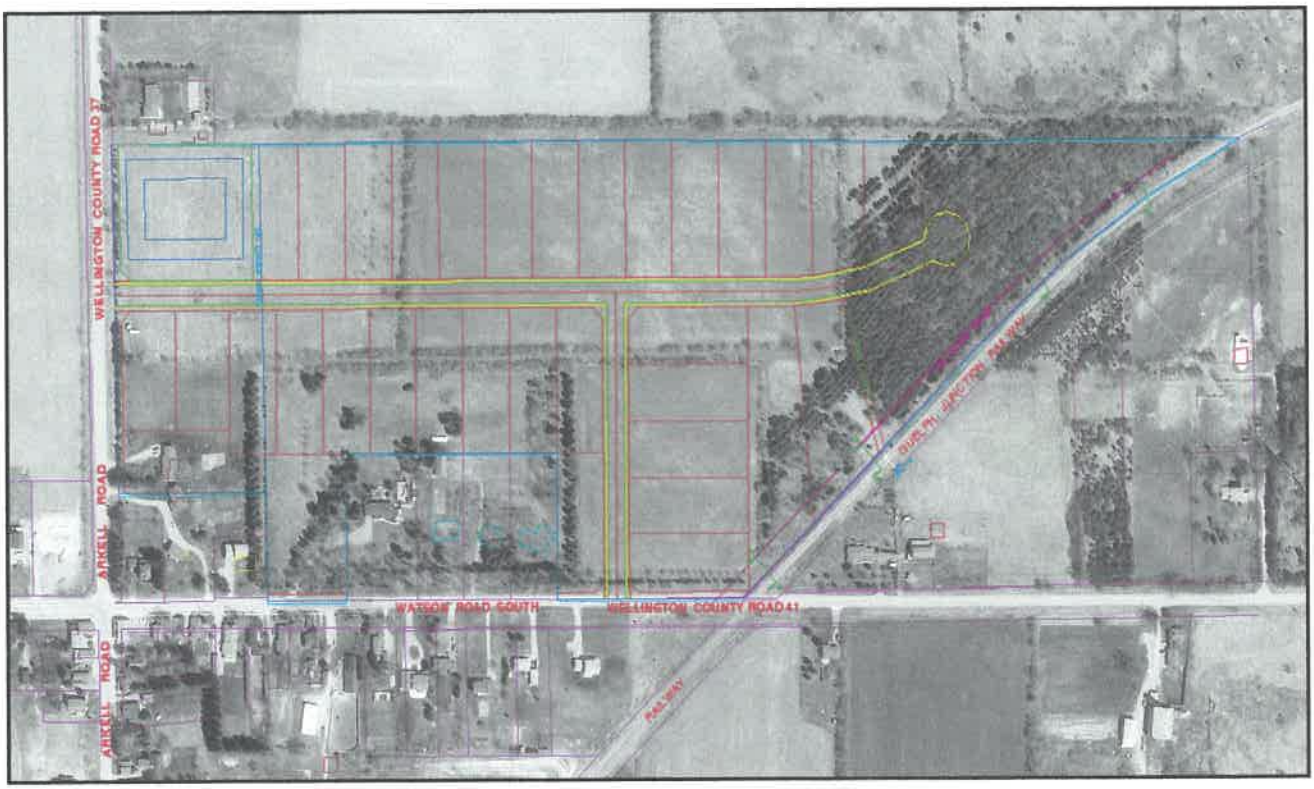
V. A. WOOD (GUELPH) INCORPORATED

P10/06

TRAFFIC IMPACT STUDY

KUKOVICA DEVELOPMENT

PART LOTS 7, 8 & 9, CONCESSION 10
TOWNSHIP OF PUSLINCH, WELLINGTON COUNTY



PREPARED FOR:
TOM KUKOVICA

OUR FILE NO: 1307
AUGUST 2006

PREPARED BY:

RICHARDSON FOSTER LTD.
CONSULTING ENGINEERS
PHONE: (705) 728-0009 TOLL FREE (1-877) 220-2461 FAX: (705) 727-7774
4 CEDAR POINTE DRIVE, UNIT L BARRIE, ONTARIO L4N 5R7

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1.0 INTRODUCTION

1.1 *APPOINTMENT*

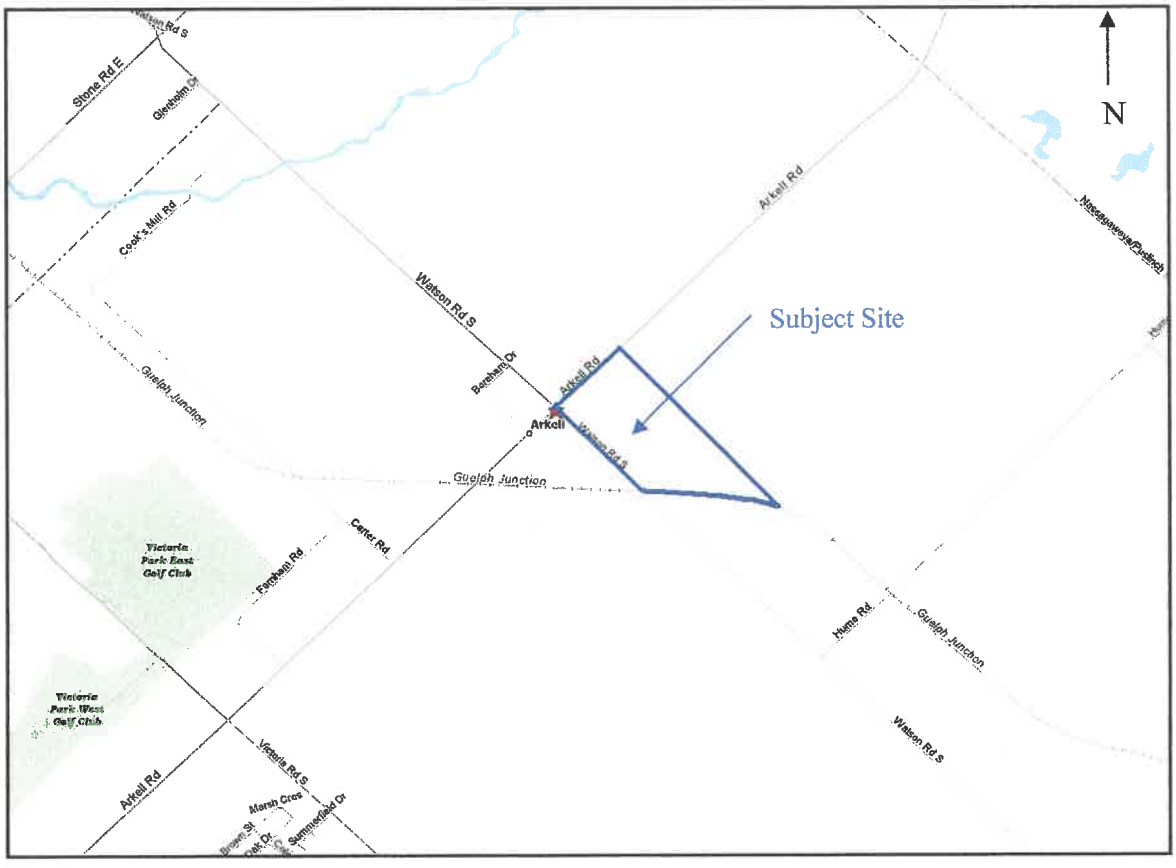
Richardson Foster Ltd has been retained by Tom Kukovica to provide engineering services for the development of a proposed 38 lot, low density, rural estate residential subdivision located in the Township of Puslinch. This traffic study is in support of the proposed site entrances onto Watson Road and Arkell Road.

1.2 *SITE BACKGROUND*

The subject property is located in the Township of Puslinch. The legal description of the subject property Part Lots 7, 8, & 9, Concession 10, Township of Puslinch, Wellington County.

The subject property comprises 21.79ha and is bounded to the north by Arkell Road (County road 37) to the south west by Watson Road (County Road 41) and existing residential lands, to the south east by the Guelph Junction railway line and to the north east by undeveloped lands see Figure 1.0.

Figure 1.0: Location Plan:

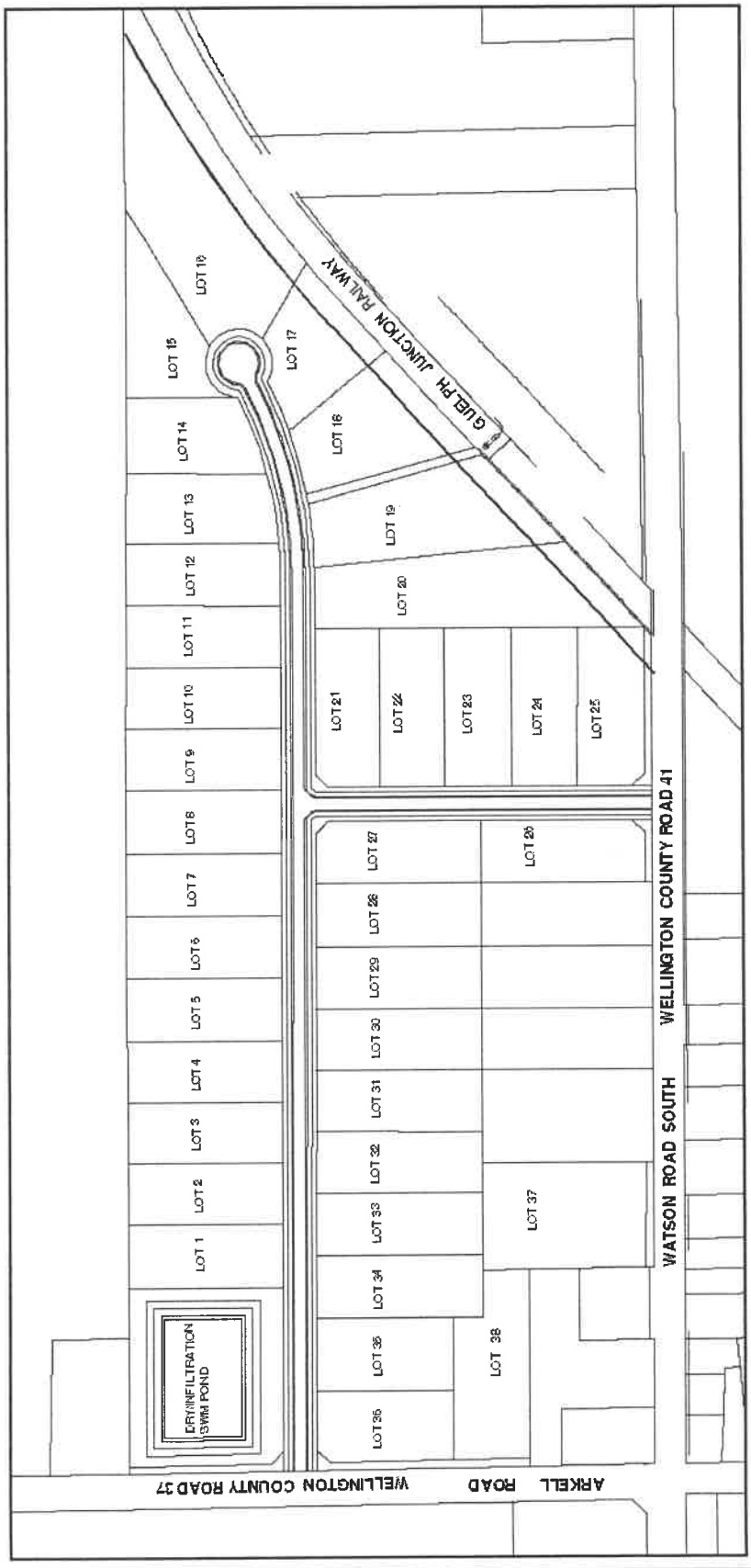


It is proposed that the subject property be developed into a rural estate residential subdivision consisting of 38 single detached residential lots. The Site Plan Concept prepared by Van Harten Surveying Inc, dated May 2006, includes a two lane undivided entrance from Watson Road and Arkell Road which will provide two access points to the proposed development see Figure 2.0.

Therefore, this traffic study is specific to the site entrances, which are proposed to facilitate full turning movements from both Watson Road and Arkell Road.

Arkell Road fronting the subject property is a two lane undivided roadway with a posted speed limit of 80km/h and a stop sign and flasher located approximately 240m west of the proposed entrance. Watson Road fronting the property is a two lane undivided roadway, with a posted speed limit of 50km/h and a stop sign located approximately 425m north of the proposed entrance.

Figure 2.0: Draft Plan:



1.3 SCOPE OF STUDY

The key issues to be investigated in this report include:

i) The *existing* traffic patterns on Watson Road and Arkell Road
ii) The *projected* traffic volume on Watson Road and Arkell Road
iii) Traffic volumes generated by the proposed development.
iv) Turning movement analysis.
v) Sight line distances for the proposed entrances and railway crossing on Watson Road.

2.0 Existing (2003/2004) Traffic Volumes

Annual Average Daily Traffic (AADT) data was obtained from the Wellington County Engineering Services Department for two (2) stations on Watson Road and Arkell Road for the years 2003 and 2004. Based on this data the AADT for Arkell Road was 1732 to 2500 and for Watson Road 2300 to 3500 vehicles respectively.

TABLE #1 – AADT VALUES

Station				Peak Hour	
Number	Roadway	Year	AADT	AM	PM
4101	Watson	2003	3500		
9914	Watson	2003	2300	170	250
3702	Arkell	2004	1732	157	200
3703	Arkell	2003	2500		

The Wellington County Engineering Services Department standard growth rate is 2.5% per year and the standard directional spilt is 50/50. All calculations were completed using these standards.

Sample Calculation:

Station 4104 AADT = 3500

Station 3703 AADT = 2500

Total AADT = (3500+2500) = 6000

Percentage Split: (3500/6000)x100 = 58%

(2500/6000)x100 = 42%

Therefore, 58% of vehicles will use the Watson Road entrance and 42% will use the Arkell Road entrance.

2.1 ARKELL ROAD

During the a.m. peak hour 158 vehicles with a directional split of 50% east bound and 50% west bound were recorded. The p.m. peak is 200 vehicles with a directional split of 50% east bound and 50% west bound.

TABLE #2 – PEAK A.M AND P.M. VOLUMES ON ARKELL ROAD

	EAST	WEST	TOTAL
Average Peak A.M. Hour Volume	79	79	158
% Distribution	50%	50%	
Average Peak P.M. Hour Volume	100	100	200
% Distribution	50%	50%	

Figure 1A illustrates the existing peak a.m. hourly traffic movements and Figure 1B illustrates the existing peak p.m. hourly traffic movements fronting the subject development. (Appended)

2.2 WATSON ROAD

During the a.m. peak hour 170 vehicles with a directional split of 50% north bound and 50% south bound were recorded. The p.m. peak hour experiences 250 vehicles with a similar directional split.

TABLE #3 – PEAK A.M AND P.M. VOLUMES ON WATSON ROAD

	NORTH	SOUTH	TOTAL
Average Peak A.M. Hour Volume	85	85	170
% Distribution	50%	50%	
Average Peak P.M. Hour Volume	125	125	250
% Distribution	50%	50%	

Figure 2A illustrates the existing peak a.m. hourly traffic movements and Figure 2B illustrates the existing peak p.m. hourly traffic movements fronting the subject development. (Appended)

3.0 Projected (2026) Traffic Volumes

3.1 ARKELL ROAD

While maintaining the current (2004) directional distribution, the future (2026) vehicle volumes along Arkell Road are indicated in Table 4 below. The projected volumes are based on applying an annual growth rate of 2.5%, to the 2004 peak hourly traffic volumes received from Wellington County Engineering Services Department.

TABLE #4 – PEAK A.M AND P.M. VOLUMES ON ARKELL ROAD (2026)

	EAST	WEST	TOTAL
Average Peak A.M. Hour Volume	122	122	244
% Distribution	50%	50%	
Average Peak P.M. Hour Volume	155	155	310
% Distribution	50%	50%	

Figure 3A illustrates the existing peak a.m. hourly traffic movements and Figure 3B illustrates the existing peak p.m. hourly traffic movements fronting the subject development. (Appended)

Sample Calculation:

Number of Projected Years:
2026 – 2004 = 22yrs

Projected Vehicle Volume:
158vph [Table #2] x (1+ (2.5%/yr x 22yrs)) = 245vph

3.2 WATSON ROAD

While maintaining the current (2004) directional distribution, the future (2026) vehicle volumes along Watson Road are indicated in Table 5 below. The projected volumes are based on applying an annual growth rate of 2.5%, to the 2004 peak hourly traffic volumes received from Wellington County Engineering Services Department

TABLE #5 – PEAK A.M AND P.M. VOLUMES ON WATSON ROAD (2026)

	NORTH	SOUTH	TOTAL
Average Peak A.M. Hour Volume	134	134	268
% Distribution	50%	50%	
Average Peak P.M. Hour Volume	194	194	388
% Distribution	50%	50%	

Figure 4A illustrates the existing peak a.m. hourly traffic movements and Figure 4B illustrates the existing peak p.m. hourly traffic movements fronting the subject development. (Appended)

Sample Calculation:

Number of Projected Years:
2026 – 2004 = 23yrs

Projected Vehicle Volume:
170vph [Table #3] x (1+ (2.5%/yr x 23yrs)) = 268vph

4.0 Traffic Volumes Generated by the Proposed Development

4.1 LAND USE DESIGNATION

The proposed land use designation for the subject property is residential.

The Land Use Designation as described in the **I.T.E. Trip Generation Manual** selected for the future residential development is Designation (210) Single-Family Detached Housing. The average vehicle trip generation rates for the AM and PM peak hours may be found on pages 270 and 271, respectively.

4.2 FUTURE DEVELOPMENT PEAK HOUR TRAFFIC

The AADT numbers for Watson Road and Arkell Road, were used to determine what percentage of cars would use the Arkell Road entrance/exit and the Watson Road entrance/exit. It was determined that 58% of cars would use the Watson Road entrance/exit and 42% would use the Arkell Road entrance/exit. For a directional split calculation see the sample calculation with Table 1.0.

4.2.1 AM Peak Hour Volume

During the AM Peak Hour **29 vehicle trip ends** are generated from the future development. Of those 7 are projected to enter and 22 to exit the proposed development

By applying the directional split calculated above, 4 vehicles enter from Watson Road and 3 vehicles will enter from Arkell Road. Similarly, 13 vehicles will exit onto Watson Road and 9 vehicles will exit onto Arkell Road.

4.2.2 PM Peak Hour Volume

During the PM Peak Hour **40 vehicle trip ends** are generated from the future development. Of those 25 are projected to enter and 15 to exit the proposed development

By applying the directional split as calculated in section 4.2.1, 15 vehicles enter from Watson Road and 10 enter from Arkell Road. Similarly, 9 vehicles will exit onto Watson Road and 6 vehicles will exit onto Arkell Road.

The number of trip ends generated by the development will be unchanged in 2026.

Refer to Figure 3A, 3B, 4A, 4B, and Worksheets 1 through 4 which illustrate the traffic movements described above.

5.0 Entrance Turning Movement Analysis

5.1 Design Hour Conditions at the Arkell Road Entrance/ Exit

5.1.1 Level of Service

Worksheets 1 and2 indicate the Level of Service (LOS) for Traffic Movements 4, 7 and 9 for the proposed entrance/exit on Arkell Road for both the AM and PM peak hours. These analyses were conducted using the projected 2026 traffic volumes.

The LOS at the proposed Arkell Road entrance/exit for all movements during both the AM and PM peak hours, is LOS A. This LOS is described in the Geometric Design Standards for Ontario Highways as "little or no delays". This is due to the small number of vehicles that enter and exit the site combined with the low peak traffic volumes on Arkell Road.

5.1.2 Left Hand Turning Lane Analysis

Due to the low volume of vehicles on Arkell Road and the very low number of vehicles entering and exiting the proposed development, 1 vehicle entering and 5 vehicles exiting during the AM peak and 5 entering and 3 exiting during the PM peak, a left hand turn lane is not warranted.

Left Hand Turn Analysis AM Peak Hour

Advancing Traffic: 123
Opposing Traffic: 124
Percent age of Left Turns 0.8%, therefore use 5%
Posted Speed Limit: 80km/h Design Speed: 100km/h
Design Standard Reference EA-23; appended

From Figure EA-23 a left hand turning lane is not warranted under the above noted post development conditions.

Left Hand Turn Analysis PM Peak Hour

Advancing Traffic: 160
Opposing Traffic: 160
Percent age of Left Turns 3.1%, therefore use 5%
Posted Speed Limit: 80km/h Design Speed: 100km/h
Design Standard Reference EA-23; appended

From Figure EA-23 a left hand turning lane is not warranted under the above noted post development conditions.

5.1.3 Right Hand Turning Lane Analysis

The number of vehicles turning right into the proposed development is very low at 2 vehicles during the AM peak hour and 5 vehicles entering during the PM peak hour. The MTO requirement [E 7.2] states that a right-hand turn lane and parallel lane should be considered if the number of vehicles turning right exceeds 60 per hour. Therefore, the proposed development does not meet the warrant for a right hand turning lane at the proposed Arkell Road entrance.

5.2 DESIGN HOUR CONDITIONS AT THE WATSON ROAD ENTRANCE/ EXIT

5.2.1 Level of Service

Worksheets 3 and 4 indicate the Level of Service (LOS) for Traffic Movements 4, 7 and 9 for the proposed entrance/exit on Watson Road for both the AM and PM peak hours. These analyses were conducted using the projected 2026 traffic volumes.

The LOS at the future Watson Road entrance/exit for all movements during both the AM and PM peak hours, is LOS A. This LOS is described in the Geometric Design Standards for Ontario Highways as "little or no delays". This is due to the small number of vehicles that enter and exit the site combined with the low peak traffic volumes on Watson Road.

5.2.2 Left Hand Turning Lane Analysis

Due to the low volume of vehicles on Watson Road and the very low number of vehicles entering the proposed development at 2 vehicles during the AM peak hour and 7 vehicles during the PM peak, hour a left hand turn lane is not warranted.

Left Hand Turn Analysis AM Peak Hour

Advancing Traffic:	134	
Opposing Traffic:	134	
Percent age of Left Turns		1.5%, therefore use 5%
Posted Speed Limit: 50km/h		Design Speed: 70km/h

Design Standard Reference EA-10; appended

From Figure EA-10 a left hand turning lane is not warranted under the above noted post development conditions.

Left Hand Turn Analysis PM Peak Hour

Advancing Traffic:	201	
Opposing Traffic:	201	
Percent age of Left Turns		3.5%, therefore use 5%
Posted Speed Limit: 50km/h		Design Speed: 70km/h

Design Standard Reference EA-10; appended

From Figure EA-10 a left hand turning lane is not warranted under the above noted post development conditions.

5.2.3 Right Hand Turning Lane Analysis

The number of vehicles turning right into and out of the proposed development is very low, 2 vehicles entering and 6 vehicles exiting during the AM peak and 7 vehicles entering and 4 vehicles exiting during the PM peak. The MTO requirement [E 7.2] states that a right-hand turn lane and parallel lane should be considered if the number of vehicles turning right exceeds 60 per hour. Therefore, the proposed development does not meet the warrant for a right hand turning lane into or out of the proposed Watson Road entrance.

5.3 PAVEMENT GEOMETRY

Having two access points to a subdivision is ideal as it creates emergency access redundancy. Should one entrance be blocked by a collision, emergency vehicles can still access the subdivision through the second entrance.

It is recommended that the ingress and egress lane widths be 3.75m in width, with a 12.0m centerline radius to accommodate emergency vehicle movements. The Township of Puslinch requires a minimum of 7.5m from edge of asphalt to edge of asphalt.

All radii into and out of the site should be a minimum of 9m as per Township of Puslinch standards.

All of the proposed road works satisfy the Standards for Residential Streets in the Town of Puslinch Municipal Servicing Standards.

6.0 Stop Sign Control

6.1 ARKELL ROAD ENTRANCE/ EXIT

The design of the intersection access to the subdivision must allow for adequate sight distances for drivers to perceive potential conflicts and engage in actions to prevent such conflicts. Sight distance requirements are to be considered for vehicles approaching and departing from the proposed intersection.

Under stop sign control, drivers exiting the subdivision onto Arkell Road require a sight distance of 370m to the east and west. This distance will allow the driver to complete the turning movement and achieve 85% of the design speed without being overtaken by a vehicle approaching from the left or right and without the approaching vehicle having to slow down to 85% of the design speed.

The Arkell Road access meets these requirements, as vehicles approaching the entrance from the west will be required to stop at the stop controlled intersection; providing adequate time for the departing subdivision vehicle to safely complete the turning movement.

The sight distance for vehicles approaching from the east is approximately 800m, which greatly exceeds the required distance of 370m.

To ensure that the sufficient sight line distances are provided, trimming of existing vegetation within the right-of-way may be necessary. This will provide an adequate sight triangle at the Arkell Road entrance.

Although not necessary, the Township may wish to review the warrants of relocating the existing 50 km/h signage to the eastern limit of the site, in an effort to reduce the vehicle speed adjacent to the residential development.

6.2 WATSON ROAD ENTRANCE/ EXIT

The design of the intersection access to the subdivision must allow for adequate sight distances for drivers to perceive potential conflicts and engage in actions to prevent such

conflicts. Sight distance requirements are to be considered for vehicles approaching and departing from the proposed intersection.

Under stop sign control, drivers exiting the development onto Watson Road require a sight distance of 200m to the north and south. This distance will allow the driver to complete the turning movement and achieve 85% of the design speed without being overtaken by a vehicle approaching from the left or right and without the approaching vehicle having to slow down to 85% of the design speed.

The Watson Road access meets these requirements, as the sight line distance on either side of the entrance are in excess of 200m.

To ensure that the sufficient sight line distances are provided, trimming of existing vegetation within the right-of-way may be necessary. This will provide an adequate sight triangle at the Watson Road entrance.

7.0 Railway Crossing on Watson Road

Currently, in a 24 hour period an average of four (4) trains pass the site. The trains travel at a maximum speed of 40km/h (25 mph) and can be up to 43 cars long with up to 3 locomotives. When approaching the crossing, the train uses its whistle to warn motorists.

There are several factors that contribute to the need for an automatic warning device. In the current configuration the crossing does not satisfy Transport Canada's sight triangle requirements for a grade crossing without automatic warning devices, see drawing 1307-RWC1.

Secondly, the crossing does not meet Transport Canada's maximum/minimum crossing angle requirements. Transport Canada requires the roadway and railway tracks, at a grade crossing without an automatic warning device, to meet at an angle no less than 70 degrees and no more than 110 degrees. The railway tracks cross Watson Road at an angle of 43 degrees, making an automatic warning device necessary.

Should a by-law be passed restricting the use of the whistle on the train at the crossing, Transport Canada requires an automatic warning system consisting of flashing lights and a bell to warn motorists of the approaching train.

In its current configuration, the crossing satisfies the requirements for a grade crossing with an automatic warning device. The road right-of-way (ROW) must be clear of any obstructions that may reduce the visibility of the crossing signs and lights. For a roadway with a permissible speed of 50km/h, the ROW must be clear for a minimum of 65m beyond the tracks. For a roadway with a permissible speed of 80km/h, the ROW must be clear for a minimum of 140m.

Currently the south bound and north bound sight lines on Watson Road at the railway crossing are in excess of 200m and 400m, respectively. Therefore, the available sight lines are in excess of those required in the north and south bound directions.

The Guelph Junction Railway requires a 2.0 m tall safety containment berm to be constructed parallel to the railway right-of-way, running the length of the proposed site, see drawing 1307-RWB1. The berm will be constructed within the 15.0m setback adjacent to the railway tracks, where grades permit. The berm height must be tapered at

Watson Road so that it does not reduce the sight line distances both on the roadway and along the railway tracks.

8.0 Conclusions and Recommendations

8.1 CONCLUSIONS

1. AADT data, AM and PM peaks, growth factor, and directional split provided by the Engineering Services Department of Wellington County were used to calculate all traffic volumes
2. All movements at both proposed entrances/exits have been designed to provide an "A" level of service.
3. The location of the entrances/exits provide adequate sight line distances for motorists.
4. There is sufficient sight line distance for the railway crossing on Watson Road.

8.2 RECOMMENDATIONS

1. All traffic exiting from the site should be under stop sign control.
2. Minimum entrance radii should be 9.0m as per Township of Puslinch Standards.
3. Undivided entrance/exit lane widths should be 3.75m wide.
4. Two-way roadways should consist of a minimum 7.5m width and 12.0m centreline radius to allow for adequate movement of emergency vehicles.
5. Changes to the existing Watson and Arkell Road pavement geometry are not required for the proposed development of the subject site into 38 estate residential lots.
6. Signal sight lines to be in accordance with Transport Canada RTD 10 Standards.

Respectfully Submitted,

RICHARDSON FOSTER LTD

August 2006

Chris Anders E.I.T.

Greg Gemmell, P.Eng.



9.0 References

Ontario Ministry of Transportation, *Design Manual for Traffic Signals*, OTM, July, 2001.

Ontario Ministry of Transportation, *Geometric Design Standards for Ontario Highways*, OTM, June, 1994.

Institute of Transportation Engineers, *Trip Generation, 7th edition*, 2003.

The Township of Puslinch Municipal Servicing Standards, May 1997 (revised July 5, 1999)

Transportation Association of Canada, *Geometric Design Guide for Canadian Roads*, 1999 Edition, Supplement February 2002

Transport Canada's RTD 10 Draft Standards, October 2002

Appendix

Figure 1A – Existing Peak A.M. Hourly Traffic Movements Arkell Road
Figure 1B – Existing Peak P.M. Hourly Traffic Movements Arkell Road

Figure 2A – Existing Peak A.M. Hourly Traffic Movements Watson Road
Figure 2B – Existing Peak P.M. Hourly Traffic Movements Watson Road

Figure 3A – Projected Peak A.M. Hourly Traffic Movements Arkell Road
Figure 3B – Projected Peak P.M. Hourly Traffic Movements Arkell Road

Figure 4A – Projected Peak A.M. Hourly Traffic Movements Watson Road
Figure 4B – Projected Peak P.M. Hourly Traffic Movements Watson Road

Projected A.M. – Worksheet for Analysis of T-Intersection Arkell Road
Projected P.M. – Worksheet for Analysis of T-Intersection Arkell Road

Projected A.M. – Worksheet for Analysis of T-Intersection Watson Road
Projected P.M. – Worksheet for Analysis of T-Intersection Watson Road

Projected A.M. – Left Turn Storage Lane Worksheet Arkell Road
Projected P.M. – Left Turn Storage Lane Worksheet Arkell Road

Projected A.M. – Left Turn Storage Lane Worksheet Watson Road
Projected P.M. – Left Turn Storage Lane Worksheet Watson Road

Figure 1A – Existing Peak A.M. Hourly Traffic Movements Arkell Road

Figure 1A

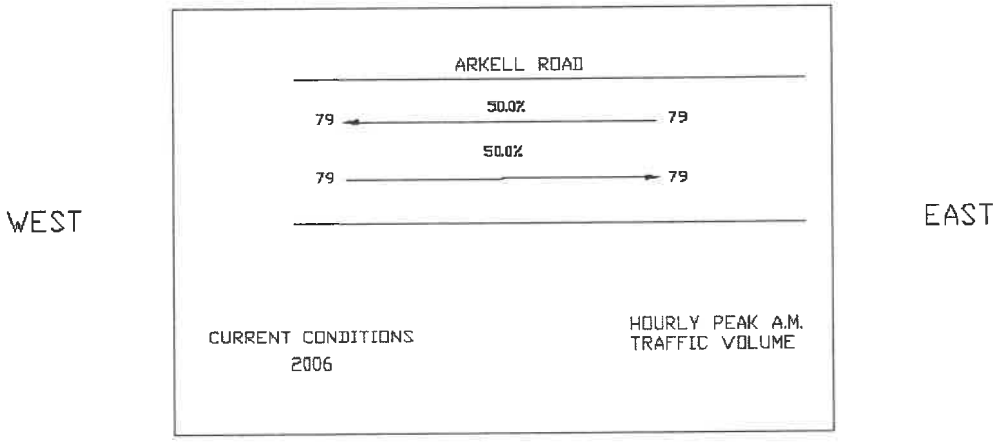


Figure 1B – Existing Peak P.M. Hourly Traffic Movements Arkell Road

Figure 1B

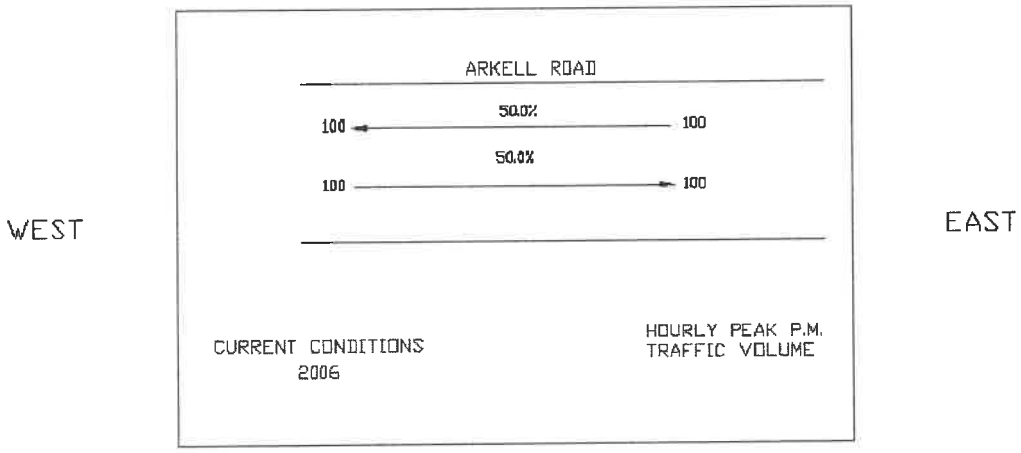


Figure 2A – Existing Peak A.M. Hourly Traffic Movements Watson Road

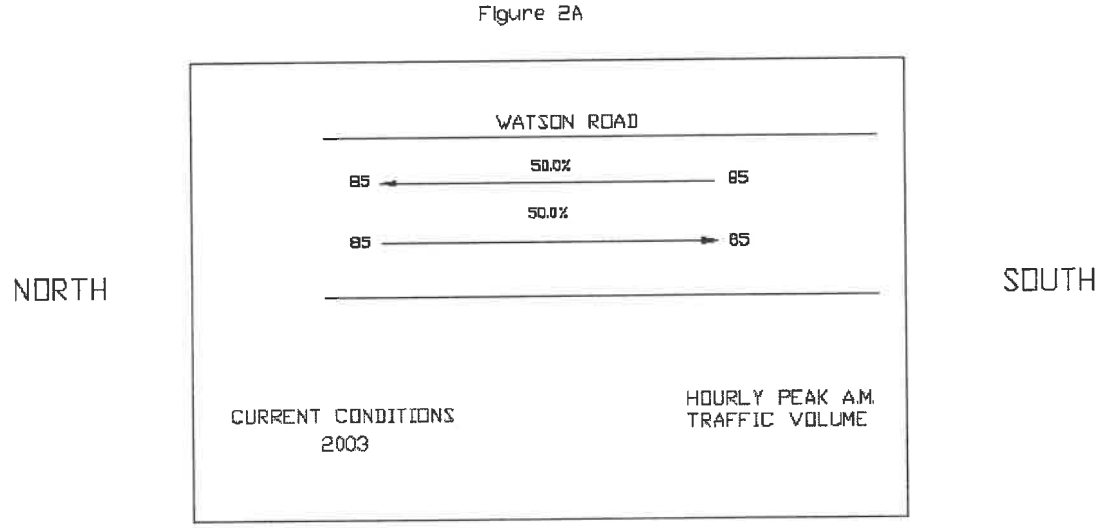


Figure 2B – Existing Peak P.M. Hourly Traffic Movements Watson Road

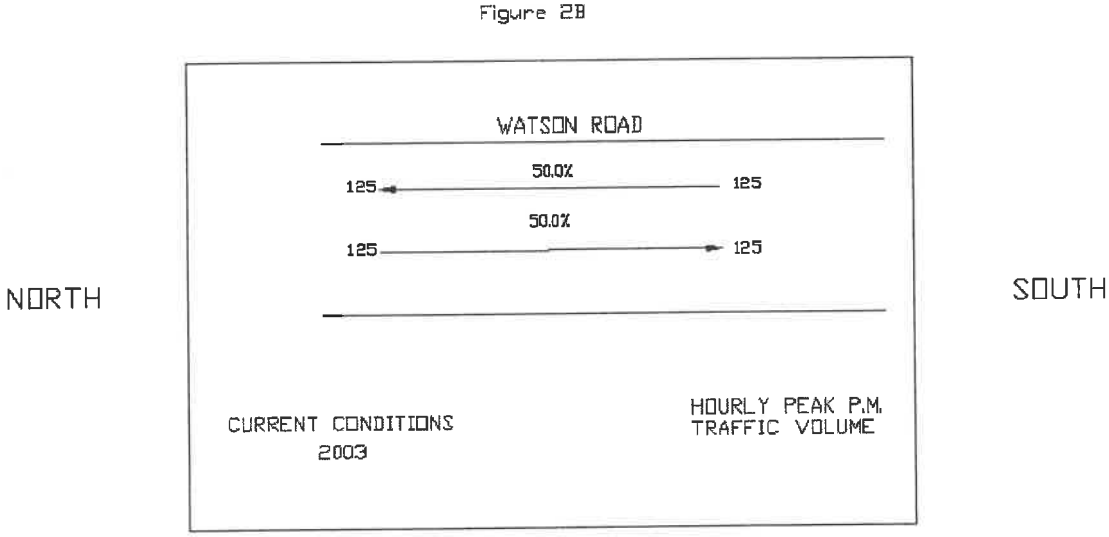


Figure 3A – Projected Peak A.M. Hourly Traffic Movements Arkell Road

Figure 3A

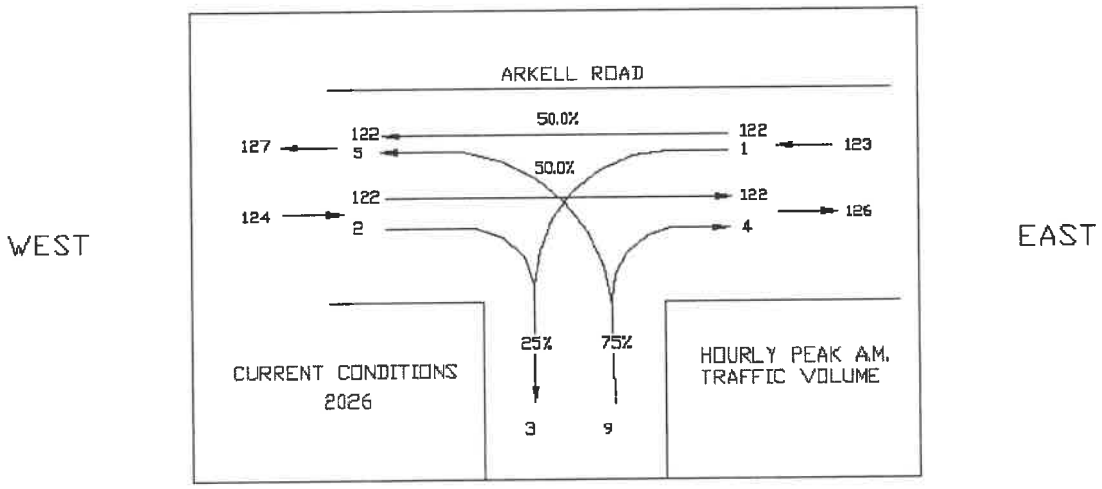


Figure 3B – Projected Peak P.M. Hourly Traffic Movements Arkell Road

Figure 3B

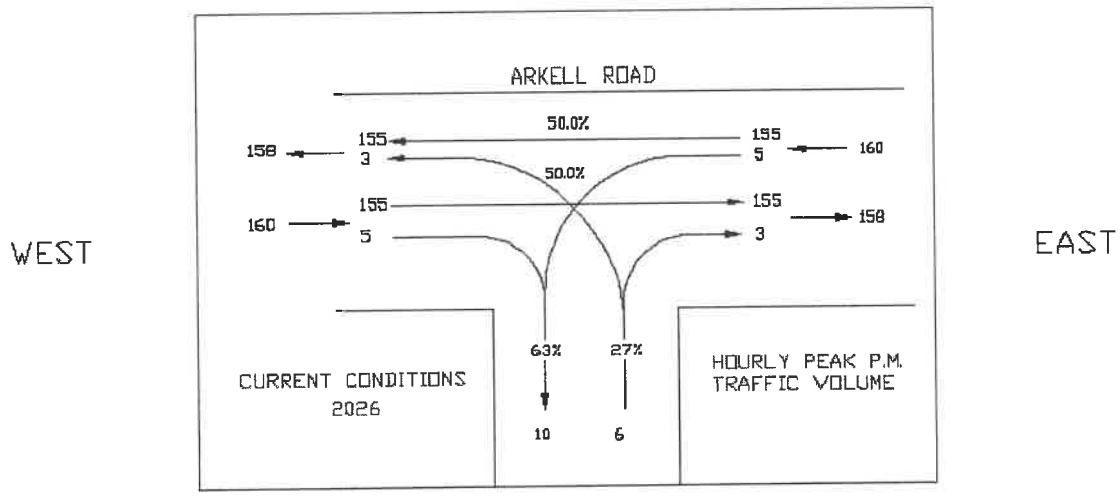


Figure 4A – Projected Peak A.M. Hourly Traffic Movements Watson Road

Figure 4A

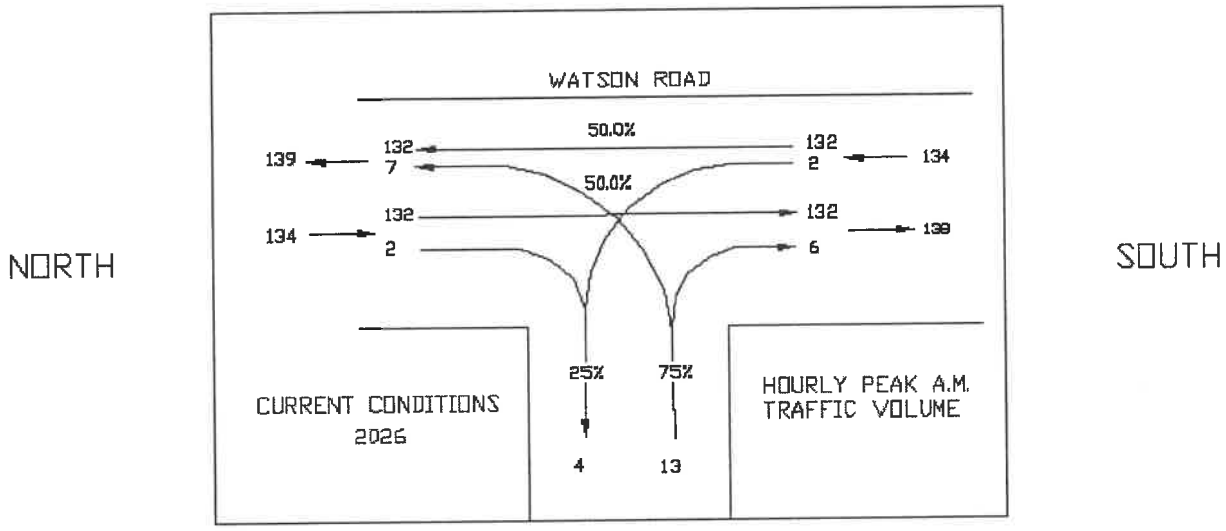
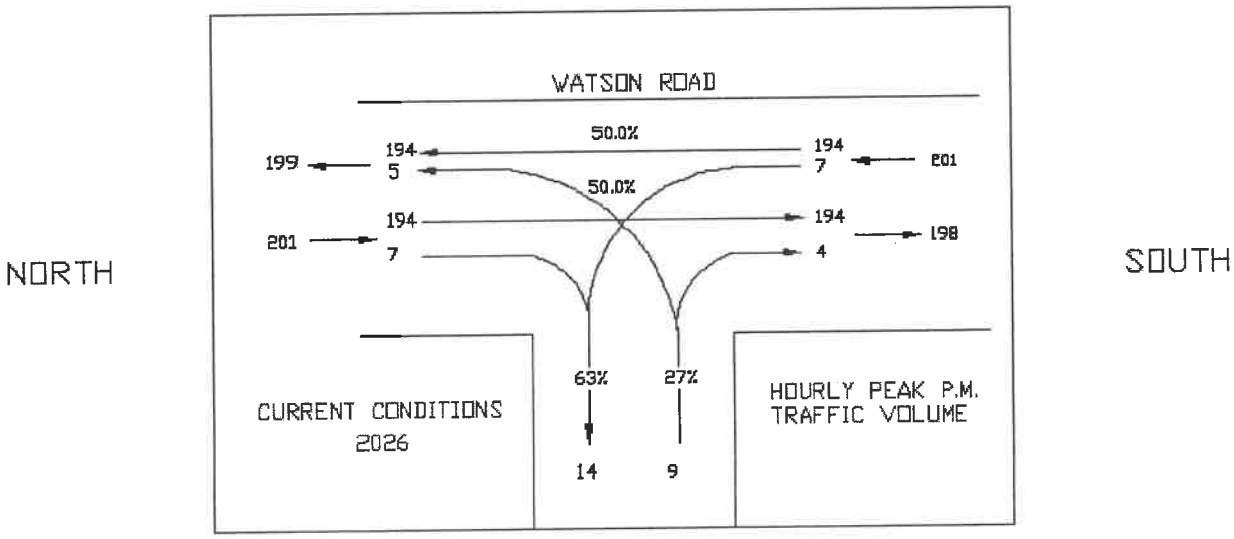


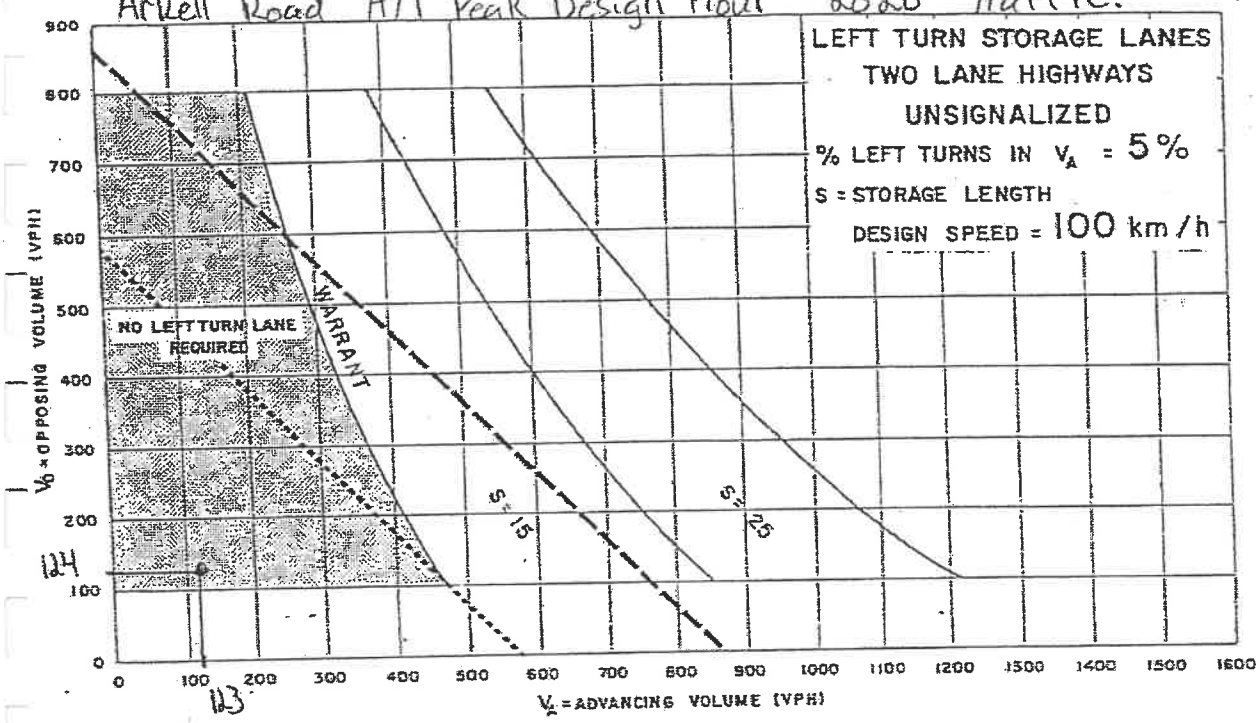
Figure 4B – Projected Peak P.M. Hourly Traffic Movements Watson Road

Figure 4B



-GRADE INTERSECTIONS

Arkell Road AM Peak Design Hour 2026 Traffic.



TRAFFIC SIGNALS MAY BE WARRANTED IN RURAL AREAS OR URBAN AREAS WITH RESTRICTED FLOW

TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS

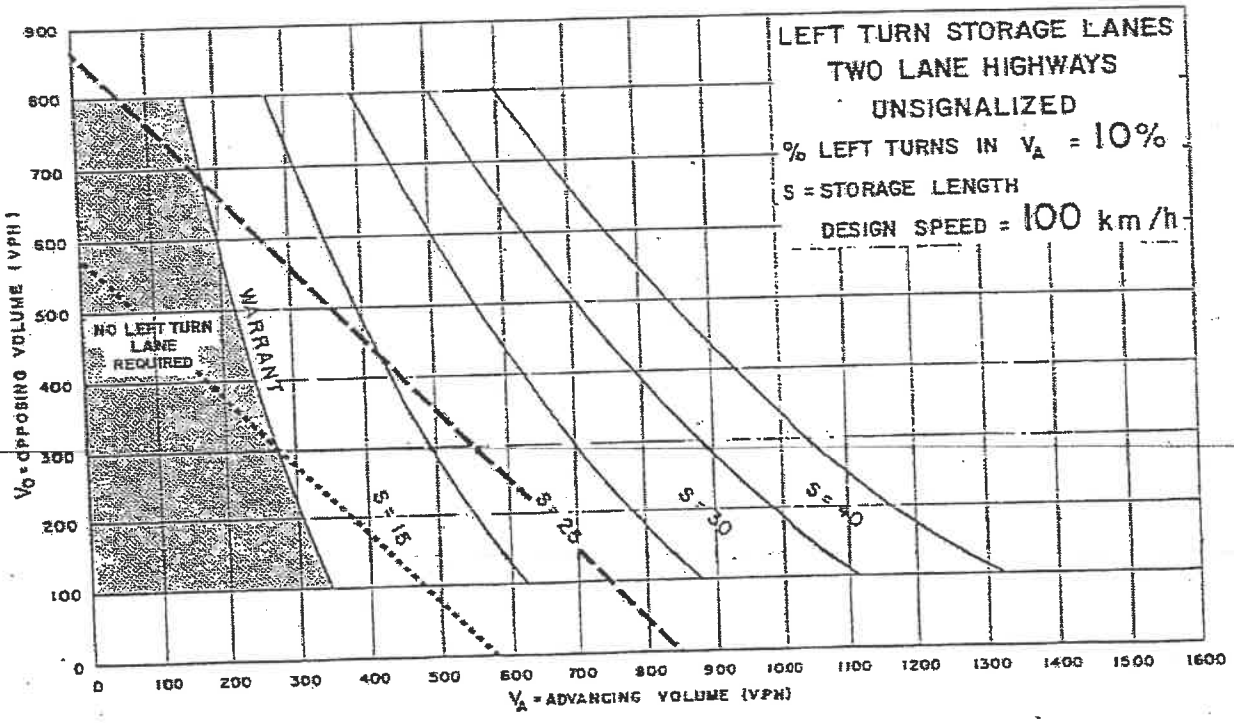
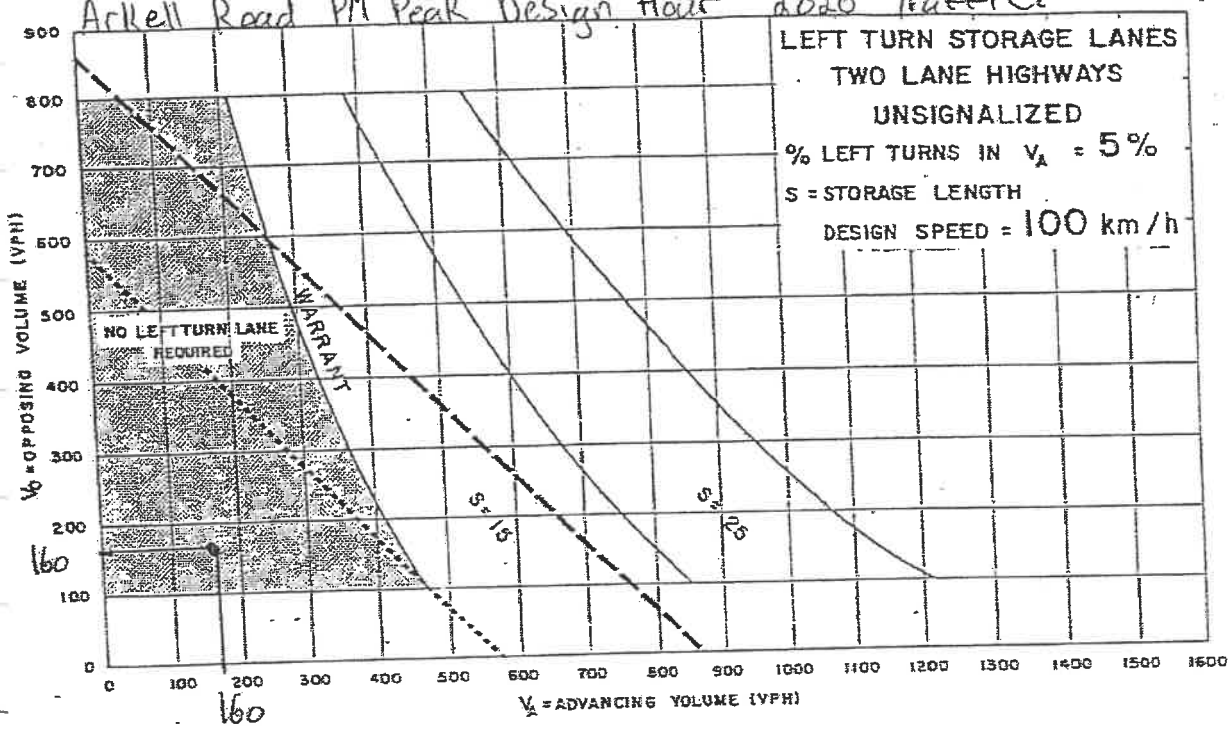


Figure EA-22

-GRADE INTERSECTIONS

Arkell Road PM Peak Design Hour 2026 Traffic



TRAFFIC SIGNALS MAY BE WARRANTED IN RURAL AREAS OR URBAN AREAS WITH RESTRICTED FLOW

TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS

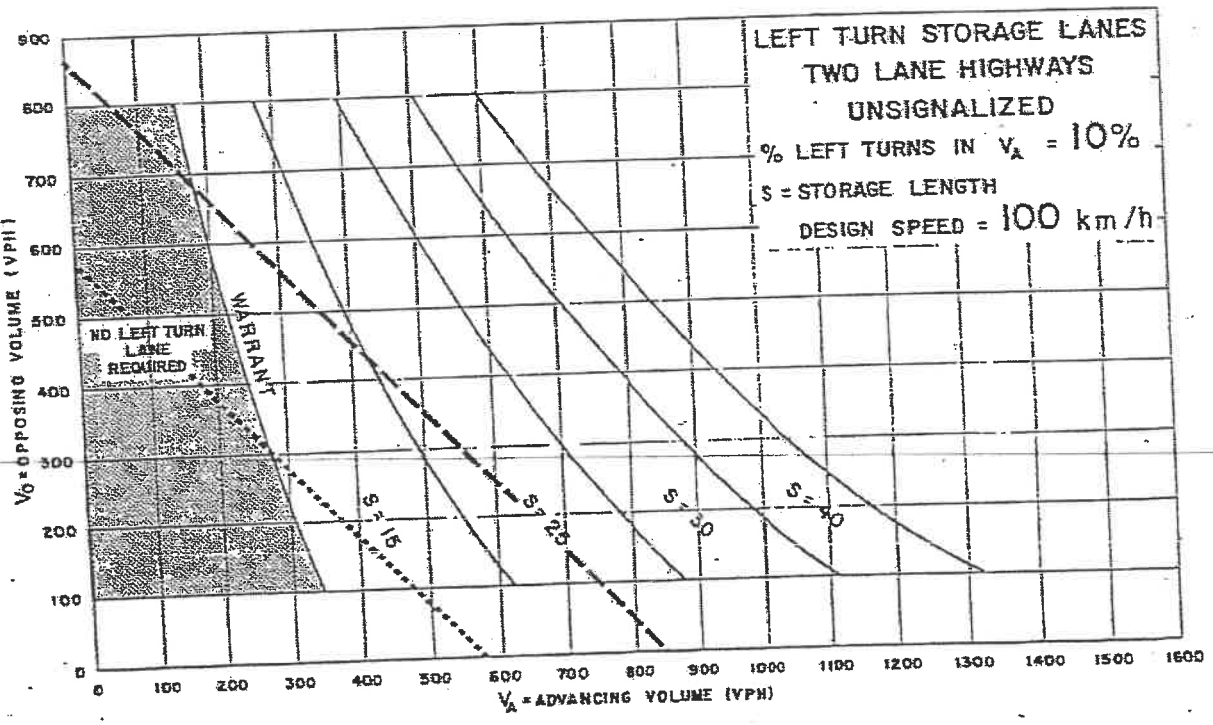
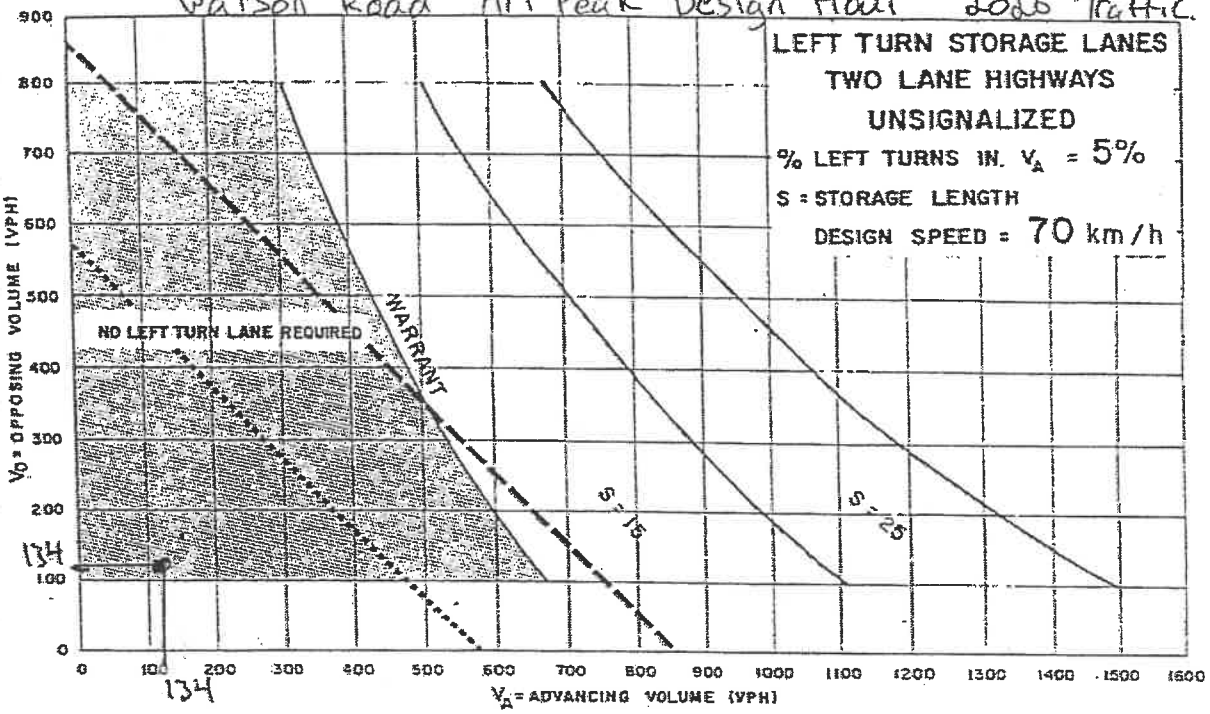


Figure EA-22

Watson Road AM Peak Design Hour 2006 Traffic.



TRAFFIC SIGNALS MAY BE WARRANTED IN RURAL AREAS OR URBAN AREAS WITH RESTRICTED FLOW

TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS

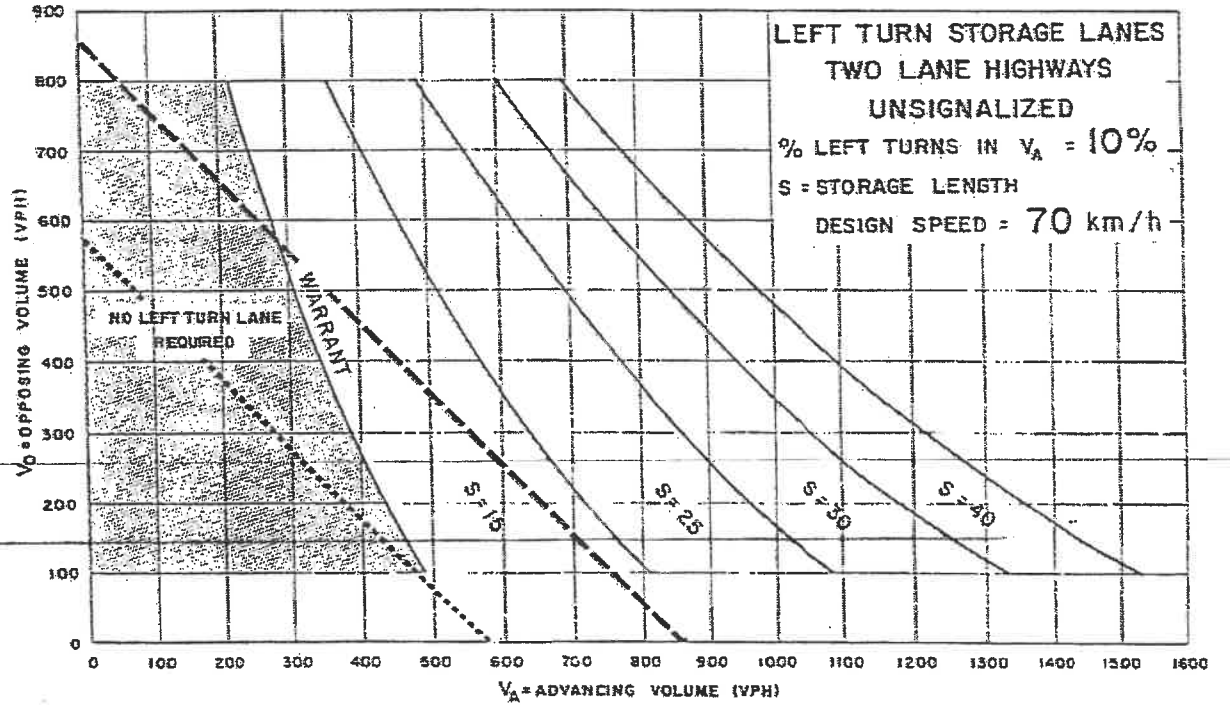
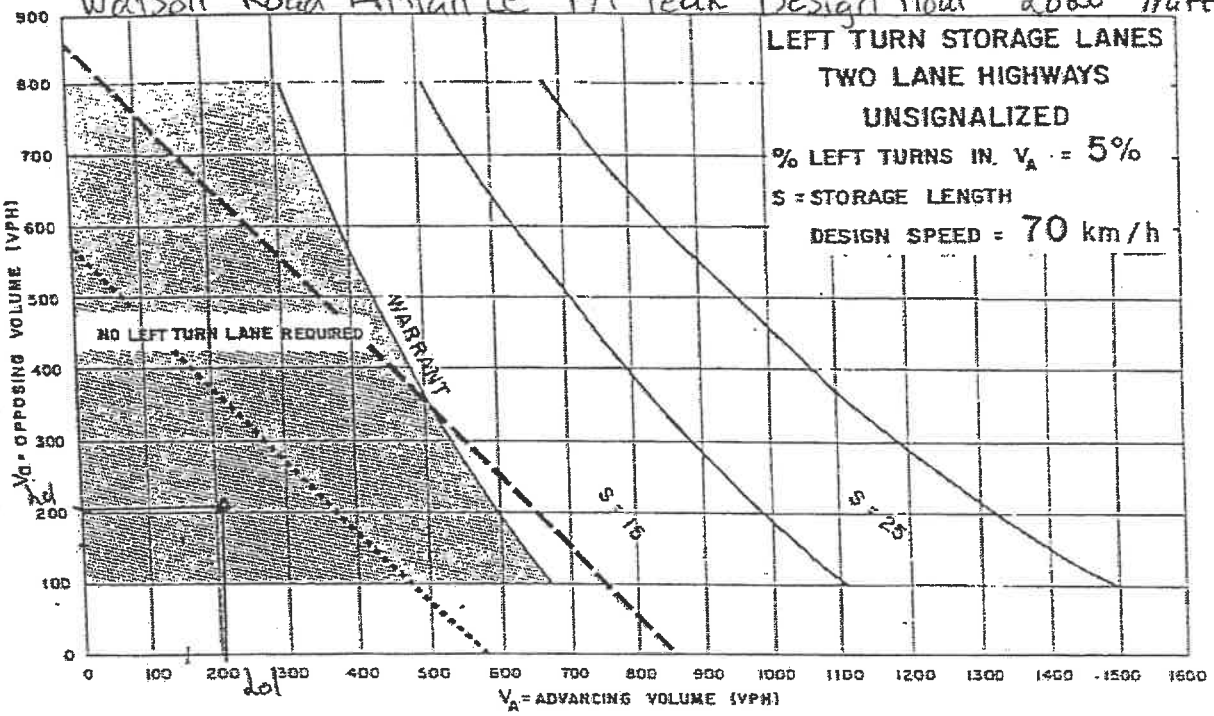


Figure EA-10

Watson Road Entrance PM Peak Design Hour 2026 Traffic.



TRAFFIC SIGNALS MAY BE WARRANTED IN RURAL AREAS OR URBAN AREAS WITH RESTRICTED FLOW

TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS

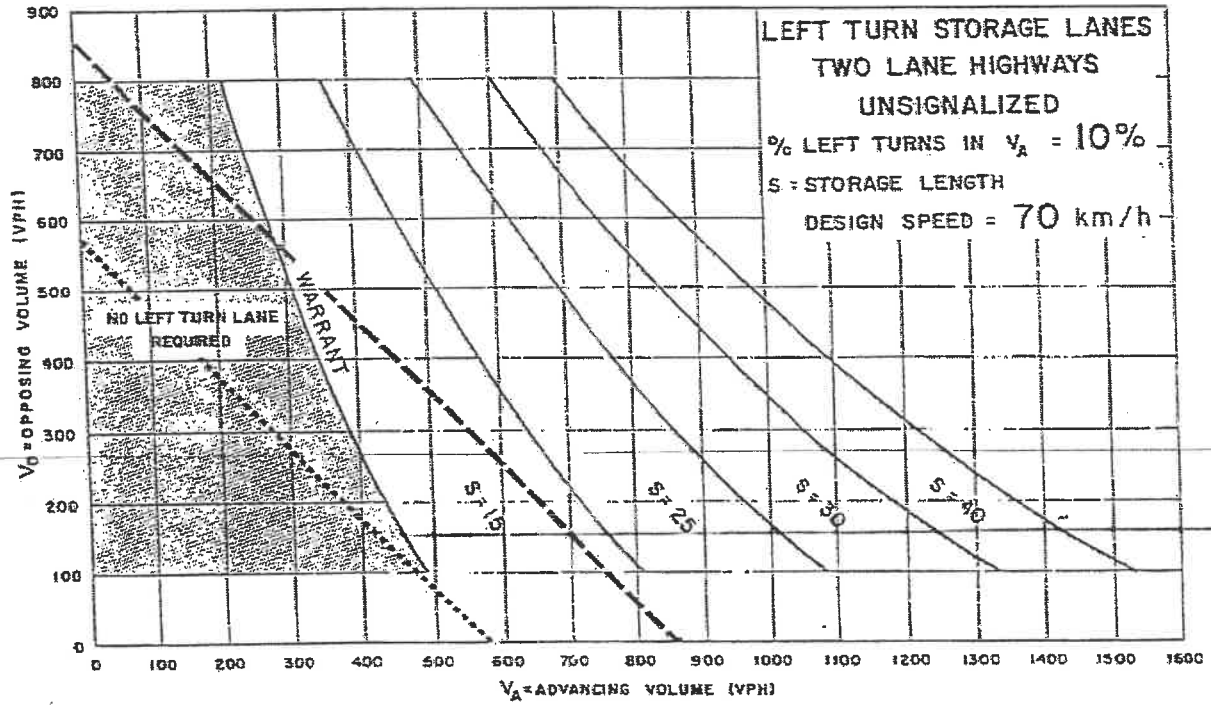


Figure EA-10

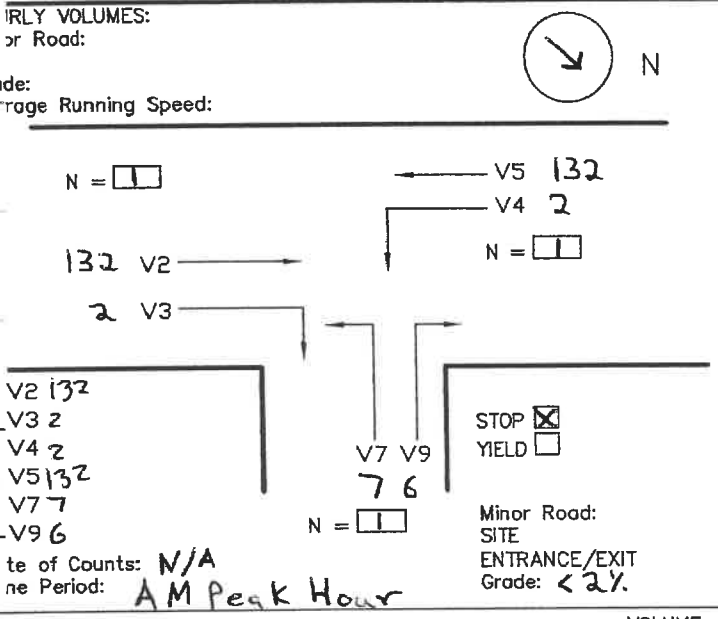
RICHARDSON FOSTER LTD.
CONSULTING ENGINEERS
PHONE: (705) 728-0009 TOLL FREE (1-877) 220-2461 FAX: (705) 727-7774
4 CEDAR POINTE DRIVE, UNIT L BARRIE, ONTARIO L4N 5R7

WORKSHEET for ANALYSIS of T-INTERSECTION

Watson Road Entrance, 2026 Traffic
AM Peak Design Hour

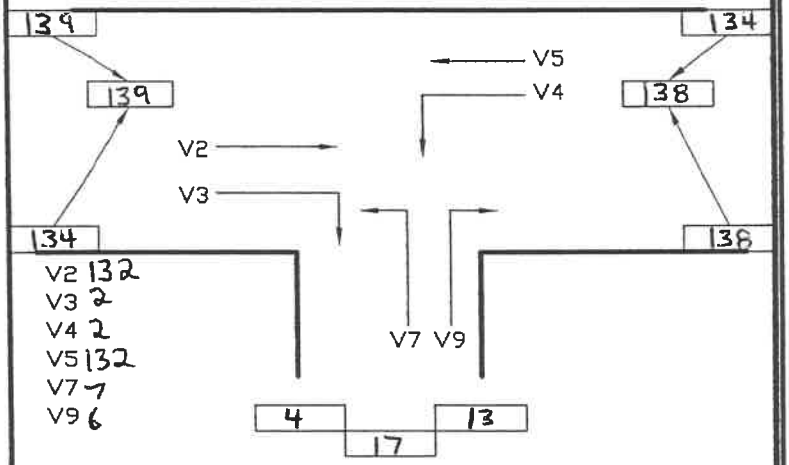
DATE: June 26 2006
PROJECT No.: 1307 - Arkell
WORKSHEET:
LOCATION: Part Lots 7, 8, 9 Concession 10
NAME: Kukovica Development

HOURLY VOLUMES:
Major Road:
Grade:
Average Running Speed:



Date of Counts: N/A
Time Period: AM Peak Hour

VOLUMES in PC/H



VOLUME ADJUSTMENTS

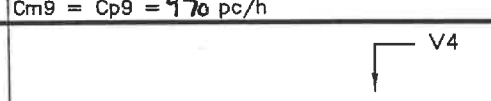
MOVEMENT No.	2	3	4	5	7	9
VOLUME (VEHICLES/H)	132	2	2	132	7	6
VOLUME (PC/H) (SEE TABLE B6 – 1)			2		8	7

STEP 1: RT from Minor Street



Conflicting Flows Vc: ½ (V3) + (V2) = Vc9 1 + 132 = 133 V/h
Critical Gap Tc & Potential Capacity: Cp: Tc = 5.5 (Table B6-2) Cp9 = 970 pc/h (Fig. B6-4)
Actual Capacity: Cm: Cm9 = Cp9 = 970 pc/h

STEP 2: LT from Major Street



Conflicting Flows Vc: (V3) + (V2) = Vc4 2 + 132 = 134 V/h
Critical Gap Tc & Potential Capacity: Cp: Tc = 5.0 (Table B6-2) Cp4 = 1000 pc/h (Fig. B6-4)
Percent Cp Utilized & Impedence Factor: (V4/Cp4)(100) = 0.2 P4 = 0.99 (Fig B6-3)
Actual Capacity: Cm: Cm4 = (Cp4)(P4) = 990 pc/h

STEP 3: LT from Minor Street



Conflicting Flows Vc: ½ (V3) + (V2) + (V5) + (V4) = 267 V/h
Critical Gap Tc & Potential Capacity: Cp: Tc = 6.5 (Table B6-2) Cp7 = 670 pc/h (Fig. B6-4)
Actual Capacity: Cm: Cm7 = (Cp7)(P4) = 663 pc/h

SHARED LANE CAPACIY: (IF LANE IS SHARED)
SH = (V7+V9)/((V7/Cm7) + (V9/Cm9)) = $\frac{8+7}{(8/663 + 7/970)}$ = 778

MOVEMENT	V (pc/h)	Cm (pc/h)	Csh (pc/h)	Cr	Level of Service
7	8	663	778	655	A
9	7	970	778	771	A
4	2	990		988	A

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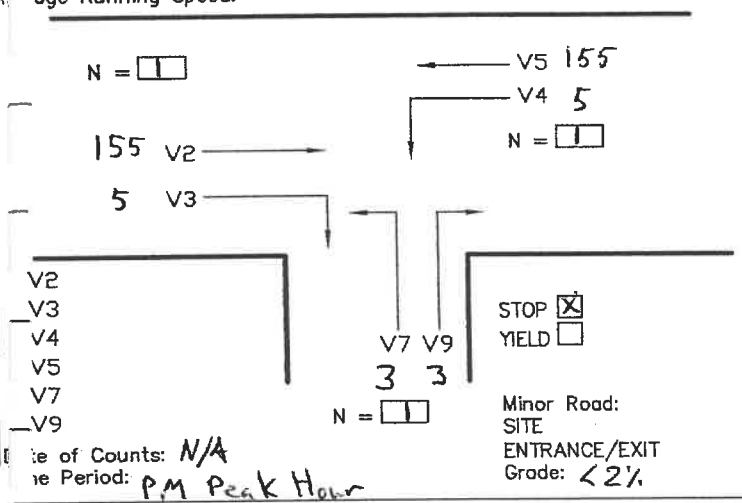
WORKSHEET for ANALYSIS of T-INTERSECTION

Arkell Road Entrance 2026 Traffic
PM Peak Design Hour

DATE: June 26, 2006
PROJECT No.: 1307 - Arkell
WORKSHEET:
LOCATION: Part Lots 7, 8, 9 Concession 10
NAME: Kukovica Development

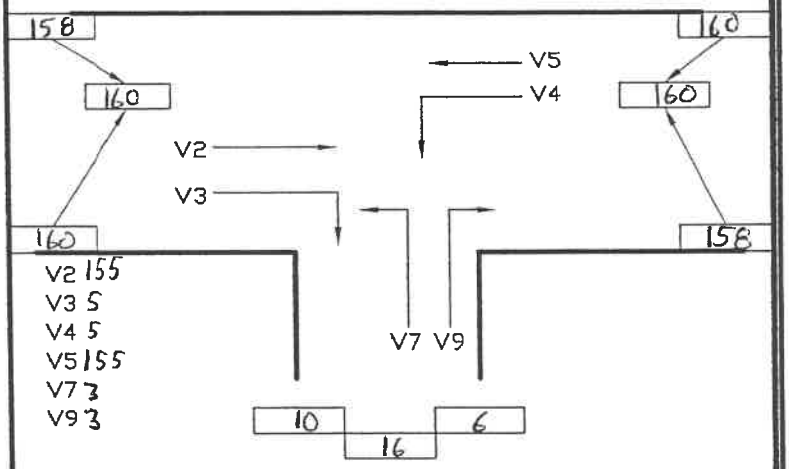
HOURLY VOLUMES:
Major Road:
Grade:
Average Running Speed:

N



Source of Counts: N/A
Time Period: PM Peak Hour

VOLUMES in PC/H



VOLUME ADJUSTMENTS

MOVEMENT No.	2	3	4	5	7	9
VOLUME (VEHICLES/H)	155	5	5	155	3	3
VOLUME (PC/H) (SEE TABLE B6 – 1)			6		3	3

STEP 1: RT from Minor Street



Conflicting Flows Vc: ½ (V3) + (V2) = Vc9 2.5 + 155 = 158 V/h
Critical Gap Tc & Potential Capacity: Cp: Tc = 6.25 (Table B6-2) Cp9 = 810 pc/h (Fig. B6-4)
Actual Capacity: Cm: Cm9 = Cp9 = 810 pc/h

STEP 2: LT from Major Street



Conflicting Flows Vc: (V3) + (V2) = Vc4 5 + 155 = 160 V/h
Critical Gap Tc & Potential Capacity: Cp: Tc = 5.4 (Table B6-2) Cp4 = 980 pc/h (Fig. B6-4)
Percent Cp Utilized & Impedence Factor: (V4/Cp4)(100) = 0.6 P4 = 0.99 (Fig B6-3)
Actual Capacity: Cm: Cm4 = (Cp4)(P4) = 970 pc/h

STEP 3: LT from Minor Street



Conflicting Flows Vc: ½ (V3) + (V2) + (V5) + (V4) = 319 V/h
Critical Gap Tc & Potential Capacity: Cp: Tc = 7.6 (Table B6-2) Cp7 = 520 pc/h (Fig. B6-4)
Actual Capacity: Cm: Cm7 = (Cp7)(P4) = 515 pc/h

SHARED LANE CAPACITY: SH = (V7+V9)/((V7/Cm7) + (V9/Cm9)) = $\frac{3+3}{(3/515 + 3/810)}$ = 630
(IF LANE IS SHARED)

MOVEMENT	V (pc/h)	Cm (pc/h)	Csh (pc/h)	Cr	Level of Service
7	3	515	630	512	A
9	3	810	630	627	A
4	6	970		964	A

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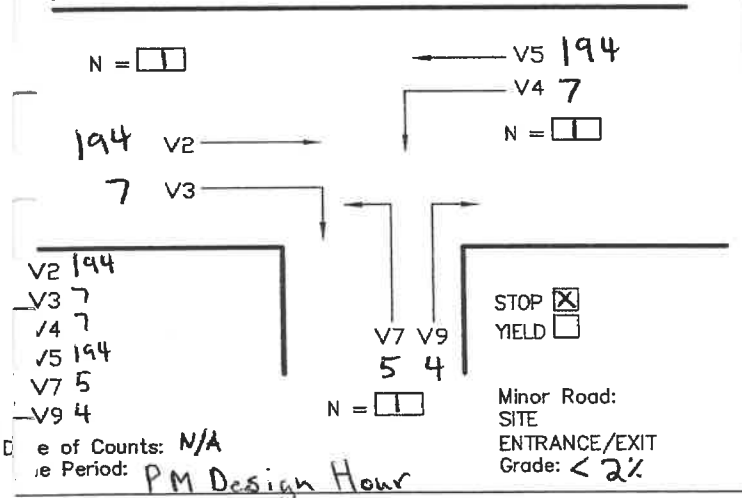
WORKSHEET for ANALYSIS of T-INTERSECTION

Watson Road Entrance, 2026 Traffic
PM Peak Design Hour

DATE: June 26 2006
PROJECT No.: 1307 Arkell
WORKSHEET:
LOCATION: Part Lots 7,8,9 Concession 10
NAME: Kukovica Development

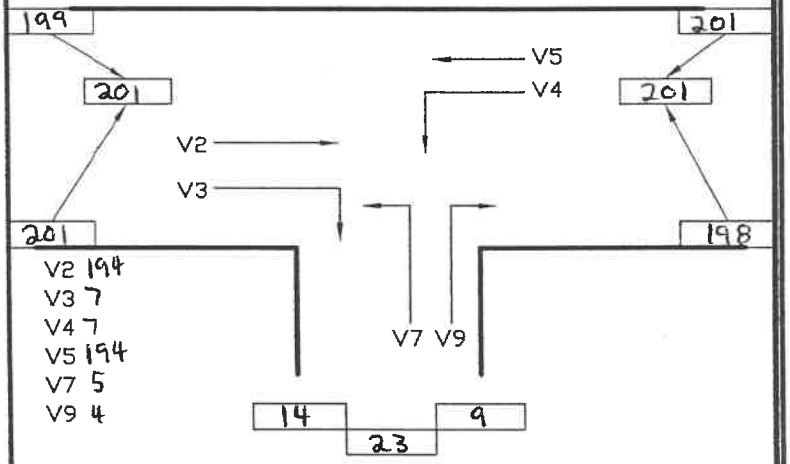
HOURLY VOLUMES:
Major Road:
Grade:
Average Running Speed:

N



Source of Counts: N/A
Time Period: PM Design Hour

VOLUMES in PC/H



VOLUME ADJUSTMENTS

MOVEMENT No.	2	3	4	5	7	9
VOLUME (VEHICLES/H)	194	7	7	194	5	4
VOLUME (PC/H) (SEE TABLE B6 – 1)			8		6	4

STEP 1: RT from Minor Street

V9

Conflicting Flows Vc
Critical Gap Tc & Potential Capacity: Cp
Actual Capacity: Cm

½ (V3) + (V2) = Vc9 3.5 + 194 = 198 V/h
Tc = 5.5 (Table B6-2) Cp9 = 880 pc/h (Fig. B6-4)
Cm9 = Cp9 = 880 pc/h

STEP 2: LT from Major Street

V4

Conflicting Flows Vc
Critical Gap Tc & Potential Capacity: Cp
Percent Cp Utilized & Impedence Factor
Actual Capacity: Cm

(V3) + (V2) = Vc4 7 + 194 = 201 V/h
Tc = 5.0 (Table B6-2) Cp4 = 980 pc/h (Fig. B6-4)
(V4/Cp4)(100) = 0.8 P4 = 0.991 (Fig B6-3)
Cm4 = (Cp4)(P4) = 970 pc/h

STEP 3: LT from Minor Street

V7

Conflicting Flows Vc
Critical Gap Tc & Potential Capacity: Cp
Actual Capacity: Cm

½ (V3) + (V2) + (V5) + (V4) = 400 V/h
Tc = 6.5 (Table B6-2) Cp7 = 560 pc/h (Fig. B6-4)
Cm7 = (Cp7)(P4) = 554 pc/h

SHARED LANE CAPACITY:

SH = (V7+V9)/((V7/Cm7) + (V9/Cm9)) =
~~(IF LANE IS SHARED)~~

MOVEMENT	V (pc/h)	Cm (pc/h)	Csh (pc/h)	Cr	Level of Service
7	6	554	650	548	A
9	4	880	650	646	A
4	8	970		962	A

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WORKSHEET for ANALYSIS of T-INTERSECTION

Arkell Road Entrance, 2026 Traffic
AM Peak Design Hour

DA : June 26 2006
IECT No.: 1307 Arkell
ORKSHEET:
LOCATION: Part Lots 7, 8, 9 Concession 10
NAME: Kukovica Development

HOURLY VOLUMES:
Major Road:
Grade:
Average Running Speed:

N

N = 1
V5 122
V4 1
N = 1
122 V2
2 V3
V2 122
V3 2
V4 1
V5 122
V7 5
V9 4
V7 V9
5 4
N = 1
STOP ☐
YIELD ☐
Minor Road:
SITE
ENTRANCE/EXIT
Grade:
Date of Counts:
Time Period:

VOLUMES in PC/H

127
127
123
126
V5
V4
V2
V3
124
126
V2 122
V3 2
V4 1
V5 122
V7 5
V9 4
V7 V9
3
9
12

VOLUME ADJUSTMENTS

MOVEMENT No.	2	3	4	5	7	9
VOLUME (VEHICLES/H)	122	2	1	122	5	4
VOLUME (PC/H) (SEE TABLE B6 – 1)			1		6	4

STEP 1: RT from Minor Street

V9

Conflicting Flows Vc
Critical Gap Tc & Potential Capacity: Cp
Actual Capacity: Cm

½ (V3) + (V2) = Vc9 1 + 122 = 123 V/h
Tc = 6.25 (Table B6-2) Cp9 = 850 pc/h (Fig. B6-4)
Cm9 = Cp9 = 850 pc/h

STEP 2: LT from Major Street

V4

Conflicting Flows Vc
Critical Gap Tc & Potential Capacity: Cp
Percent Cp Utilized & Impedence Factor
Actual Capacity: Cm

(V3) + (V2) = Vc4 2 + 122 = 124 V/h
Tc = 5.4 (Table B6-2) Cp4 = 980 pc/h (Fig. B6-4)
(V4/Cp4)(100) = 0.10 P4 = 0.99 (Fig B6-3)
Cm4 = (Cp4)(P4) = 970 pc/h

STEP 3: LT from Minor Street

V7

Conflicting Flows Vc
Critical Gap Tc & Potential Capacity: Cp
Actual Capacity: Cm

½ (V3) + (V2) + (V5) + (V4) = 246 V/h
Tc = 7.6 (Table B6-2) Cp7 = 560 pc/h (Fig. B6-4)
Cm7 = (Cp7)(P4) = 554 pc/h

SHARED LANE CAPACITY:
SH = (V7+V9)/((V7/Cm7) + (V9/Cm9)) = $\frac{5+4}{(5/554 + 4/850)}$ = 655
(IF LANE IS SHARED)

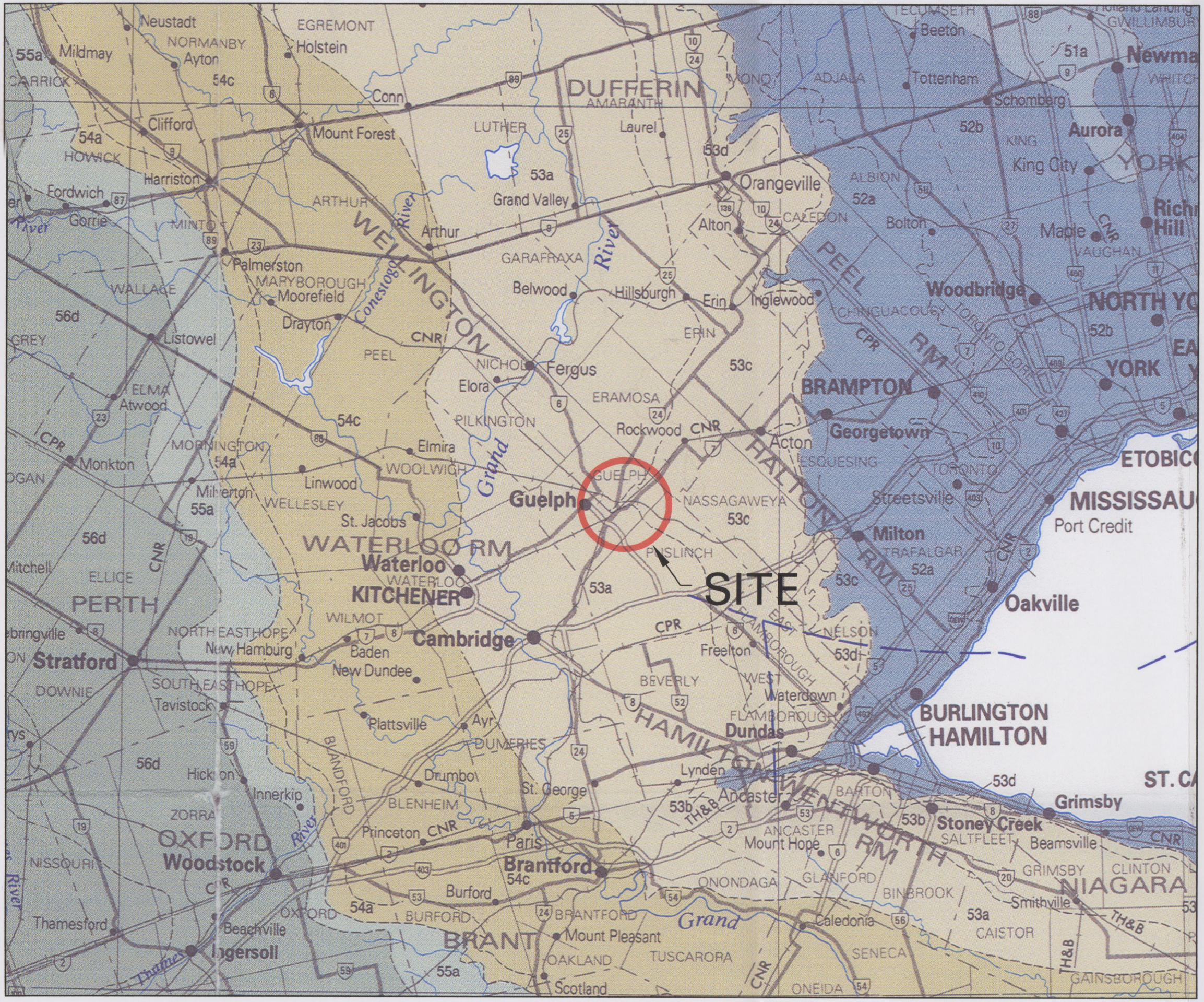
MOVEMENT	V (pc/h)	Cm (pc/h)	Csh (pc/h)	Cr	Level of Service
7	5	660	655	650	A
9	4	850	655	651	A
4	1	970		969	A

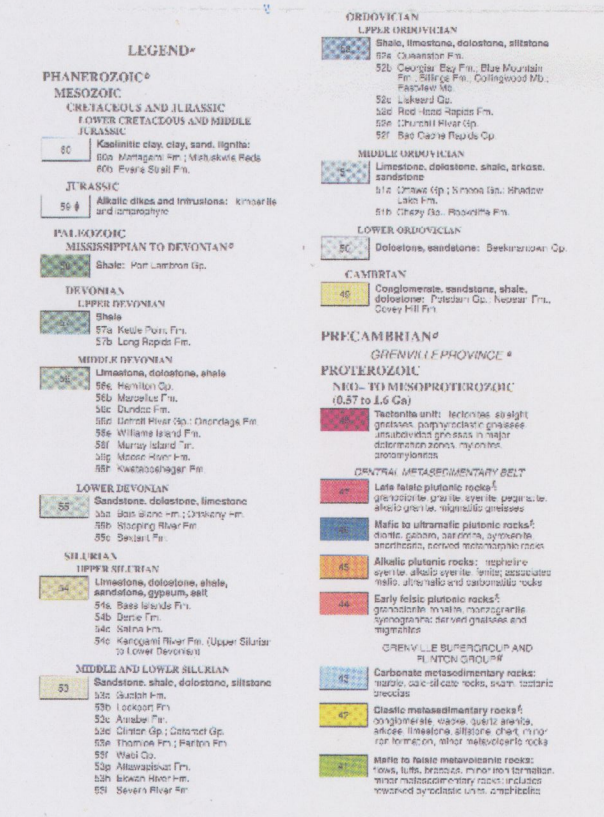
FIGURE 3

KUKOVICA SUBDIVISION

HYDROGEOLOGICAL ASSESSMENT

BEDROCK GEOLOGY





Map Source: Ontario Geological Survey 1991. Bedrock Geology of Ontario, southern sheet; Ontario Geological Survey, Map2544, scale 1:1 000 000.

N

0 5 10 15 20 25 30 35 40

Kilometers

1:5,000,000
February 2006
Project Number: PTA 10312

Prepared by: C. Reynolds

Verified by: D. Marks

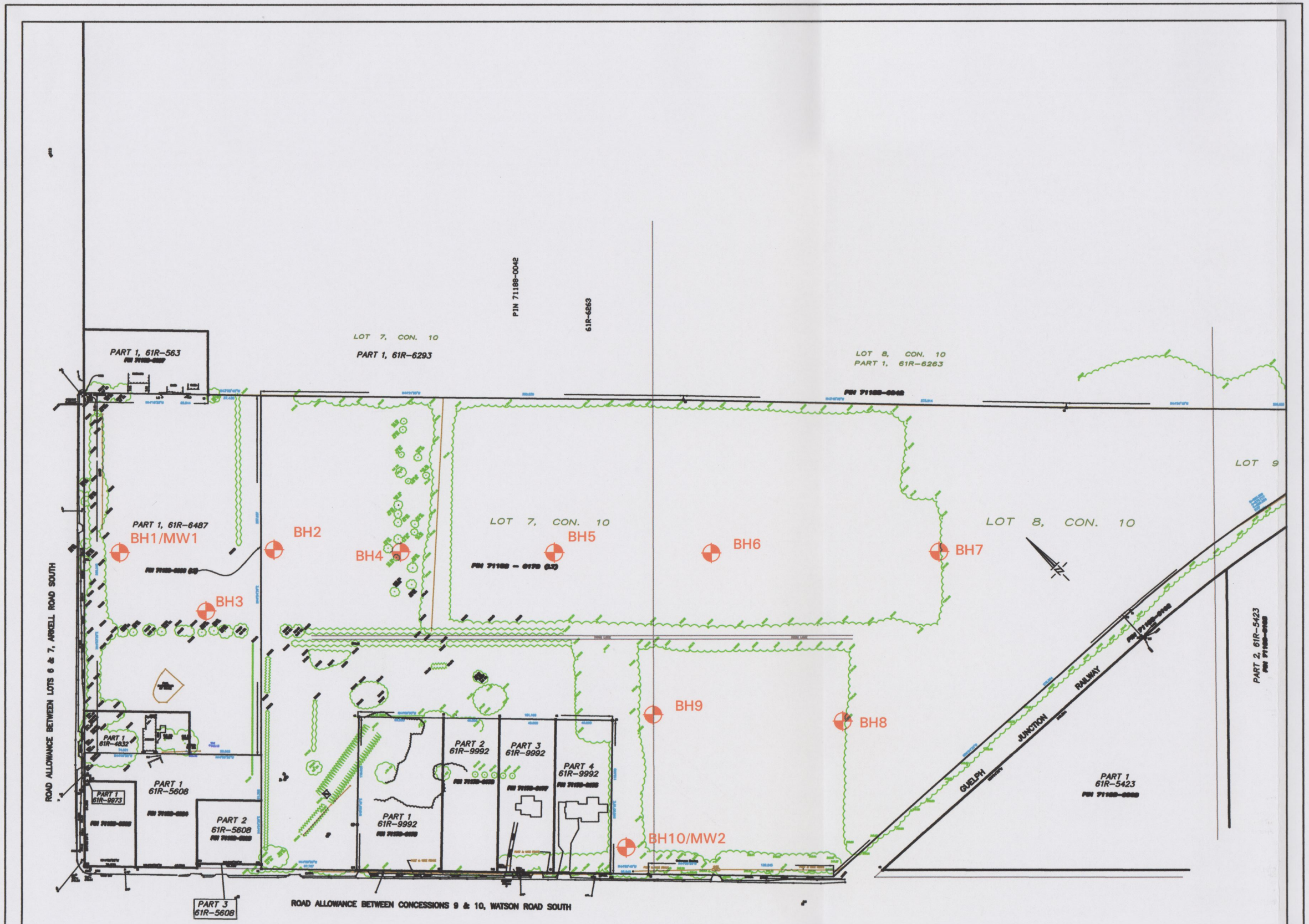
BURNSIDE

XREF: PTA10312 BEDROCK GEOLOGY.JPG PTA10312 BEDROCK GEOLOGY.DWG

FIGURE 6

KUKOVICA SUBDIVISION
HYDROGEOLOGICAL ASSESSMENT

BOREHOLE / MONITORING WELL LOCATION PLAN



Legend

MONITORING WELL LOCATION

Base Plan Provided by: Van Harten Surveying Inc., Land Surveyors and Engineers, February 2006

0 20 40 60 80 100 120 140 160 180 200 220 240
Meters

1:3,000
February 2006
Project Number: PTA 10312

Prepared by: C. Reynolds

Verified by: D. Marks

BURNSIDE

XREF: PTA10312 SP BASE.DWG

PTA10312 SP.DWG

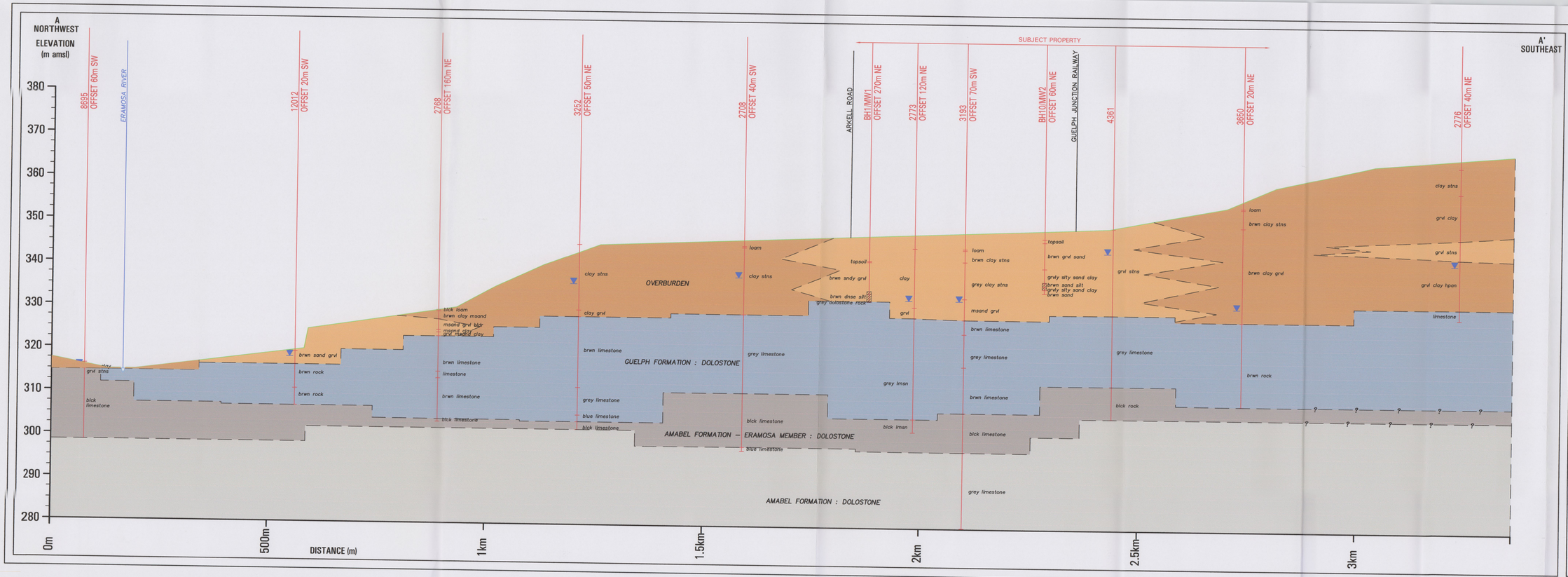


FIGURE 5

KUKOVIC SUBDIVISION

HYDROGEOLOGICAL ASSESSMENT

CROSS-SECTION A-A'

LEGEND

- 6993 — WELL LOCATION & NUMBER
- INDICATES A FLOWING WELL
- EXISTING GROUND PROFILE
- grey limestone — GEOLOGICAL STRATIGRAPHY
- STATIC WATER LEVEL
- WELL SCREEN
- PRIMARILY SAND AND GRAVEL
- PRIMARILY CLAY AND SILT

Vertical Scale 1:500
Horizontal Scale 1:5,000
Vertical Exaggeration 10x

February 2006
Project Number: PTA 10312

Prepared by: C. Reynolds

Verified by: D. Marks

BURNSIDE

XREF:

PTA10312 XSA DWG

FIGURE 4

KUKOVICA SUBDIVISION
HYDROGEOLOGICAL ASSESSEMENT

WELL LOCATION PLAN

Legend

- MOE Bedrock Well Location
- MOE Overburden Well Location
- Site Boundary
- Building: To Scale
- Building: Not to Scale
- Contour
- Contour: Approximate
- Contour: Interpolated
- Contour: Depression
- Lot
- Miscellaneous Linear Feature: Unspecified
- Pit/Quarry: Unspecified
- Rail: Unspecified
- River/Stream: Seasonal
- River/Stream: Permanent
- Road: Primary
- Road: Secondary
- Road: Other
- Spot Height
- Spot Height (Vertical Control)
- Spot Height (Water)
- Trail
- Utility Line: Unspecified
- Wooded Area
- Waterbody
- Wetland
- Cross Section Orientation

Copyright: Her Majesty the Queen in Right of Ontario.

N

0 100 200 300 400 500 600 700 800
Meters

Scale: 1:10,000
Mapping Date: February, 2006

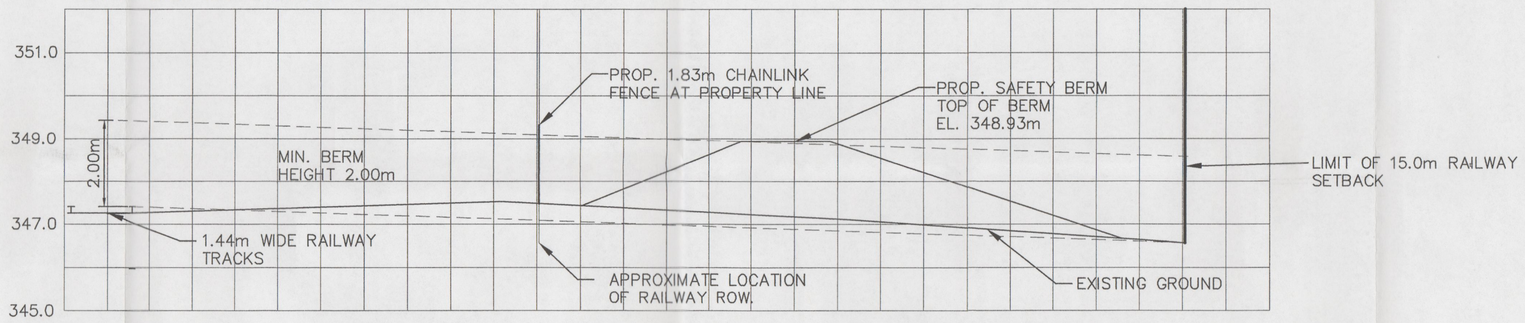
Projection: UTM Zone 17
Datum: NAD 83

Project: PTA 10312
Prepared By: C. Reynolds

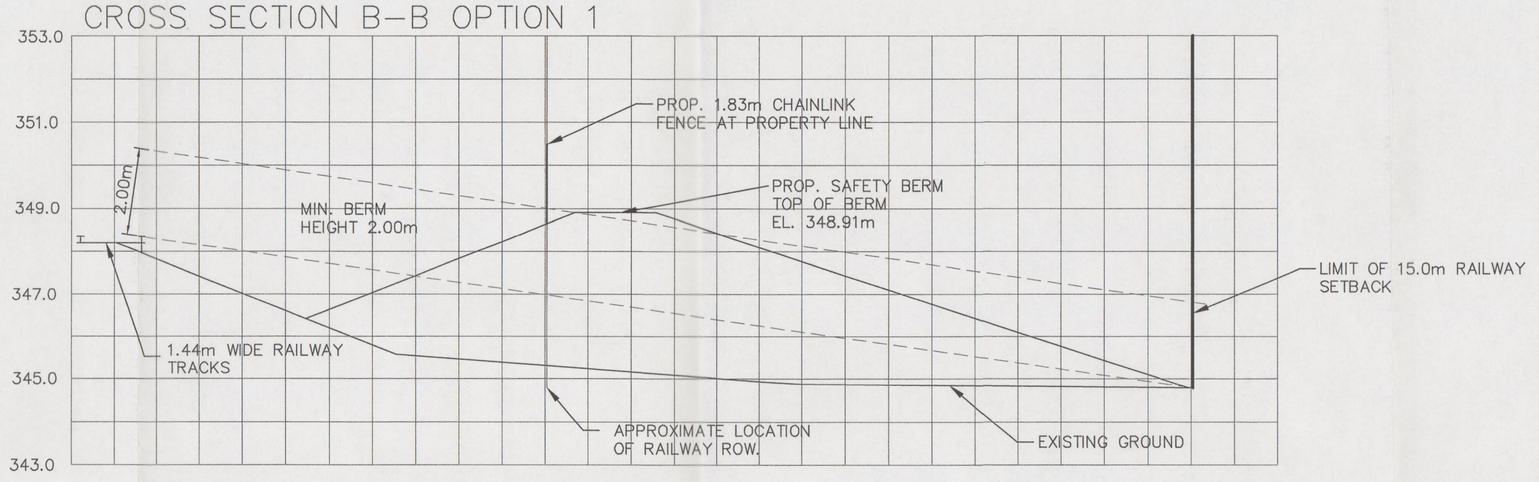
Verified By: D. Wilson

BURNSIDE

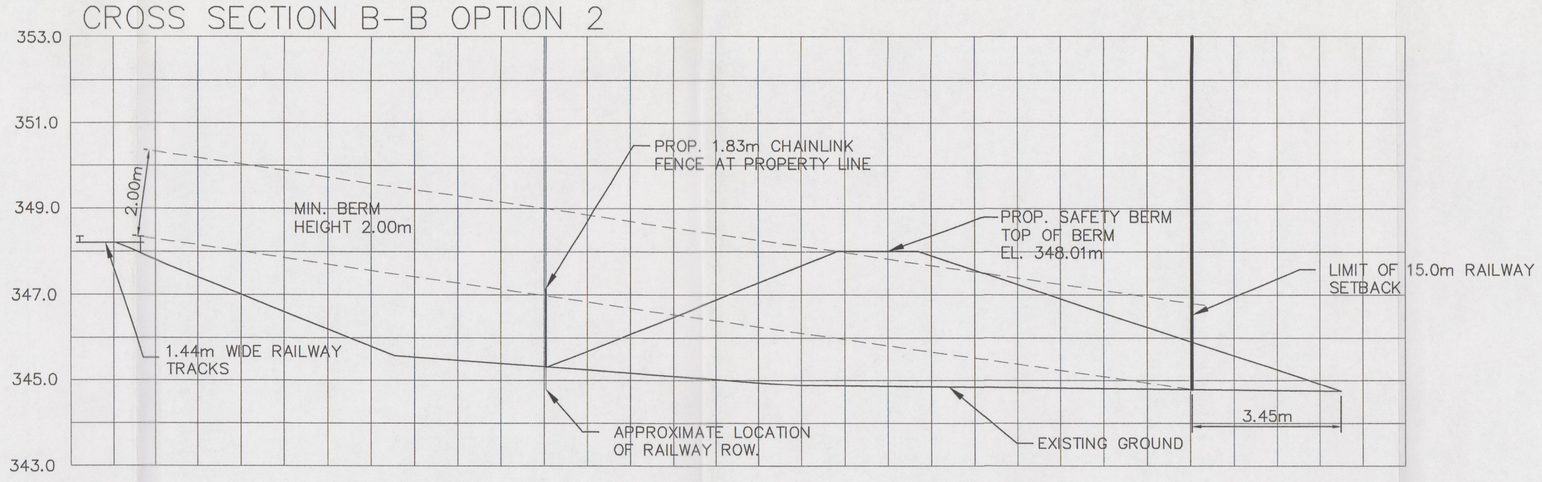
CROSS SECTION A–A



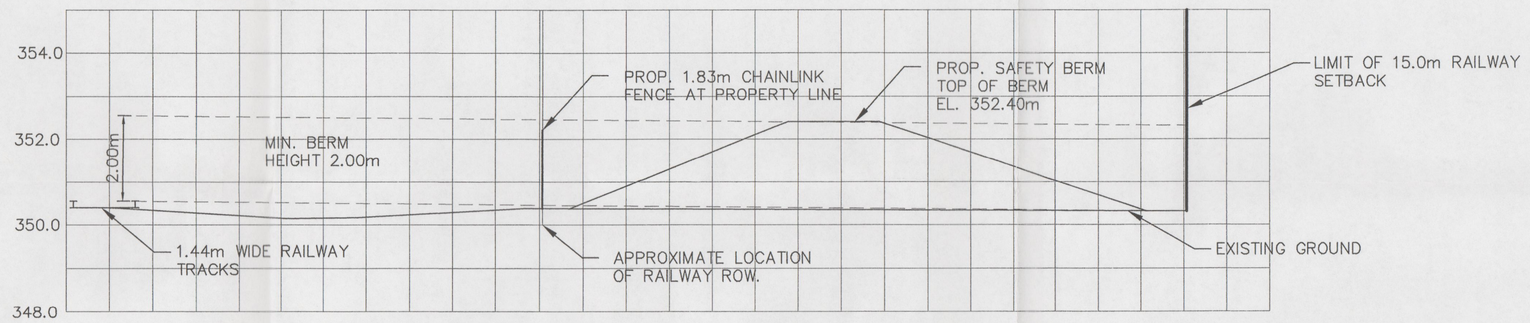
CROSS SECTION B–B OPTION 1



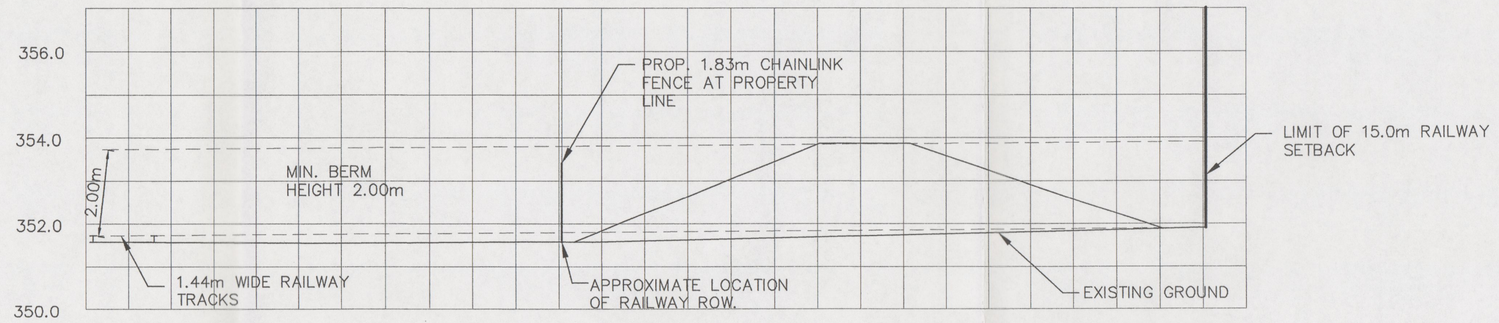
CROSS SECTION B–B OPTION 2



CROSS SECTION C–C

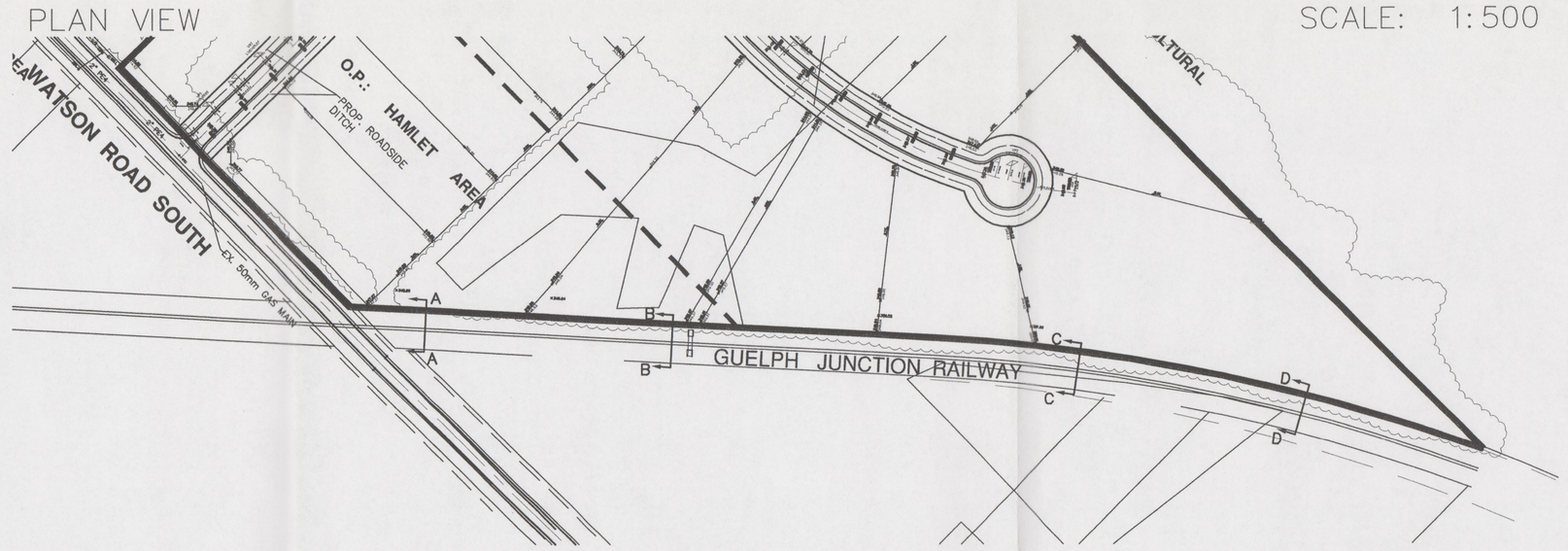


CROSS SECTION D–D



PLAN VIEW

SCALE: 1:500



GENERAL NOTES:

BENCH MARKS

NO.	REVISIONS	DATE	APPROVED

LICENSED PROFESSIONAL ENGINEER
H.G. GEMMELL
100081079
PROVINCE OF ONTARIO

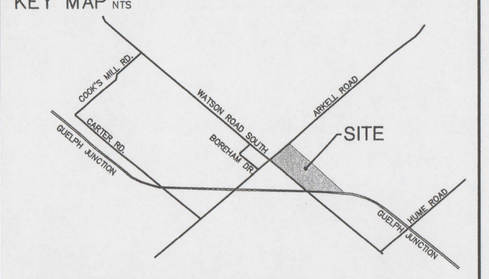
KUKOVICA DEVELOPMENT
ARKELL, ONTARIO

RAILWAY BERM CROSS-SECTIONS

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CONSULTING ENGINEERS
PHONE: (705) 728-0009 TOLL FREE (1-877) 220-2461 FAX: (705) 727-7774
4 CEDAR POINTE DRIVE, UNIT L BARRIE, ONTARIO L4N 5R7

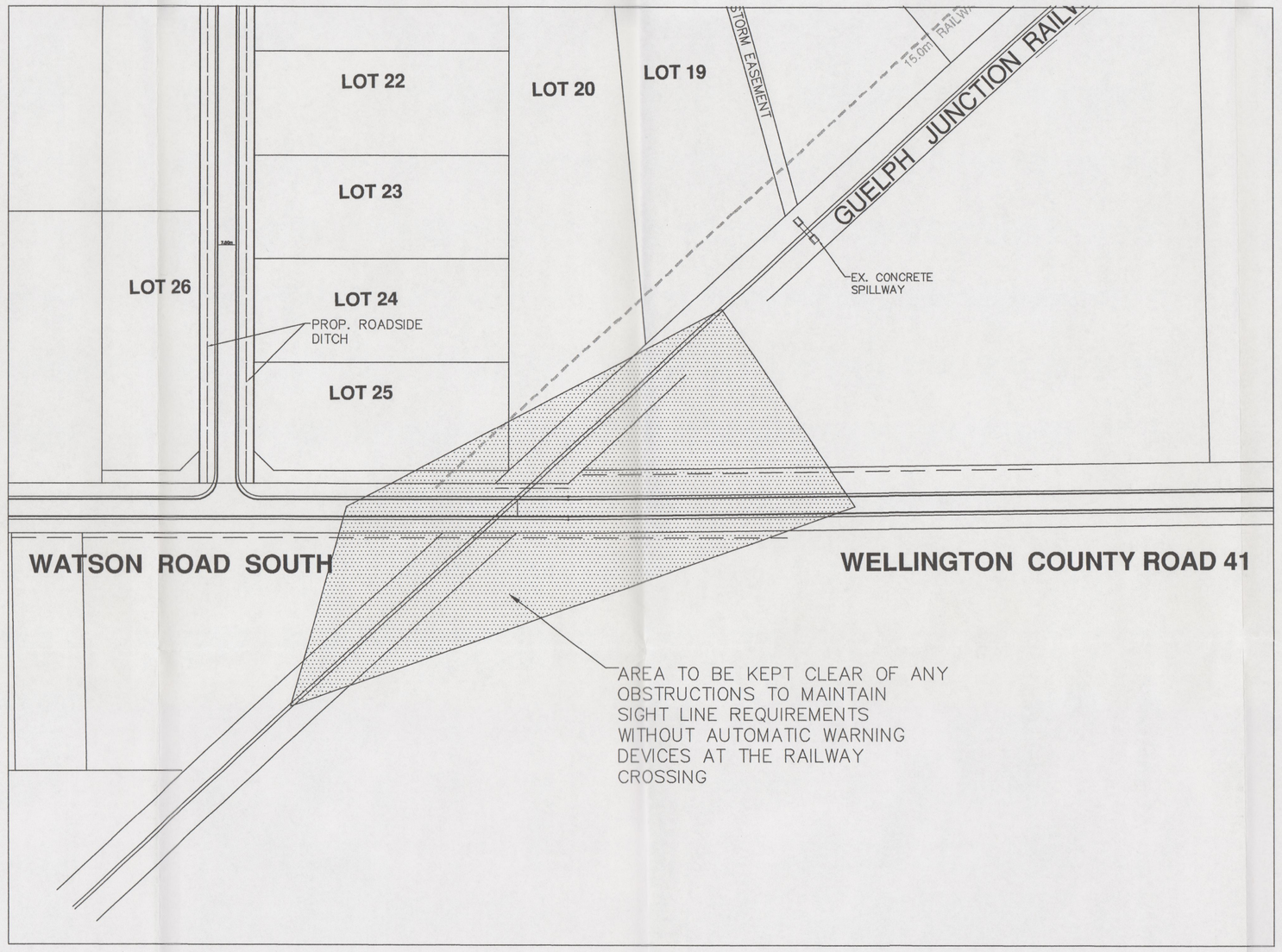
SCALE HOR.	1:100	VERT.		MMA No.	
DESIGN	C.A	DRAWN	C.A.	SHEET NO.	1307-RWB1
REVIEWED	G.G.	DATE	AUGUST 2008		

KEY MAP NTS

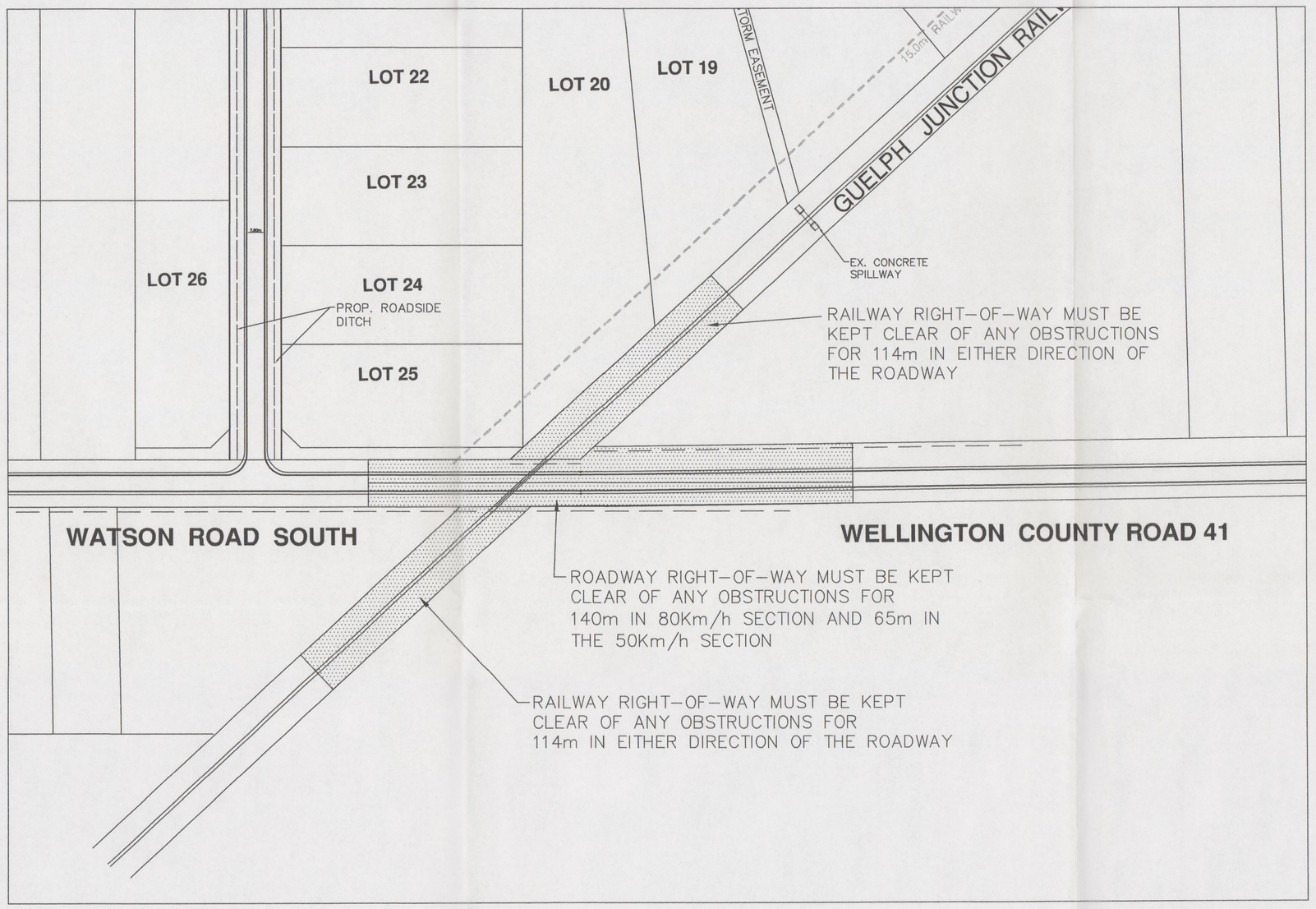


LEGAL DESCRIPTION:
PART LOTS 7, 8, & 9, CONCESSION 10
TOWNSHIP OF PUSLINCH (ARKELL), ONTARIO

SIGHT LINE REQUIREMENTS FOR A RAILWAY CROSSING WITHOUT AUTOMATIC WARNING DEVICES



SIGHT LINE REQUIREMENTS FOR A RAILWAY CROSSING WITH AUTOMATIC WARNING DEVICES



GENERAL NOTES:

BENCH MARKS

NO.	REVISIONS	DATE	APPROVED

LICENSED PROFESSIONAL ENGINEER
H.G. GEMMELL
100081079
PROVINCE OF ONTARIO
11/06

KUKOVICA DEVELOPMENT
ARKELL, ONTARIO

RAILWAY CROSSING SIGHT LINE REQUIREMENTS

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CONSULTING ENGINEERS
PHONE: (705) 728-0009 TOLL FREE (1-877) 220-2461 FAX: (705) 727-7774
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SCALE HOR.	1:1500	VERT.		MMA No.
DESIGN	C.A	DRAWN	C.A.	SHEET NO. 1307-RWC1
REVIEWED	G.G.	DATE	AUGUST 2006	

PUSLINCH

Comment Summary – Timberworx Custom Homes

Consultant	**Comments**
County of Wellington Planning	See letter attached
GM BluePlan	See letter attached
Stan Denhoed-Township Hydrogeologist	No comments received to date
Ecology Comments	See letter attached
Township of Puslinch Fire Department – Brent Smith	1. is there any requirements from the Township or Region regarding the number of lots that can be developed in a dead end portion of a subdivision before a second access is required? In the Waterloo Region for example, the maximum number of lots was set at 26 before an additional emergency access was required. 2. Water tanks and dry hydrants will be required in this subdivision. We will need to see the location, size of tanks etc. on the plans. Please find attached the township's requirements for the tanks and connections.
Township of Puslinch Building Department – Andrew Hartholt, CBO	No comments at this stage from a building code perspective
Township of Puslinch By-law Enforcement	By-law has no comments or concerns at this time.
Township of Puslinch Public Works – Mike Fowler	No concerns, sight lines are good

PUSLINCH

Source Water	See letter attached
GRCA	As the subject lands do not contain areas regulated by the GRCA, we will not be providing comment for this pre-consultation application.

COUNTY OF WELLINGTON

PLANNING AND DEVELOPMENT DEPARTMENT
Meagan Ferris, RPP MCIP
TEL: (519) 837-2600 ext. 2120
EMAIL: meaganf@wellington.ca

ADMINISTRATION CENTRE
74 WOOLWICH STREET
GUELPH, ONTARIO
N1H 3T9

May 15th, 2023

Township of Puslinch
7404 Wellington Road 34
Guelph, ON N0B 2J0

Dear Ms. Lynne Banks:

Re: Revised Development Proposal – 23T-06003, OP-2006-06 & P10/2006

Thank you for circulating additional information regarding the development proposal for the above mentioned files. It is understood that all of these files have been on hold since approximately 2006 and the property has since been sold. The intent is to revive these existing applications by preparing a formal submission as part of this proposal. The information submitted seeks to provide an update and revisions to the proposal.

Based on our review of the submitted information, and in our capacity as County Planner's and the Township's Planning consultants, we offer the following preliminary planning comments:

Proposal:

- **Two revised conceptual plans have been provided:**
  - Proposal 1 – 39 residential lots & 1 storm water management block
  - Proposal 2 – 46 residential lots; excludes approximately 3.1 ha (additional lands owned by developer); and 1 storm water management block
  - Access is proposed solely from Watson Road South

- **Key changes from original proposal:**
  - The lands along Arkell Road (605 Arkell Road) are no longer part of the subject development. Access is now solely being provided via Watson Road South.
  - The previous proposal included approximately 36 lots, a stormwater management block, and access onto Watson Road South and Arkell Road/Wellington Road 37
  - All lots in original proposal met or exceeded minimum lot area. The revised proposal shows reduced lot sizes ranging from 0.2 ha – 0.3 ha. Approximately 16 lots are undersized.

- **New Reports Proposed to be Submitted:**
  - Groundwater Assessment; Alternative Site Evaluation Study and Mineral Aggregate Resource Assessment; Planning Justification Report and Agricultural Impact Assessment; Nitrate Assessment; and an Archaeological Assessment.
  - The proponent does not propose to submit updated: Noise/Vibration Study; Geotechnical Report; Stormwater Management Report; or Traffic Impact Study. Updates are suggested by the application to be addressed as part of a holding provision.

COUNTY OF WELLINGTON

PLANNING AND DEVELOPMENT DEPARTMENT
Meagan Ferris, RPP MCIP
TEL: (519) 837-2600 ext. 2120
EMAIL: meaganf@wellington.ca

ADMINISTRATION CENTRE
74 WOOLWICH STREET
GUELPH, ONTARIO
N1H 3T9

General Planning Comments:

- General note -- It is noted that the Province has prepared a draft proposed Provincial Planning Statement. The new PPS combines the PPS and Growth into one document; however, this document is still under review.

  Any comments made as part of these preliminary planning notes have been made under the current policy framework. The applicant may wish to consider the timing of their resubmission in relation to the implementation of the new PPS.

- It's understood that the applicant has submitted some studies to the County in 2022; however, it is requested that a formal complete resubmission with all studies (including the ones identified as already being submitted separately) are provided under one cover with an accompanying cover letter to the County and the Township for formal review.

- Planning staff would request that the Draft Plan be reviewed concurrently with the Official Plan and Zoning By-law amendment. However, additional discussion regarding process may be helpful.

- Public Engagement – It is understood that these applications did not progress to a Public Meeting. Due to the time that has passed since the original proposal, the Township may want to consider hosting an Open House in advance of a statutory Public Meeting.

  The applicant has proposed a "public participation program" which has the owner meeting with land owners that abut the subject lands. If this approach is accepted by the Township, it is suggested that written documentation of this engagement strategy and comments received by the Public be provided to the Township in a singular package to form part of the planning file.

- The proposal does not include any parks or open space. Additional discussion on need for park space within the Township and within this development will be required.

- Additional discussion regarding the different sign options would be helpful. County planning staff would like to explore preserving the trees on site, the lot configurations, the lot configuration off of Watson Road S, location of the storm pond, transition to the rural area etc.

- Current provincial policies - Expansion to a rural settlement area is only permitted through the Municipal Comprehensive Review (MCR) process; however, Section 2.2.9.7 allows "minor" adjustments. Generally, the inclusion of 39 plus lots would not be considered minor. Additional justification through a Planning Justification Report would be required to demonstrate that this proposal could meet Provincial policy; however, consideration of the County's MCR process and also the updated Provincial Planning Statement is pertinent.

COUNTY OF WELLINGTON

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ADMINISTRATION CENTRE
74 WOOLWICH STREET
GUELPH, ONTARIO
N1H 3T9

Re-Submission Requirements for Existing Official Plan Amendment, Draft Plan of Subdivision and Zoning By-law Amendment:

Included below is a preliminary list of potential supporting studies that are required for the resubmission of these applications:

- Planning Justification Report – including a draft by-law for the proposed Official Plan and Zoning Amendment including schedules; an MDS review; summary of all supporting studies; overview of how this development is considered "minor" or moderate in scale, a review of Section 4.8 of the Official Plan, assessment of impacts to mineral aggregate resources in the area etc.

- Environmental Impact Assessment, Arborist Report, Tree Inventory and Preservation Plan. The scoping of the EIS can be a topic of discussion.

- Agricultural Impact Assessment

- Alternative Site Evaluation Study

- Source Water Protection Form and/or any other additional items as requested by Source Water Protection staff.

- Updated Noise/Vibration Study

- Update Traffic Impact Study – separate comments from the County's Roads Department are anticipated.

- Any other studies and/or plans as identified by the Township's consultants are required as part of the future resubmission. This includes any requests for specific existing studies to be updated.

- The Hydrogeological Study should also address the Paris Galt Moraine policies of the Official Plan (i.e. 4.9.7). A review of servicing options that addresses Section 11.2.3 should also be undertaken.

- The subdivision application will require all Plans, including existing topographical surveys, as identified in the Township's Municipal Development Standard (Puslinch Municipal Development Standards) unless the Township's consultants requiring something different.

All studies are to meet the requirements of the County Official Plan, including Section 4.6 Impact Assessment.

These comments have been prepared without the benefit of reviewing detailed comments from other consultants or agencies and based on a conceptual proposal. These comments may change as more details are provided and the plans evolve.

COUNTY OF WELLINGTON

PLANNING AND DEVELOPMENT DEPARTMENT
Meagan Ferris, RPP MCIP
TEL: (519) 837-2600 ext. 2120
EMAIL: meaganf@wellington.ca

ADMINISTRATION CENTRE
74 WOOLWICH STREET
GUELPH, ONTARIO
N1H 3T9

I trust these comments will be of assistance if you have questions please contact the County of Wellington Planning and Development Department.

Yours truly,

[redacted]

_____
Meagan Ferris, RPP MCIP
Manager of Planning and Environment

May 15, 2023
Our File: 123006-013

Township of Puslinch
7404 Wellington Road 34
Guelph, ON N0B 2J0

Attention: Ms. Lynne Banks

Re: Development Review Request
Arkell Residential Development
Township of Puslinch

Dear Ms. Banks,

Following our review of pre-consultation submission documents received on May 2, 2023, it is our understanding that the Developer is intending to undergo a Zoning By-Law Amendment (ZBA) and Official Plan Amendment (OPA) to designate the subject lands located at Part of Lots 7,8 & 9 Concession 10, Township of Puslinch (Arkell), Ontario as residential lands. We are providing pre-consultation comments related to a future Zoning By-law Amendment and Official Plan Amendment application.

In support of the identification of the engineering requirements for the Zoning By-law Amendment and Official Plan Amendment, the following documents and drawings were received and reviewed:

- Conceptual Plan – 39 Residential Lots prepared by Stovel and Associates Inc., dated April 24, 2023
- Conceptual Plan – 46 Residential Lots prepared by Stovel and Associates Inc., dated April 24, 2023
- Rail Noise and Vibration Impact Assessment prepared by HGC Engineering dated July 24, 2006
- Preliminary Geotechnical Investigation prepared by V.A. Wood (Guelph) Inc., dated February 2006.
- Preliminary Stormwater Management Report prepared by Richardson Foster Ltd., dated August 2006
- Preliminary Traffic Impact Study prepared by Richardson Foster Ltd., dated August 2006

We defer review of the following to Wellington Source water Protection and the Township Hydrogeologist:

- Groundwater Supply Assessment prepared by ARL Groundwater Resources Ltd., dated March 2023.
- Water Well Records and various excerpts from the Hydrogeological Assessment completed by R.J. Burnside & Associates Ltd., 2006.

We defer commenting on the requirement for a secondary emergency site access to the County Planner.

Therefore, we provide the following requirements in support of Zoning By-law Amendment and Official Plan Amendment:

- ***Site Plan***, provide confirmation which concept plan will form part of the future applications (i.e. 39 or 47 lots) and ensure that the relevant studies support the proposed concept plan.

- ***Stormwater Management Brief*** prepared by a Professional Engineer confirming that the proposed use of the lands will not have a significant impact on stormwater management and drainage on the property, including water quantity, water quality, water balance and drainage flow routes. Should infiltration be proposed, the stormwater management brief must demonstrate that a minimum separation distance of 1.0m is maintained between the bottom of the infiltration structures and the seasonal high groundwater levels. Confirmation of site legal outlet is required.

We acknowledge that the proponent has provided a Stormwater Management Report from 2006, however the findings of the 2006 report need to be updated to reflect the current concept and latest Township of Puslinch Municipal Development Standards as the concept plan put forward is very different from what was proposed in 2006 and the Township of Puslinch Municipal Development Standards have been updated since then. The 2006 stormwater management report stipulates that quality pre-treatment of runoff will be provided by roadside ditches prior to infiltrating in the stormwater management pond. Roadside ditches are no longer supported in the Township of Puslinch and a standard urban cross section must be used per the latest Town of Puslinch Municipal Development Manual. The 2006 stormwater management report assumed 14% imperviousness for the proposed development and that the stormwater management pond will outlet to the existing roadside ditches on Arkell Road. While these assumptions might have been appropriate for the previous concept plan where the stormwater management pond was located adjacent to Arkell Road and a similar number of lots were proposed for a larger area, the percent imperviousness and legal outlet for the proposed development concept must be confirmed as the area adjacent to Arkell Road is no longer part of the development concept.

- ***Site Grading Plan,*** generally showing the site grading and drainage patterns on the subject lands and confirming legal outlet.

- ***Traffic Impact Study***, due to the proximity and potential impacts to Watson Road South, an updated Traffic Impact Study is required to support the development.

  We acknowledge that the applicant has provided a Traffic Impact Study from 2006, however this needs to be updated to reflect current traffic volumes and the revised development concept. The new concept proposes a single entrance from Watson Road South where as the previous traffic study included two entrances to the site.

- ***Noise and Vibration Study***, due to the proximity of the existing railway, an updated Noise and Vibration Study is required to support the development.

  We acknowledge that the applicant has provided a Noise and Vibration Study from 2006, however this needs to be updated to reflect the revised development concept, current rail volume data and to confirm berm and setback requirements from the existing railway.

If you have any questions or require additional information, please do not hesitate to contact us.

Yours truly,

GM BLUEPLAN ENGINEERING
Per:

[redacted]

Sergio Zaga, M.Eng.
Project Designer

[redacted]

Steve Conway, C.E.T., rcsi, PMP
Branch Manager, Senior Project Manager

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

Environmental Assessments & Approvals

May 11, 2023 AEC 21-130

Township of Puslinch
7404 Wellington Road 34
Puslinch, Ontario N0B 2J0

Attention: Justine Brotherston, Deputy Clerk

Re: **Pre-consultation Ecology Peer Review for Proposed Timberworx Custom Homes Development - Arkell Road and Watson Road South (Parts of Lots 7, 8 and 9, Concession 10), Township of Puslinch, Ontario**
File #D00/KUK

Dear Ms. Brotherston:

Azimuth Environmental Consulting, Inc. (Azimuth) is pleased to provide this pre-consultation peer review letter for the Township of Puslinch (Township) pertaining to a proposed development at the address above. Azimuth's review was completed by Dr. Scott Tarof (natural heritage).

Azimuth reviewed the following documents on behalf of the Township:

1) Conceptual Plan – 39 Residential Lots [dated April 24, 2023 from Stovel and Associates Inc. (SAI)];
2) Conceptual Plan – 46 Residential Lots (dated April 24, 2023 from SAI); and,
3) The email "FW: Arkell Conceptual Plans 39 & 46 Lots" (dated May 1, 2023).

The documents reviewed relate to two alternative Conceptual Plans (39 or 46 lots) for a proposed future residential subdivision (Appendix A). Based on correspondence with the Township, the scope of Azimuth's review was to:

- Complete a peer review of the information provided from an ecology perspective at the pre-consultation stage of the development application process;
- Provide a peer review letter to the Township that gives professional direction and recommendations regarding natural heritage matters pertinent to the proposed development on the property and/or adjacent lands [*i.e.* within 120 metres (m) of the property]; and,
- Attend a pre-consultation meeting (virtual) scheduled for May 18, 2023.

1.0 BACKGROUND REVIEW

The property is in an existing rural residential community entirely within Ecoregion 6E. At the landscape scale, natural heritage features (*e.g.* woodlands, wetlands) occur approximately 300m to the north (Appendix B). Lands to the south and west are comprised of residential lots and farmland.

Provincial background mapping from the Natural Heritage Information Centre (NHIC) shows woodlands occupy the eastern one-third of the property (Appendix B). Google Street View suggests that these woodlands are mature. The woodlands may be considered part of regional Significant Woodlands to the north and northeast, and may be included in the County of Wellington (County) Greenlands System [Section 5.5.4 in the County Official Plan (County OP, 2022)]. The remainder of the property is occupied by open grass fields bound by hedgerows. There appear to be no mapped wetlands or drainage features on or within 120m of the property limits (Appendix B). The eastern half of the property is mapped as part of the Natural Heritage System of the Growth Plan for the Greater Golden Horseshoe [Ministry of Municipal Affairs and Housing (MMAH), 2020a)]. Natural heritage planning policies of the Growth Plan Area (MMAH, 2020a) should be considered (Appendix B).

A Species at Risk (SAR) background search of NHIC grid squares 17NJ6720 and 17NJ6820 indicates records for the following Threatened or Endangered species: Black Ash (*Fraxinus nigra*, Endangered); Eastern Meadowlark (*Sturnella magna*, Threatened); Henslow's Sparrow (*Ammodramus henslowii*, Endangered); Bobolink (*Dolichonyx oryzivorus*, Threatened); Rusty-patched Bumble Bee (*Bombus affinis*, Endangered); Gypsy Cuckoo Bumble Bee (*Bombus bohemicus*, Endangered) and Transverse Lady Beetle (*Coccinella transversoguttata*, Endangered) (Appendix B). The current range for Rusty-patched Bumble Bee and Gypsy Cuckoo Bumble Bee is understood to be limited to Pinery Provincial Park; the likelihood of these two species being found on the property is low. Records for Transverse Lady Beetle are most likely historic.

Records also exist for several Special Concern species: Grasshopper Sparrow (*Ammodramus savannarum*); Wood Thrush (*Hylocichla mustelina*); Eastern Wood-pewee (*Contopus virens*); Canada Warbler (*Cardellina canadensis*); Barn Swallow (*Hirundo rustica*); Eastern Ribbonsnake (*Thamnophis sauritus*) and Yellow-banded Bumble Bee (*Bombus terricola*) (Appendix B). Given the habitat types present (based on aerial imagery), SAR and Significant Wildlife Habitat functions have potential to occur in association with the property.

Habitat of Threatened or Endangered species, and the species themselves, are protected under Sections 9 and 10 of Ontario's *Endangered Species Act*, 2007 (ESA). Special Concern species do not receive protection under Ontario's ESA, but are considered under provincial Significant Wildlife Habitat guidelines. Other possible natural heritage constraints with potential to be associated with the property and/or adjacent lands include Butternut (*Juglans cinerea*, Endangered), SAR bats, SAR bat habitat and possibly other SAR or rare plant species.

2.0 RECOMMENDATIONS

Based on the information provided and background mapping, Azimuth is providing the following recommendations to the Township. The background information summarized above suggests the potential for several natural heritage features and functions to be associated with the property and/or adjacent lands. As per Ontario's Provincial Policy Statement (MMAH, 2020b), development or site alteration is not permitted in Significant Woodlands (Ecoregions 6E or 7E), Significant Wildlife Habitat or on lands adjacent to Significant Woodlands or Significant Wildlife Habitat unless it can be demonstrated [*e.g.* through an Environmental Impact Study (EIS)] that there will be no negative impacts to the natural heritage features and functions. Development in habitat of ESA-protected species may require authorizations issued under the ESA if the activity is deemed damaging or destructive to habitat and/or poses a direct impact to the species. Local OPs also outline policies governing natural heritage features and their ecological functions, including setbacks and Vegetation Protection Zones.

It is recommended that the Township consider an EIS be undertaken to identify natural heritage features and functions associated with the property and/or adjacent lands, and assess the potential for impact in relation to the development under consideration. At minimum, the following EIS scope is recommended:

- Evaluate/map vegetation communities based on provincial Ecological Land Classification (ELC) methods for Southern Ontario;
- Two (2) vascular plant inventories with regard for SAR plants including Butternut and Black Ash (spring and summer);
- Three (3) dawn breeding bird surveys with consideration for SAR grassland birds;
- SAR bat snag mapping (*e.g.* density plot method) during leaf-off conditions. Should the 46-lot Conceptual Plan be selected, potential impacts to the woodland would be anticipated to be reduced. Under this development option, detailed bat snag mapping instead of density plots may be more appropriate for the smaller area of tree removals;

- Assessment of potential SAR habitat on and/or adjacent to the property;
- Assessment of potential Significant Wildlife Habitat on and/or adjacent to the property, including possible presence of habitat for Special Concern species; and,
- Observations of incidental wildlife while on the property for other surveys.

Azimuth recommends this typical EIS approach to assist the Township in their decision-making process pertaining to the proposed development. If the snag mapping survey identifies candidate SAR bat habitat on the property, consultation with the Ministry of the Environment, Conservation and Parks (MECP) may be warranted to confirm appropriateness of acoustic monitoring to determine habitat use by SAR bats (given the extent of proposed tree removals under either Conceptual Plan option). Due to the woodlands in the eastern half of the property and potential for the feature to be part of a regional Significant Woodland, the Township may wish to also consider that the proponent provide a Tree Inventory and Tree Preservation Plan (prepared by a Certified Arborist). An Edge Management Plan may be suitable to "soften" the hard woodland edges created by tree removals.

If the proponent wishes to remove trees/vegetation to accommodate the proposed development, removals should be completed outside of the migratory breeding bird window and active SAR bat window (*i.e.* outside April 1 to September 30 of a given year) to avoid potential impacts to migratory breeding birds protected under the *Migratory Birds Convention Act*, 1994 and/or Ontario's *Fish and Wildlife Conservation Act*, 1997. This recommended window would also avoid accidental contravention of Ontario's *Endangered Species Act*, 2007 (ESA) in regards to SAR bats.

We trust this pre-consultation ecology review is helpful. Azimuth will be pleased to attend the May 18, 2023 pre-consultation meeting (virtual), as requested by the Township. If you have any questions please do not hesitate to contact the undersigned.

Yours truly,
AZIMUTH ENVIRONMENTAL CONSULTING, INC.

[redacted]

Dr. Scott Tarof (Ph.D. Biology)
Terrestrial Ecologist

Attach:
Appendix A - Conceptual Plans
Appendix B – Background Mapping



Conceptual Plan
39 Residential Lots

Part of Lots 7,8 & 9 Concession 10
Assessment Roll Number 2301000008034800000
ARKELL, ONTARIO

Notes

1. All Coordinates Were Determined Using NAD83 CSRS - Zone 17.
2. Structural Locations Have Not Been Confirmed.
3. This Is Not a Plan Of Survey.
4. Proposed "Draft Plan Of Subdivision - Kukovica" Supplied By Van Harten / Jeffrey E. Buisman - O.L.S.
5. Delination of CLI Class 3/5 Polygon taken from AgMaps.
5. Aerial Imagery Provided By Microsoft Corporation @ 2022 Maxar CNES (2022) Distribution Airbus DS.
7. Coordinates on This Plan Are UTM, ZONE 17, NAD83 (CSRS-2010) Adjustment and Are Based on GPS Observations From a Network of Permanent GPS Reference Stations.

Legend

- Existing Railway
- Subject Lands
- Proposed Lot Line
- Existing Lot Line
- Proposed Stormwater Management Facility / Pond
- Future Road Widening (5m)
- Proposed Roadway

Parcel Area Table

Lot #	Area	Frontage (m)
1	0.3ha	44
2	0.4ha	50
3	0.3ha	51
4	0.3ha	49
5	0.3ha	33
6	0.2ha	33
7	0.2ha	33
8	0.2ha	33
9	0.2ha	37
10	0.3ha	24
11	1.0ha	109
12	0.3ha	32

Parcel Area Table

Lot #	Area	Frontage (m)
13	0.3ha	39
14	0.4ha	51
15	0.4ha	51
16	0.4ha	36
17	0.4ha	47
18	0.4ha	40
19	0.4ha	40
20	0.4ha	40
21	0.4ha	40
22	0.4ha	40
23	0.4ha	40
24	0.4ha	40

Parcel Area Table

Lot #	Area	Frontage (m)
25	0.4ha	41
26	0.8ha	SWMP
27	0.8ha	27
28	0.7ha	43
29	0.5ha	42
30	0.5ha	41
31	0.5ha	40
32	0.4ha	39
33	0.4ha	36
34	0.3ha	50
35	0.3ha	50
36	0.4ha	65

Parcel Area Table

Lot #	Area	Frontage (m)
37	0.4ha	62
38	0.2ha	42
39	0.2ha	32
40	0.2ha	37
41	0.0ha	Road Widening
42	0.0ha	Road Widening
43	1.8ha	Roadway

Client: Sloot Construction Inc. & 1000286480 Ontario Inc.

Stovel and Associates Inc.
651 Orangeville Road,
Fergus ON
N1M 1T9
P: 519-768-8042
E: stovel.associates@outlook.com

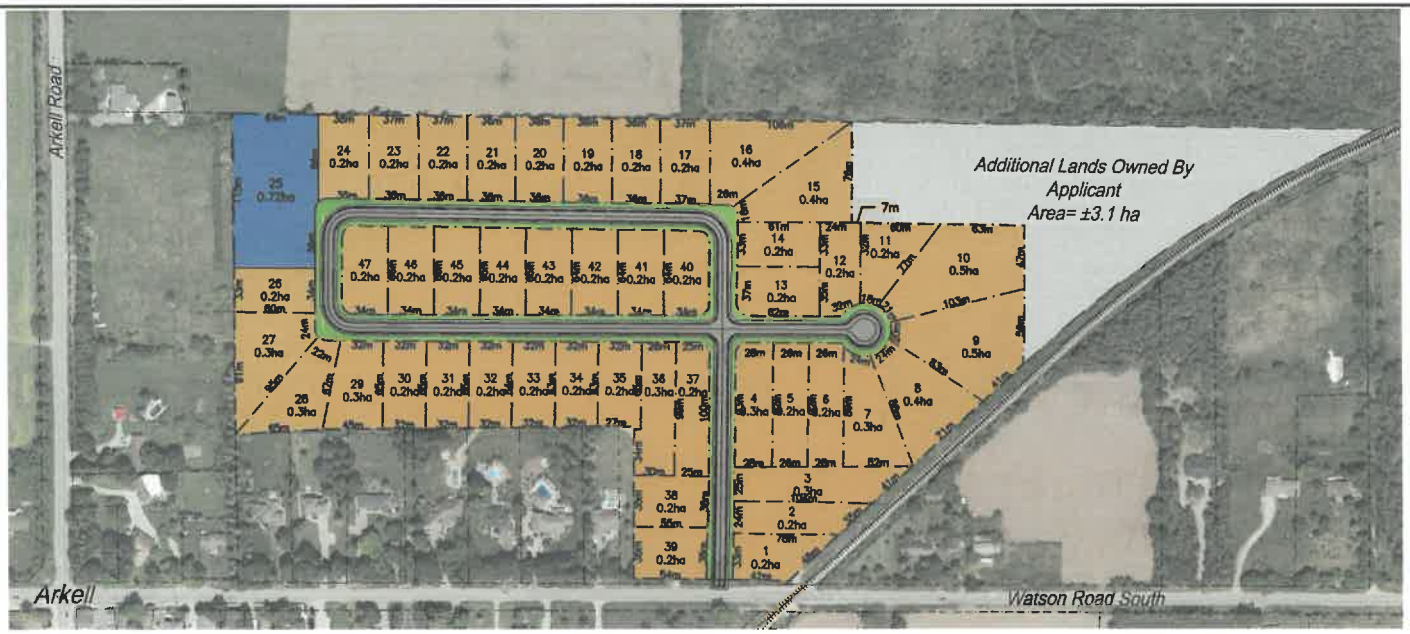
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DRAFT

Date : 04/24/2023

0 100 200 Meters

Scale 1:3500



Conceptual Plan
46 Residential Lots

Part of Lots 7,8 & 9 Concession 10
Assessment Roll Number 2301000008034800000
ARKELL, ONTARIO

Notes

1. All Coordinates Were Determined Using NAD83 CSRS - Zone 17.
2. Structural Locations Have Not Been Confirmed.
3. This Is Not a Plan Of Survey.
4. Proposed "Draft Plan Of Subdivision - Kukovica" Supplied By Van Harten / Jeffrey E. Buisman - O.L.S.
5. Aerial Imagery Provided By Microsoft Corporation @ 2022 Maxar CNES (2022) Distribution Airbus DS.
7. Coordinates on This Plan Are UTM, ZONE 17, NAD83 (CSRS-2010) Adjustment and Are Based on GPS Observations From a Network of Permanent GPS Reference Stations.

Legend

- Existing Railway
- Subject Lands
- Proposed Lot Line
- Existing Lot Line
- Proposed Stormwater Management Facility / Pond
- Proposed Roadway
- Additional Lands Owned By Applicant

Parcel Area Table			Parcel Area Table			Parcel Area Table			Parcel Area Table		
Parcel #	Area	Frontage (m)	Parcel #	Area	Frontage (m)	Parcel #	Area	Frontage (m)	Parcel #	Area	Frontage (m)
1	0.2ha	33m	13	0.2ha	37m	25	0.7ha	SWMP	37	0.2ha	25m
2	0.2ha	24m	14	0.2ha	33m	26	0.2ha	34m	38	0.2ha	38m
3	0.3ha	25m	15	0.4ha	18m	27	0.3ha	24m	39	0.2ha	38m
4	0.3ha	28m	16	0.4ha	26m	28	0.3ha	22m	40	0.2ha	34m
5	0.2ha	26m	17	0.2ha	37m	29	0.3ha	32m	41	0.2ha	34m
6	0.2ha	26m	18	0.2ha	36m	30	0.2ha	32m	42	0.2ha	34m
7	0.3ha	24m	19	0.2ha	36m	31	0.2ha	32m	43	0.2ha	34m
8	0.4ha	24m	20	0.2ha	36m	32	0.2ha	32m	44	0.2ha	34m
9	0.5ha	20m	21	0.2ha	36m	33	0.2ha	32m	45	0.2ha	34m
10	0.5ha	21m	22	0.2ha	36m	34	0.2ha	32m	46	0.2ha	34m
11	0.2ha	18m	23	0.2ha	36m	35	0.2ha	32m	47	0.2ha	34m
12	0.2ha	32m	24	0.2ha	36m	36	0.3ha	26m			

Client: Sloot Construction Inc. & 1000286480 Ontario Inc.

Stovel and Associates Inc.
651 Orangeville Road,
Fergus ON
N1M 1T9
P: 519-766-8042
E: stovel.associates@outlook.com

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Date : 04/24/2023

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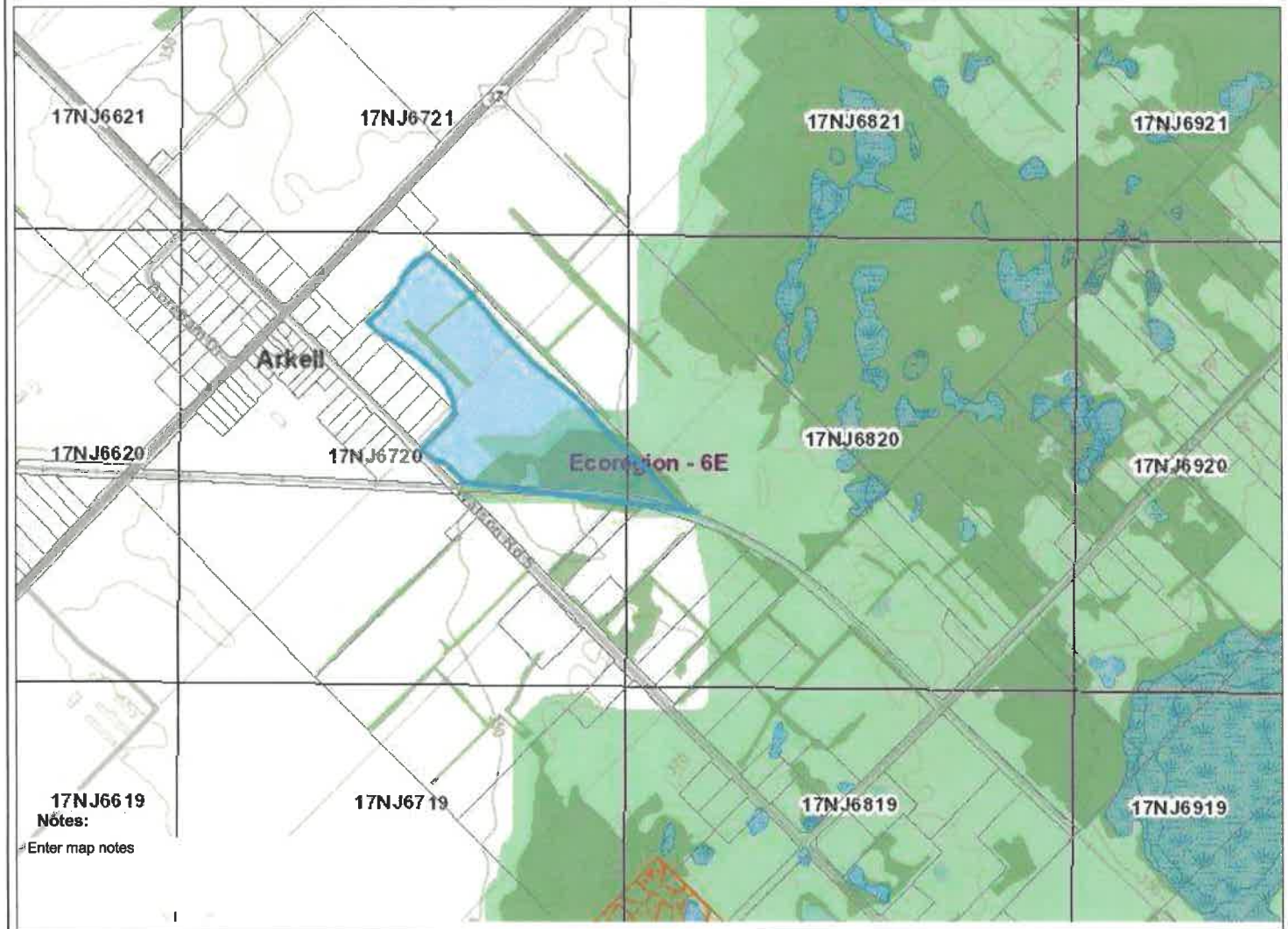
Ontario

Ministry of Natural Resources and Forestry

Make-a-Map: Natural Heritage Areas

21-130 #14 Arkell Road and Watson Road South

Map created:5/9/2023



Legend

- Assessment Parcel
- NHIC 1 Km Grid
- Ecoregion
- ANSI
- Earth Science Provincially Significant/sciences de la terre d'importance provinciale
- Earth Science Regionally Significant/sciences de la terre d'importance régionale
- Life Science Provincially Significant/sciences de la vie d'importance provinciale
- Life Science Regionally Significant/sciences de la vie d'importance régionale
- Evaluated Wetland
- Provincially Significant/considérée d'importance provinciale
- Non-Provincially Significant/non considérée d'importance provinciale
- Unevaluated Wetland
- Woodland
- Conservation Reserve
- Provincial Park
- Natural Heritage System

0.7 0 0.33 0.7 Kilometres

Absence of a feature in the map does not mean they do not exist in this area.



This map should not be relied on as a precise indicator of routes or locations, nor as a guide to navigation. The Ontario Ministry of Natural Resources and Forestry(OMNRF) shall not be liable in any way for the use of, or reliance upon, this map or any information on this map.

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NHIC Data

To work further with this data select the content and copy it into your own word or excel documents.

OGF ID	Element Type	Common Name	Scientific Name	SRank	SARO Status	COSEWIC Status	ATLAS NAD83 IDENT	COMMENTS
967414	SPECIES	Grasshopper Sparrow	Ammodramus savannarum	S4B	SC	SC	17NJ6820	
967414	SPECIES	Midland Painted Turtle	Chrysemys picta marginata	S4		SC	17NJ6820	
967414	SPECIES	Wood Thrush	Hylocichla mustelina	S4B	SC	THR	17NJ6820	
967414	SPECIES	Eastern Wood-pewee	Contopus virens	S4B	SC	SC	17NJ6820	
967414	SPECIES	Canada Warbler	Cardellina canadensis	S5B	SC	SC	17NJ6820	
967414	SPECIES	American Burying Beetle	Nicrophorus americanus	SH	EXP	EXP	17NJ6820	
967414	SPECIES	Black Ash	Fraxinus nigra	S4	END	THR	17NJ6820	
967414	SPECIES	Eastern Meadowlark	Sturnella magna	S4B,S3N	THR	THR	17NJ6820	
967414	SPECIES	Barn Swallow	Hirundo rustica	S4B	THR	THR	17NJ6820	
967414	SPECIES	Henslow's Sparrow	Centronyx henslowii	S1B	END	END	17NJ6820	
967414	SPECIES	Bobolink	Dolichonyx oryzivorus	S4B	THR	THR	17NJ6820	
967404	SPECIES	Grasshopper Sparrow	Ammodramus savannarum	S4B	SC	SC	17NJ6720	
967404	SPECIES	Transverse Lady Beetle	Coccinella transversoguttata	S1	END	SC	17NJ6720	
967404	SPECIES	Midland Painted Turtle	Chrysemys picta marginata	S4		SC	17NJ6720	
967404	SPECIES	Wood Thrush	Hylocichla mustelina	S4B	SC	THR	17NJ6720	
967404	SPECIES	Eastern Wood-pewee	Contopus virens	S4B	SC	SC	17NJ6720	
967404	SPECIES	Canada Warbler	Cardellina canadensis	S5B	SC	SC	17NJ6720	
967404	SPECIES	American Burying Beetle	Nicrophorus americanus	SH	EXP	EXP	17NJ6720	
967404	SPECIES	Eastern Ribbonsnake	Thamnophis saurita	S4	SC	SC	17NJ6720	
967404	SPECIES	Yellow-banded Bumble Bee	Bombus terricola	S3S5	SC	SC	17NJ6720	

OGF ID	Element Type	Common Name	Scientific Name	SRank	SARO Status	COSEWIC Status	ATLAS NAD83 IDENT	COMMENTS
967404	SPECIES	Rusty-patched Bumble Bee	Bombus affinis	S1	END	END	17NJ6720	
967404	SPECIES	American Bumble Bee	Bombus pensylvanicus	S3S4		SC	17NJ6720	
967404	SPECIES	Eastern Meadowlark	Sturnella magna	S4B,S3N	THR	THR	17NJ6720	
967404	SPECIES	Barn Swallow	Hirundo rustica	S4B	THR	THR	17NJ6720	
967404	SPECIES	Gypsy Cuckoo Bumble Bee	Bombus bohemicus	S1S2	END	END	17NJ6720	
967404	SPECIES	Bobolink	Dolichonyx oryzivorus	S4B	THR	THR	17NJ6720	

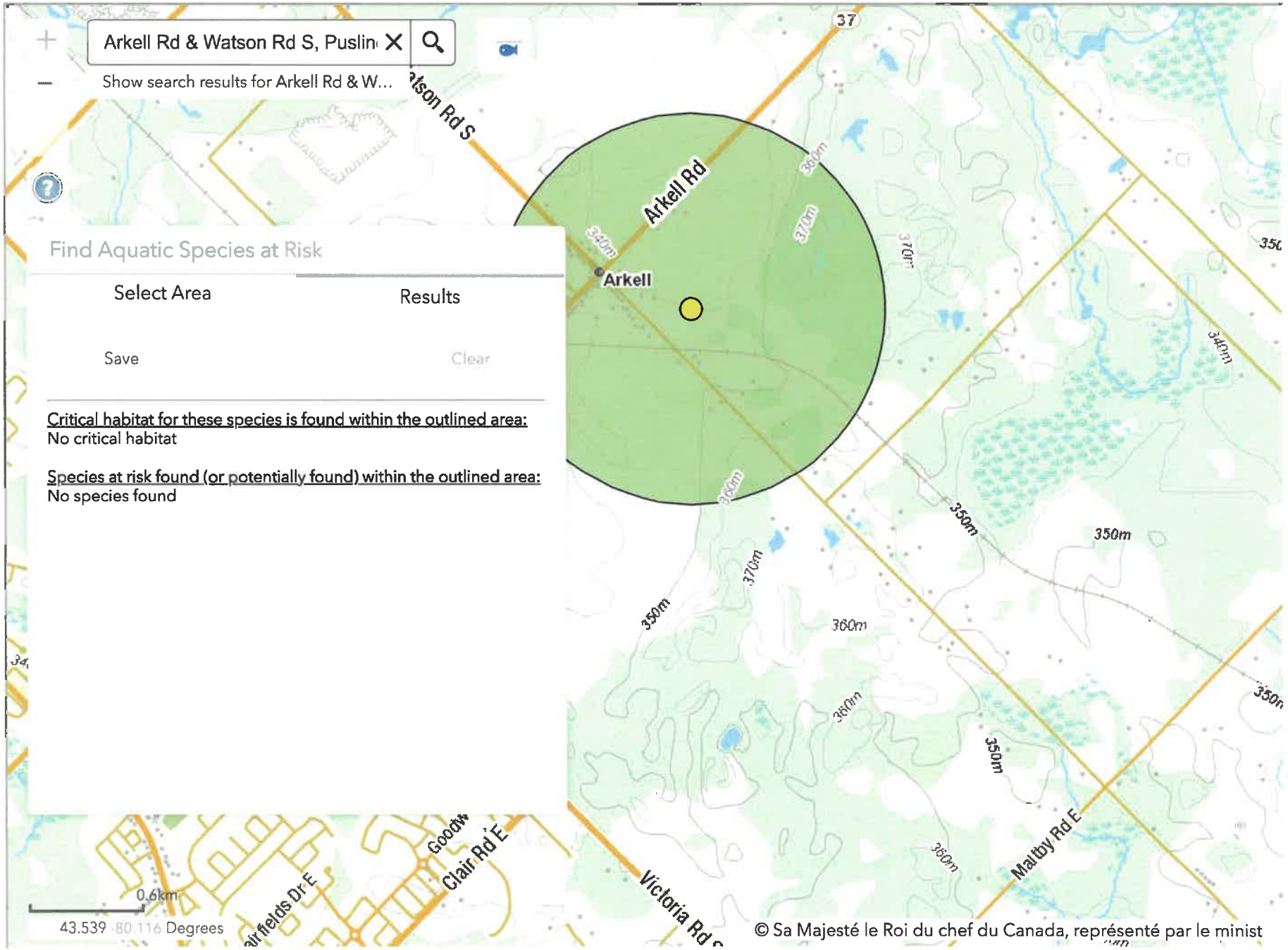
Government of Canada Gouvernement du Canada

Aquatic species at risk map

We've compiled critical habitat and distribution data for aquatic species listed under the Species at Risk Act (SARA). This map is intended to provide an overview of the distribution of aquatic species at risk and the presence of their critical habitat within Canadian waters. The official source of information is the Species at Risk Public Registry.

If you encounter an aquatic species at risk in an area that isn't currently mapped, please notify your regional Fisheries Protection Program office to ensure that you're compliant with SARA.

▶ **Information and legend**


Arkell Rd & Watson Rd S, Puslin
Show search results for Arkell Rd & W...
Watson Rd S
Arkell Rd
Arkell
37
Find Aquatic Species at Risk
Select Area
Results
Save
Clear
Critical habitat for these species is found within the outlined area:
No critical habitat
Species at risk found (or potentially found) within the outlined area:
No species found
340m
360m
370m
350m
Goodw
Clair Rd E
Fairfields Dr E
Victoria Rd
Maltby Rd E
0.6km
43.539 -80.116 Degrees
© Sa Majesté le Roi du chef du Canada, représenté par le minist

May 15, 2023

Memorandum

To: Lynne Banks – Development and Legislative Coordinator, Township of Puslinch

Cc: Meagan Ferris – Manager of Planning and Environment, Wellington County

From: Danielle Walker, Source Protection Coordinator, Wellington Source Water Protection

RE: Arkell Subdivision: Roll # 2301000008034800000, Township of Puslinch – Preconsultation

1. Clean Water Act Part IV Requirements

Please note that a Section 59 notice is not required as this development is proposed to be solely residential. It should be noted that if the nature of the development changes to include mixed residential and/or commercial use, Section 59 Notices will likely apply.

2. Conditions and Recommendations

Permitting a future planning application is approved, Wellington Source Water Protection recommends that the following conditions be fulfilled to the satisfaction of the Township's Risk Management Official, prior to the applications approval. The below conditions and recommendations are suggested based on a review of the Preconsultation documents submitted by the applicant and could be included as conditions in a Zoning By-law Amendment or Draft Plan of Subdivision Agreement.

a. That the Drinking Water Threats Screening Form be completed and submitted.
b. That the applicant provide a liquid fuel handling / storage and spill response procedure for construction, to the satisfaction of the Risk Management Official.
c. That the applicant clearly identify all Provincial Instruments, such as Permits to Take Water, Environmental Compliance Approvals, and Environmental Activity and Sector Registrations (EASRs) that will be required for the proposal and provide any necessary technical details.
d. That the applicant provide details on water usage (consumptive and non-consumptive).
e. That the applicant confirm and address mitigation of any transport pathways proposed for this development.
f. That the applicant implement best management practices, such as LID measures, with the goal to maintain predevelopment recharge.
g. That all private water wells be properly maintained or decommissioned in accordance with *Ontario Regulation 903* and that documentation be submitted to the Township Risk Management Official.
h. That the applicant submit the Record of Site Condition for the property, if applicable, to the Risk Management Official.

Recommendations

a. That the Township Hydrogeologist review and provide comment on the proposed septic system design and proper construction of drilled wells, in relation to nitrate loading.

- It is further recommended that the Township Hydrogeologist review and provide comment on the Nitrate Assessment report, once submitted by Crozier

b. That Best Management Practices for winter maintenance activities be followed during construction, until the roads are assumed by the Township. See attached guidance.

The following sections are provided for rationale and further information to the reader pertaining to the *Clean Water Act* requirements and recommended *Planning Act* approval conditions listed above. The following sections do provide any additional requirements.

3. Rationale

Drinking Water Threats Screening Form

- This form is an important tool that the Risk Management office uses to determine how Source Protection Plan policies may affect the property.
    - Please note that depending on what is disclosed in the Screening form, a Drinking Water Threats Disclosure Report may be required to complete.

Liquid Fuel Handling during Construction

- Given the nature of the proposal and that liquid fuel is anticipated to be on site during construction, a liquid fuel handling / storage and spill response procedure is requested. In addition, please provide details on the quantity of fuel anticipated on site during the application approval process.

Provincial Instruments and water usage

- Please provide details and applicable documentation of any provincial instrument(s) subject to this property or proposal.
- Given the size and the nature of the proposed development within the draft WHPA-Q, we are requesting details on water usage.
    - It should be noted that depending on estimated water usage, a flow meter to monitor water takings may be recommended.
    - Please note, if water takings exceed 50,000L per day, Ministry approval is required.

Transport Pathways

- Any preferential pathways (transport pathways) existing or created must be reported to the Source Protection Authority by the Township. These include, but are not limited to:
    a. old and/or unused wells that have not been properly abandoned
    b. new vertical geothermal systems
    c. underground infrastructure (parking garages, maintenance tunnels etc.)
    d. removal of large portions of overburden (gravel pits, fill removal)
    e. construction of deep pilings

  There were no transport pathways indicated in the proposal. The applicant should confirm that no transport pathways are proposed.

LID measures to maintain predevelopment recharge

- The submitted reports indicate that an infiltration gallery is proposed in the form of a hybrid dry/ infiltration pond, and that further specifics regarding it will be provided during the detailed design stage. It is our preference that 'clean' run off be infiltrated wherever possible, and that it does not mix with salt laden waters (from winter maintenance activities). Please discuss in future submissions how this concern will be addressed.
- It should be noted that the soak-away pits that are proposed to be constructed for each home to infiltrate clean roof run-off will assist with maintaining pre-development recharge.

4. Further Information

The subject property is located in:

a) a Wellhead Protection Area B (WHPA-B), 2 year time of travel, with a high vulnerability score of 8;
b) a draft Wellhead Protection Area Q (WHPA-Q); and
c) a Significant Groundwater Recharge Area (SGRA).

Attachments show the relevant mapping. Please note the subject property is not located in a Highly Vulnerable Aquifer (HVA), or Issue Contributing Area (ICA).

Further comments will be provided during future planning applications and the requested conditions and recommendations may be updated at that time. If the applicant feels that any of the above conditions should not be required, please contact the undersigned **prior** to a resubmission.

For more information, please contact the undersigned.

Sincerely,

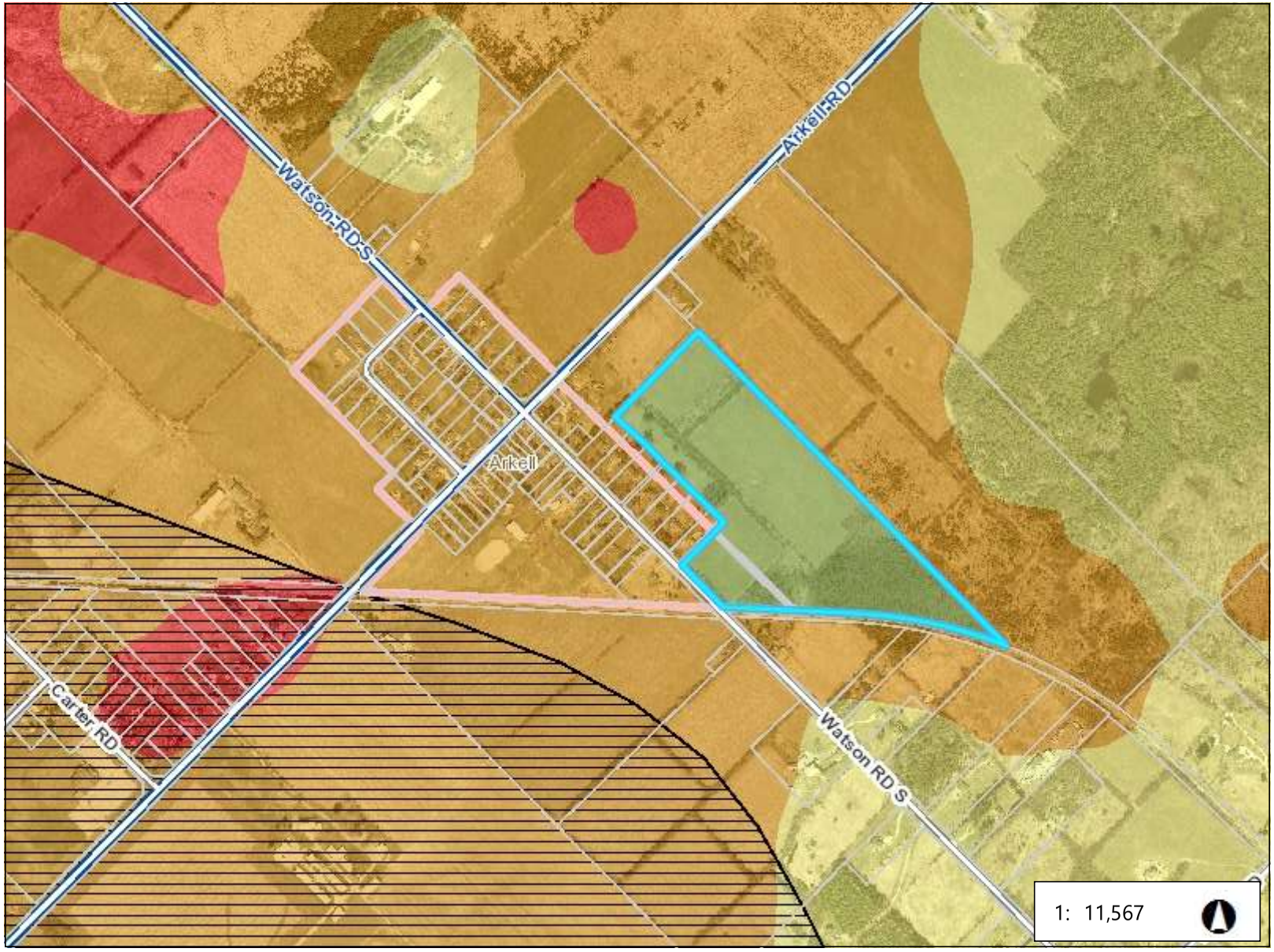
[redacted] 2023/05/15

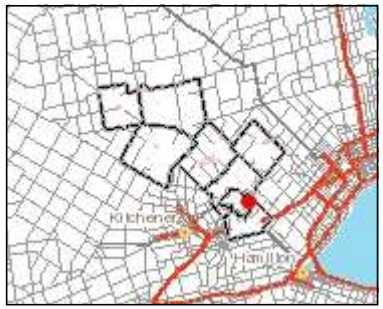
Danielle Walker, Source Protection Coordinator
519-846-9691 ext 236
dwalker@centrewellington.ca

Attachments: DWT Screening Form
Recharge Design Measures
Winter Maintenance Measures Guidance
WHPA Maps

Explore Wellington

2301000008034800000, Arkell





Legend

- Parcels
- Roads
  - Local Road
  - County Road
  - Highway
- Urban Centres and Hamlets
- Well Locations
  - Existing
  - Proposed
- Issue Contributing Area
  - Chloride
  - Nitrate
  - Sodium
  - TCE
- Wellhead Protection Area
  - A
  - B
  - C
  - D
- Vulnerability Score
  - 10
  - 8, D; 8; 8, C
  - 2, 4, 6 (A, B or C)
  - 2,4,6, D; 2,4, D; 2, 4, 6 (D); 4, D; 6,
- HVA
- RoadsLookup

0.6 0 0.29 0.6 Kilometers

WGS_1984_Web_Mercator_Auxiliary_Sphere

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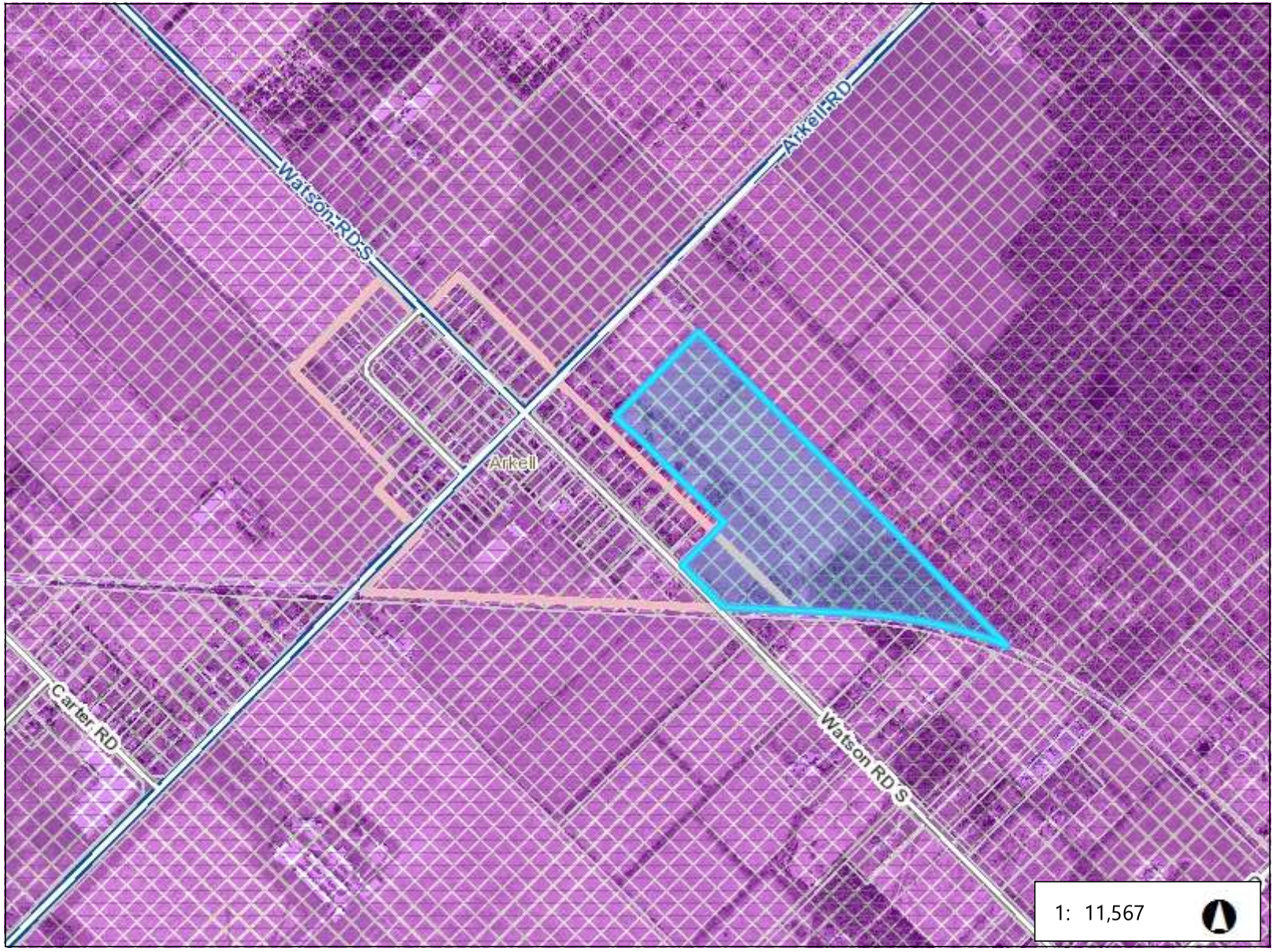
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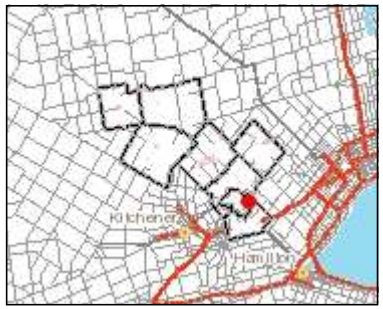
THIS IS NOT SURVEY DATA. Parcels - Teranet 2002, Wellington County 2022

Notes

Explore Wellington

2301000008034800000, Arkell-Quantity





Legend

- Parcels
- Roads
  - Local Road
  - County Road
  - Highway
- Urban Centres and Hamlets
- Well Locations
  - Existing
  - Proposed
- WHPA Q1_Q2_Boundary
- WHPA Q1_Q2
  - Approved
  - Draft
- SGRA
- RoadsLookup

0.6 0 0.29 0.6 Kilometers

WGS_1984_Web_Mercator_Auxiliary_Sphere

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THIS IS NOT SURVEY DATA. Parcels - Teranet 2002, Wellington County 2022

Notes

Puslinch Fire and Rescue

7404 Wellington Rd 34, Puslinch, ON, N0B 2J0

Fire Chief Luis Gomes

Water Storage Tanks and Hydrants for Fire Protection

Water Storage Tanks

1. Water storage tanks will be sized as per the Ontario Building Code.

2. The top of the tank to be installed below the frost line. Minimum 1.3 M.

3 The bottom of the tank must not be more than 4.6 M below ground level.

4. Access manhole must have lockable heavy metal cover with no holes.

5. Access ladder to be aluminum with rungs to floor of tank.

6. Concrete to be 35 MPA at 30 days with 6% air entrainment.

7. Reinforcement to be per manufacturers specifications.

8. Install a vent pipe with rodent and insect screen.

9. Install automatic float valve system to a water source with back flow preventer.

10. Compliance with the inspection, testing and maintenance provisions of NFPA 25, “Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems”, for tanks is deemed to satisfy the maintenance requirements

11. The water supply source for the dry hydrant shall provide, on a year-round basis, the required quantity of water, as determined in NFPA 1142, Chapter 4, and Ontario Fire Marshal’s Guidelines on Rural water Supplies for firefighting.

12. The fire department will:

- inspect during installation of tank or tanks
- inspect location of hydrant
- inspect before filling
- perform a pump test with fire pumper before final approval.

Dry Hydrant Design and Location.

1 Puslinch Fire and Rescue Services shall approve all aspects of the dry hydrant design and construction, including the type of materials, pipe size, and system fittings to be used.

2 All dry hydrant systems shall be designed and constructed to provide a minimum flow of 1000 gpm (3800 L)

3. Adequate working space shall be provided around the dry hydrant to provide for a safe working environment.

4. Dry hydrant systems shall be designed and constructed so that slope and piping configurations do not impede drafting operations.

5. Suction hose connection(s) shall be compatible with the fire department's hard suction hose size and shall conform to NFPA 1963, *Standard for Fire Hose Connections*. The connection(s) shall include a protective cap. The cap and adapter shall be of materials that minimize rust and galvanic corrosion at draft.

6. Dry hydrant to be installed a minimum of 30 M from any building and will be approximately 1.8 meters from the edge of driveway using 150 mm (6") pipe. The fire department connection fitting will be 67 cm to 90cm above the ground and facing fire truck location. The Fire Department connection must be NH (National Hose) 150mm (6") thread - female connection with a cap to seal the opening.

7. The dry hydrant system and access to the site shall be developed in a manner that allows the fire department pump to connect to the hydrant using not more than 20 ft (6 m) of hard suction hose

.

8. Dry hydrants shall be located such that they are accessible under all weather conditions. Grass, brush, and other vegetation shall be kept trimmed and neat. Vegetation shall be cleared for a minimum 3 ft (0.9 m) radius from around hydrants

9. Dry hydrants shall be located a minimum of 100 ft (30 m) from any structure

.

10. No parking or other obstacles shall be allowed within 20 ft (6 m) of the access side of the hydrant.

11. Dry hydrants shall be protected from damage by vehicular and other perils, including freezing and damage from ice and other objects.

12. Dry hydrants shall be inspected at least quarterly and maintained as necessary to keep them in good operating condition. The hydrants shall be flow tested at least annually with an approved pump to ensure the minimum design flow is maintained. Compliance with the inspection, testing and maintenance provisions of NFPA 25, "Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems", for hydrants is deemed to satisfy the maintenance requirements

13. Dry hydrant locations shall be made visible from the main roadway during emergencies by reflective marking and signage approved by Puslinch Fire and Rescue services

Ref: NFPA 1142-2017 Ed., NFPA 25-2017 Ed

General Notes:

NFPA 25;

4.1 **Responsibility of the Owner or Occupant**.

4.1.1* The owner or occupant shall provide ready accessibility to components of waterbased fire protection systems that require inspection, testing, or maintenance.

4.1.2* The responsibility for properly maintaining a waterbased fire protection system shall be that of the owner of the property.

In accordance with the Fire Protection and Prevention Act, Puslinch Fire and Rescue Services requests that all test and inspection documentation be submitted annually to fireprevention@puslinch.ca **,all work must be performed by qualified fire protection technicians.**

Rev 2019.01.21

TRAFFIC IMPACT STUDY

SECTION OF LOTS 7,8 AND 9, CONCESSION 10
TOWNSHIP OF PUSLINCH
COUNTY OF WELLINGTON

PREPARED FOR:

TIMBERWORX CUSTOM HOMES INC., SLOOT CONSTRUCTION LTD., JOHN SLOOT INVESTMENTS LTD.

PREPARED BY:

C.F. CROZIER & ASSOCIATES INC.
211 YONGE STREET, SUITE 600
TORONTO, ON M5B 1M4

MARCH 2024

CFCA FILE NO. 2433-6646

The material in this report reflects best judgment in light of the information available at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. C.F. Crozier & Associates Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

CROZIER
CONSULTING ENGINEERS

Revision Number	Date	Comments
Rev.0	March 2024	Issued for 1st Submission

EXECUTIVE SUMMARY

C.F. Crozier & Associates Inc. (Crozier) was retained by Timberworx Custom Homes Inc., Sloot Construction Ltd., John Sloot Investments Ltd. to undertake a Traffic Impact Study in support of the Zoning By-Law Amendment application for the property located on sections of Lots 7, 8 and 9 of Concession 10, in the Township of Puslinch, County of Wellington. The purpose of the study is to assess the impacts of the proposed development on the boundary road network and to recommend required mitigation measures, if warranted. This study has been completed in accordance with the County of Wellington's Traffic Impact Study Guidelines (2021).

As illustrated on the conceptual site plan prepared by Stovel and Associates Inc. dated February 2024, the development proposal includes the following:

- Fifty (50) Single detached residential properties.
- Associated internal roads.
- Proposed Site Accesses via Watson Road South and Arkell Road

Under 2023 existing traffic conditions, the study intersection of Arkell Road and Watson Road South is operating below capacity with minimal delay during both weekday a.m. and p.m. peak hours. The study intersections include Arkell Road and Watson Road South and the proposed access connection to Watson Road South.

The proposed development is expected to generate 40 and 52 two-way primary trips in the a.m. and p.m. peak hours, respectively.

Under the ultimate 2031 future total conditions,

- the all-way stop-controlled intersection of Arkell Road and Watson Road South is projected to operate below capacity at a LOS "A" and "B" during the weekday a.m. and p.m. peak hours, respectively. Average intersection control delays of 9.5 and 14.3 seconds in the a.m. and p.m. peak hours, respectively and maximum volume-to-capacity ratios of 0.27 (EB) and 0.54 (NB) are expected in the weekday a.m. and p.m. peak hours, respectively.

- The proposed site access connection at Watson Road South is forecast to operate at a LOS "A" and "B" during the a.m. and p.m. peak hours, respectively.

- Overall, the nearby road network is projected to operate adequately without any capacity constraints under the ultimate 2031 future total scenario. The nearby road network is expected to operate similarly or better under the 2026 horizon year.

- These operations are similar to the 2031 and 2026 Future Background traffic operations. Therefore, operations are expected to be similar with or without the proposed development.

The proposed access connections to Watson Road South and Arkell Road are satisfactory per the Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads (GDGCR) with regards to sight distance, access spacing, corner clearance and Transport Canada's Grade Crossing Standards with regards to access spacing.

Based on the study findings, the development application can be supported from a traffic operations perspective as the nearby road network can accommodate the increase in traffic volumes attributable to the proposed development located on sections of Lots 7, 8 and 9 of Concession 10, in the Township of Puslinch, County of Wellington.

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Appendix B: Site Plan
Appendix C: Traffic Data
Appendix D: Level of Service Definitions
Appendix E: Detailed Capacity Analysis Reports
Appendix F: TTS Data

1.0 INTRODUCTION

C.F. Crozier & Associates Inc. (Crozier) was retained by Timberworx Custom Homes Inc., Sloot Construction Ltd., John Sloot Investments Ltd. to undertake a Traffic Impact Study in support of the Zoning By-Law Amendment application for the property located on sections of Lots 7,8 and 9 of Concession 10, in the Township of Puslinch, County of Wellington. The purpose of the study is to assess the impacts of the proposed development on the boundary road network and to recommend required mitigation measures, if warranted.

This study has been completed in accordance with the County of Wellington's Traffic Impact Study Guidelines (2021). Further, the scope of work and terms of reference was coordinated with the Town of Puslinch and County of Wellington staff via email correspondence in August 2023. Refer to **Appendix A** for relevant correspondence excerpts.

2.0 DEVELOPMENT PROPOSAL

As illustrated on the conceptual site plan prepared by Stovel and Associates Inc. dated February 2024, the development proposal includes the following:

- Fifty (50) Single detached residential properties.
- Associated internal roads.
- Proposed Site Accesses via Watson Road South and Arkell Road

It is noted that the site access off Arkell Road is for emergency purposes only hence vehicular traffic was not assigned to it. Refer to **Appendix B** for the Site Plan.

3.0 EXISTING CONDITIONS

This section outlines the current conditions of the transportation network in the vicinity of the subject site. Details of the study road network, including traffic controls, lane configurations, speed limits, active transportation infrastructure and other relevant transportation elements are identified.

3.1 Development Lands

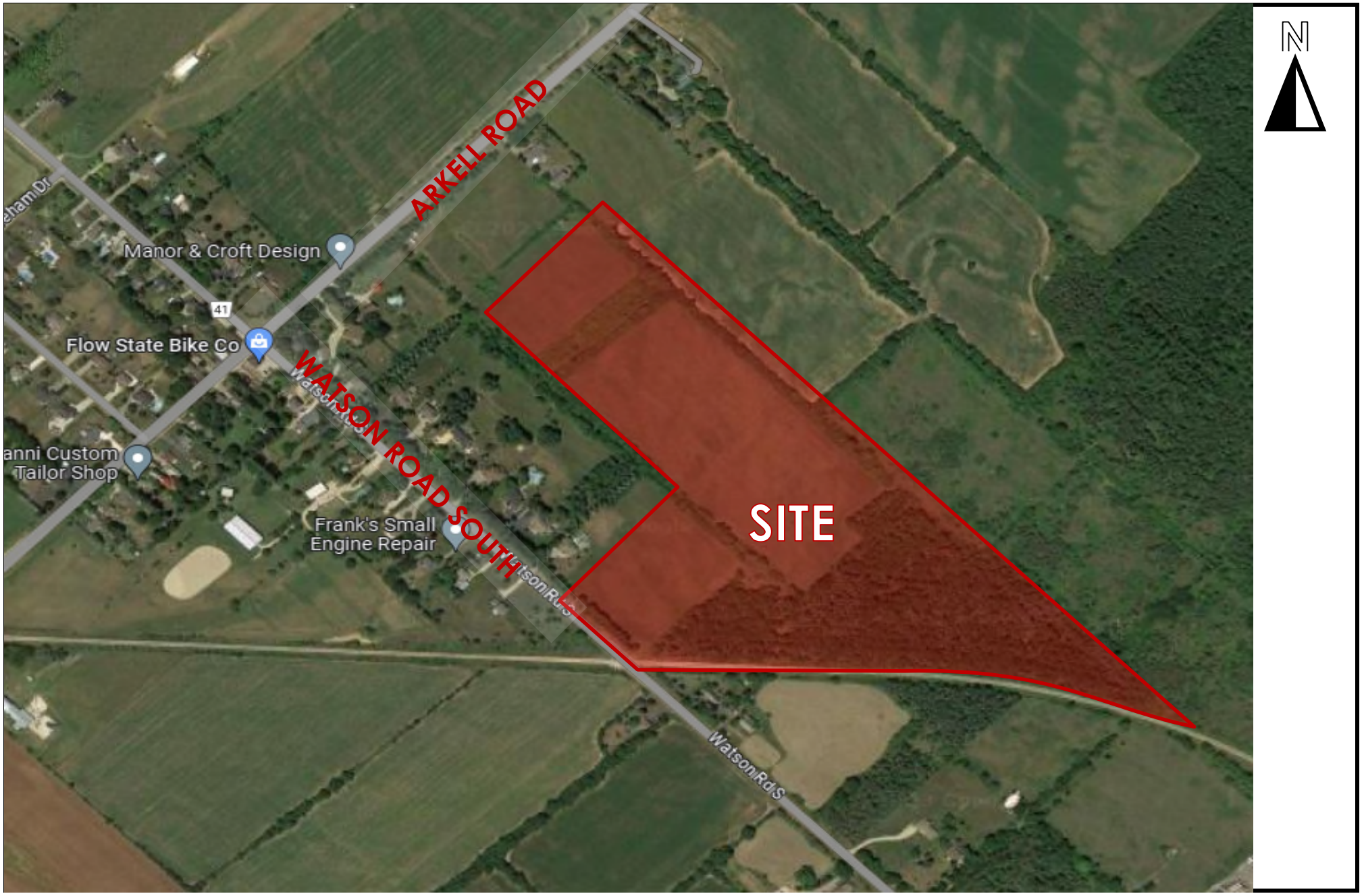
The subject lands cover an area of approximately 17 ha and currently consists of agricultural/vegetated land. The property, located on the northeast corner of the intersection at Arkell Road and Watson Road South, is bounded by a residential property to the west, agricultural/vegetated lands to the north, the Guelph Junction Railway to the east, and Watson Road/residential properties to the south. The site location and surrounding area are illustrated in **Figure 1.**

3.2 Study Area

The Traffic Impact Study analyzes the following study intersections as confirmed with Town of Puslinch and County of Wellington staff (refer to **Appendix A**).

- Watson Road South and Arkell Road
- Proposed Site Access via Watson Road South

Details of the boundary road network is provided in **Section 3.3.**



Arkell Developments	CROZIER CONSULTING ENGINEERS	**Figure 1**
Site Location		Project No. 2433-6646 Date. 2023.07.05 Analyst. Parth Bhatt

3.3 Boundary Road Network

The boundary road network is described in **Table 1** below.

Table 1: Boundary Road Network

Feature	Roadway	
	Arkell Road	**Watson Road South**
Alignment	Two-Way (North-South)	Two-Way (East-West)
Classification[1]	Collector	Collector
Jurisdiction	County of Wellington	Town of Puslinch
Speed Limit	50 km/h	50 km/h
Pedestrian Facilities	Yes (Only available on the east side, north of Watson Road)	None
Cycling Facilities	None	None

Table 2 outlines the existing traffic control, configurations, at the study intersections on the boundary road network.

Table 2: Study Intersections

Intersection	Control	App.[1]	Major Street	Lane Configurations
Arkell Road and Watson Road South	All-Way Stop	4	Arkell Road	EBLTR; WBLTR; NBLTR; SBLTR

Note 1: App. - number of approaches for a given intersection.

Figure 2 illustrates the existing boundary road network, including lane configurations, lane storage lengths, and intersection control.

3.4 Existing Active Transportation Network

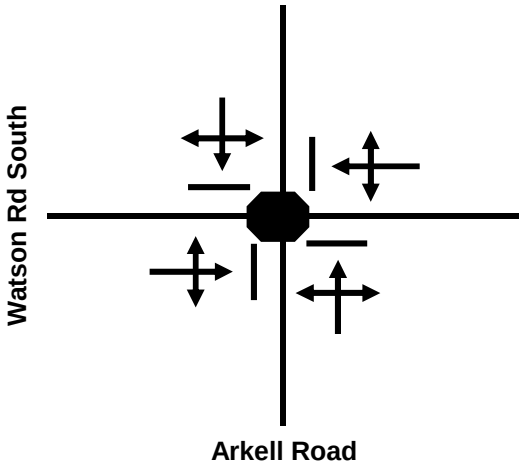
Sidewalks are available on the east side of Arkell Road, south of the intersection of Arkell Road and Watson Road, no cycling facilities exist on the boundary roads near the site.

3.5 Existing Transit Services

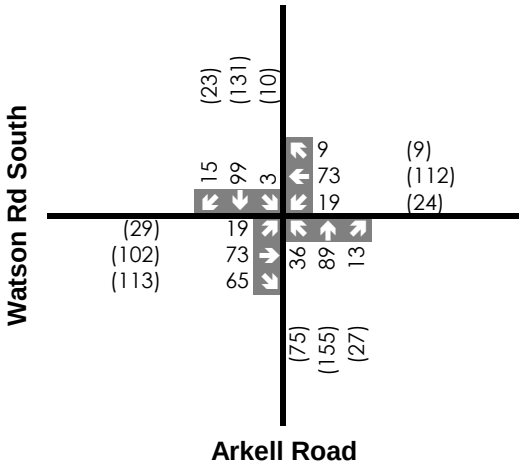
Given the rural nature and largely undeveloped surrounding lands, there are no transit services available within the study area currently.

3.6 Traffic Data

Turning movement counts (TMC) were collected at the study intersection from 7:00 a.m. to 7:00 p.m. on Thursday, July 28, 2022, by Wellington County. The traffic count data is summarized in **Appendix C.** 2023 existing traffic volumes were derived by applying annual growth rate of 2% to 2022 volumes. **Figure 3** illustrates the 2023 existing traffic volumes.



Legend	Arkell Developments		Figure 2
xx A.M. Peak Hour Traffic Volumes (xx) P.M. Peak Hour Traffic Volumes {xx} Weekend Peak Hour Traffic Volumes	Boundary Road Network	CROZIER CONSULTING ENGINEERS	Project No. 2433-6646 Date. 45321 Analyst. Parth Bhatt



Legend	Arkell Developments	CROZIER CONSULTING ENGINEERS	Figure 3
xx A.M. Peak Hour Traffic Volumes (xx) P.M. Peak Hour Traffic Volumes {xx} Weekend Peak Hour Traffic Volumes	Existing Traffic Volumes		Project No. 2433-6646 Date. 45321 Analyst. Parth Bhatt

3.7 Traffic Modeling

Synchro software (Version 11) was used for the intersection capacity and queueing analysis. Capacity Analysis per the general guidelines from the County and Town were used for the study intersections. All parameters for the intersection analysis were based on the Synchro default values.

The intersection assessment is based on the method outlined in the "Highway Capacity Manual, 2010" using Synchro modelling software. Intersections are assessed using a Level of Service metric, with ranges of delay assigned a letter from "A" to "F." For stop-controlled intersections, a Level of Service "A" or "B" would typically be measured during off-peak hours when lesser traffic volumes are on the roadways. Levels of Service "C" through "F" would typically be measured in the commuter peak hours when more significant vehicle volumes cause longer travel times. The Level of Service (LOS) definitions for signalized and stop control intersections are included in **Appendix D**.

3.8 Intersection Operations

The traffic operations at the study intersections were analyzed based on the 2023 existing traffic volumes illustrated in **Figure 3**. Detailed capacity analysis worksheets are included in **Appendix E**. **Table 4** outlines the 2023 existing traffic operations.

Table 4: 2023 Existing Traffic Operations Summary

Intersection	Control	Peak Hour	Level of Service[1]	Control Delay	v/c ratio[2]	95th Percentile Queue Length > Storage Length
Arkell Road and Watson Road South	All-Way Stop	A.M.	A	8.8s	0.21(EB)	None
		P.M.	B	11.4s	0.42(NB)	None

Note 1: Level of Service – The Level of Service (LOS) of a signalized intersection is based on the average control delay per vehicle. The LOS of unsignalized intersection is based on the critical control delay per approach.
Note 2: The critical v/c ratio is considered to be the maximum v/c ratio for movements at the intersection where the maximum v/c ratio does not exceed the critical thresholds.

As outlined in **Table 4**, under the 2023 existing conditions scenario, the all-way stop-controlled intersection of Arkell Road and Watson Road South is operating below capacity at a Level of Service (LOS) "A" and "B" during the weekday a.m. and p.m. peak hours, respectively. The average intersection control delay is 8.8s and 11.4s in the weekday a.m. and p.m. peak hours, respectively, and the maximum volume-to-capacity ratios are 0.21 (EB) and 0.42 (NB) in the weekday a.m. and p.m. peak hours, respectively.

4.0 FUTURE BACKGROUND CONDITIONS

This section summarizes the future background conditions of the study road network and provides details relating to growth rates, future transportation network improvements, and background developments within the study area.

4.1 Study Horizons

As confirmed through Terms of Reference correspondence, the full buildout year as well as five years beyond buildout is required, consistent with the County guidelines. Therefore, the 2026 horizon year (anticipated full buildout year) as well as 2031 were selected to assess future operations of the boundary road network.

4.2 Future Roadway Improvements

Currently, there are no planned improvements to roadway network within the study area. Therefore, the future background and future total analysis herein assumes the existing roadway configurations in the 2026 and 2031 horizon years.

4.3 Growth Rate

The Town recommended annual growth rate of 2%, compounded annually, was applied to all movements.

4.4 Background Developments

As confirmed by Town's staff, no background developments were identified in the vicinity of the site.

4.5 Intersection Operations

The traffic operations at the study intersections were analyzed based on the 2026 and 2031 future background traffic volumes illustrated in **Figures 4 and 5**. Detailed capacity analysis worksheets are included in **Appendix E**. **Tables 6 and 7** outline the 2026 and 2031 future background traffic operations.

Table 6: 2026 Future Background Traffic Operations

Intersection	Control	Peak Hour	Level of Service[1]	Control Delay	v/c ratio[2]	95th Percentile Queue Length > Storage Length
Arkell Road and Watson Road South	All-Way Stop	A.M.	A	9.0s	0.24(EB)	None
		P.M.	B	12.1s	0.46(NB)	None

Note 1: Level of Service – The Level of Service (LOS) of a signalized intersection is based on the average control delay per vehicle. The LOS of unsignalized intersection is based on the critical control delay per approach.
Note 2: The critical v/c ratio is considered to be the maximum v/c ratio for movements at the intersection where the maximum v/c ratio does not exceed the critical thresholds.

Table 7: 2031 Future Background Operations Summary

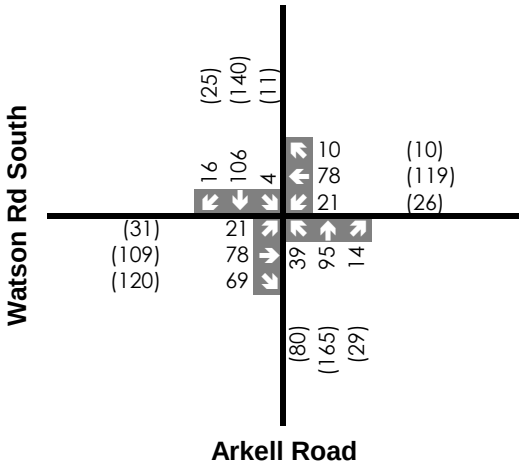
Intersection	Control	Peak Hour	Level of Service[1]	Control Delay	v/c ratio[2]	95th Percentile Queue Length > Storage Length
Arkell Road and Watson Road South	All-Way Stop	A.M.	A	9.3s	0.27(EB)	None
		P.M.	B	13.7s	0.53(NB)	None

Note 1: Level of Service – The Level of Service (LOS) of a signalized intersection is based on the average control delay per vehicle. The LOS of unsignalized intersection is based on the critical control delay per approach.

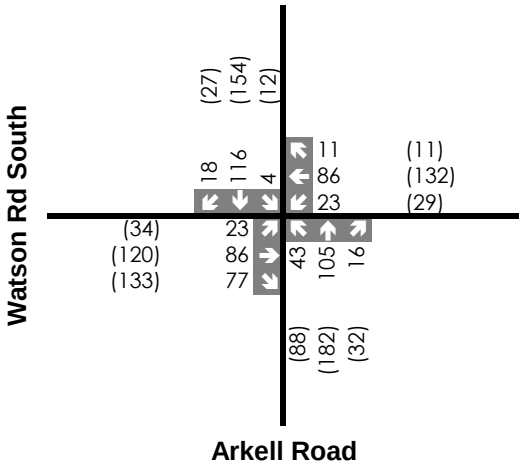
Note 2: The critical v/c ratio is considered to be the maximum v/c ratio for movements at the intersection where the maximum v/c ratio does not exceed the critical thresholds.

As shown in **Table 7**, under 2031 future background conditions, the all-way stop-controlled intersection of Arkell Road and Watson Road South is projected to operate below capacity at a LOS "A" and "B" during the weekday a.m. and p.m. peak hours, respectively. Average intersection control delays of 9.3 and 13.7 seconds in the a.m. and p.m. peak hours, respectively and maximum volume-to-capacity ratios of 0.27 (EB) and 0.53 (NB) are expected in the weekday a.m. and p.m. peak hours, respectively. The intersection is forecast to operate efficiently with reserve capacity to accommodate future increases in traffic volumes.

The study intersection is forecast to operate similarly or better under the 2026 future background compared to the 2031 future background. No traffic operation issues are forecast on the boundary road network.



Legend	Arkell Developments		Figure 4
xx A.M. Peak Hour Traffic Volumes (xx) P.M. Peak Hour Traffic Volumes {xx} Weekend Peak Hour Traffic Volumes	2026 Future Background Traffic Volumes	CROZIER CONSULTING ENGINEERS	Project No. 2433-6646 Date. 45321 Analyst. Parth Bhatt



Legend	Arkell Developments	CROZIER CONSULTING ENGINEERS	Figure 5
xx A.M. Peak Hour Traffic Volumes (xx) P.M. Peak Hour Traffic Volumes {xx} Weekend Peak Hour Traffic Volumes	2031 Future Background Traffic Volumes		Project No. 2433-6646 Date. 45321 Analyst. Parth Bhatt

5.0 SITE GENERATED TRAFFIC

The proposed development will result in new traffic turning movements on the boundary road network that would otherwise not exist. This section presents the generated trips and trip assignment through the study intersections.

5.1 ITE Trip Generation

To forecast the trips generated by the development, the ITE Trip Generation Manual, 11th Edition was used. The ITE Trip Generation Manual is a compendium of industry collected trip generation data across North America for a variety of land uses and is used industry wide as a source for trip generation forecasts. Given the site location, the general urban/suburban setting was used; fitted curve estimates were used if available and deemed statistically valid per the ITE Trip Generation Manual (i.e., more than 20 data points and coefficient of determination R2 > 0.75). The trips generated by the proposed development are presented in **Table 8**.

Table 8: Total Site Generated Traffic

Land Use	Units	Peak Hour	Equation Used	Inbound	Outbound	Total
Single-Family Detached Housing (LUC 210)	50	A.M.	Ln(T)=0.91*Ln(X)+0.12	10 (25%)	30 (75%)	40
		P.M.	Ln(T)=0.94*Ln(X)+0.27	33 (63%)	19 (37%)	52

As shown in **Table 8**, the proposed residential development is expected to generate a total of 40 and 52 two-way trips in the a.m. and p.m. peak hours, respectively.

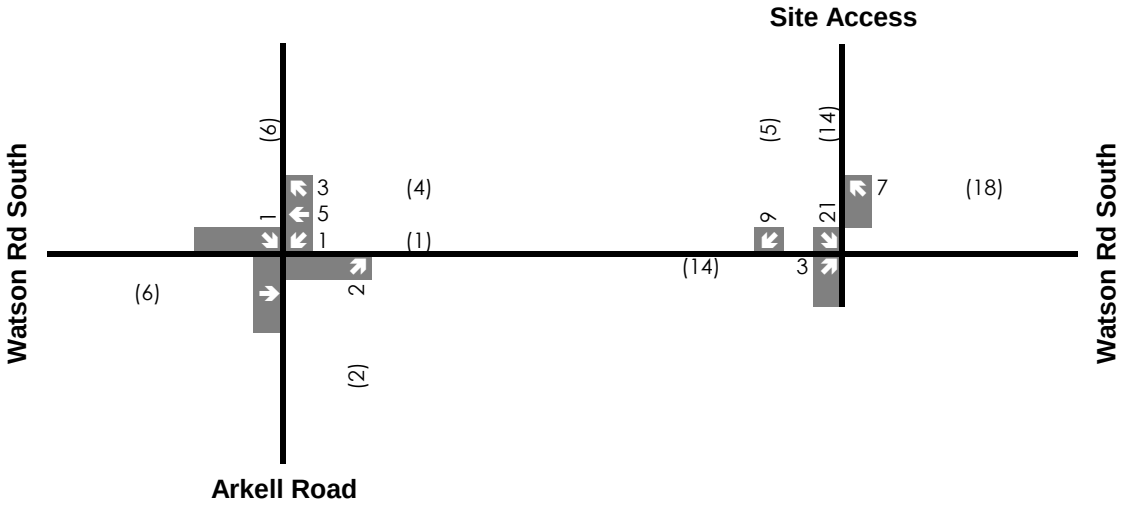
5.2 Trip Distribution and Assignment

The Transportation Tomorrow Survey (TTS) is a comprehensive travel data survey conducted in the Greater Toronto and Hamilton Area. Data from the 2016 TTS was used to determine the peak hour trip distribution at the site for the residential land use proposed at the site.

The inbound and outbound trip distributions were derived by filtering TTS data with a trip purpose of "Home", destined to and originating from the subject GTA Zone 8303. The A.M. and P.M. distributions were determined by filtering for trips starting during the periods of 6:30 A.M. – 9:30 A.M. and 3:30 P.M. – 6:30 P.M., respectively. **Appendix F** provides the TTS query used to determine the site trip distribution. **Table 9** summarizes the trip distribution at the site. **Figure 6** illustrates the trip assignment for the proposed development.

Table 9: Trip Distribution

Direction	A.M. Inbound	A.M. Outbound	P.M. Inbound	P.M. Outbound
Northwest	24%	18%	32%	40%
North	0%	0%	0%	0%
Northeast	0%	0%	7%	0%
East	0%	18%	15%	0%
Southeast	0%	0%	0%	0%
South	0%	0%	0%	0%
Southwest	38%	7%	12%	13%
West	38%	58%	35%	47%
Total	**100%**	**100%**	**100%**	**100%**



Legend	Arkell Developments	CROZIER CONSULTING ENGINEERS	Figure 6
xx A.M. Peak Hour Traffic Volumes (xx) P.M. Peak Hour Traffic Volumes {xx} Weekend Peak Hour Traffic Volumes	Trip Assignment		Project No. 2433-6646 Date. 45321 Analyst. Parth Bhatt

6.0 TOTAL TRAFFIC CONDITIONS

This section discusses the traffic operations of the study intersections with the addition of the new site generated trips.

6.1 Intersection Operations

Traffic operations at the study intersections were assessed with the addition of the new site generated trips to the future background traffic volumes. The 2026 and 2031 future total traffic volumes are illustrated in **Figures 7 and 8**. **Tables 10 and 11** outline the future total traffic operations for the 2026 and 2031 horizon years, respectively. Detailed capacity analysis worksheets are included in **Appendix E.**

Table 10: 2026 Future Total Traffic Operations Summary

Intersection	Control	Peak Hour	Level of Service[1]	Control Delay	v/c ratio[2]	95th Percentile Queue Length > Storage Length
Arkell Road and Watson Road South	All-Way Stop	A.M.	A	9.1s	0.24(EB)	None
		P.M.	B	12.4s	0.47(NB)	None
Site Access via Watson Road South	Stop (Minor Street)	A.M.	A(SB)	9.6s	0.07(WB)	None
		P.M.	B(SB)	10.3s	0.11(WB)	None

Note 1: Level of Service – The Level of Service (LOS) of a signalized intersection is based on the average control delay per vehicle. The LOS of unsignalized intersection is based on the critical control delay per approach.
Note 2: The critical v/c ratio is considered to be the maximum v/c ratio for movements at the intersection where the maximum v/c ratio does not exceed the critical thresholds.

Table 11: 2031 Future Total Operations Summary

Intersection	Control	Peak Hour	Level of Service[1]	Control Delay	v/c ratio[2]	95th Percentile Queue Length > Storage Length
Arkell Road and Watson Road South	All-Way Stop	A.M.	A	9.5s	0.27(EB)	None
		P.M.	B	14.3s	0.54(NB)	None
Site Access via Watson Road South	Stop (Minor Street)	A.M.	A(SB)	9.6s	0.07(WB)	None
		P.M.	B(SB)	10.3s	0.11(WB)	None

Note 1: Level of Service – The Level of Service (LOS) of a signalized intersection is based on the average control delay per vehicle. The LOS of unsignalized intersection is based on the critical control delay per approach.
Note 2: The critical v/c ratio is considered to be the maximum v/c ratio for movements at the intersection where the maximum v/c ratio does not exceed the critical thresholds.

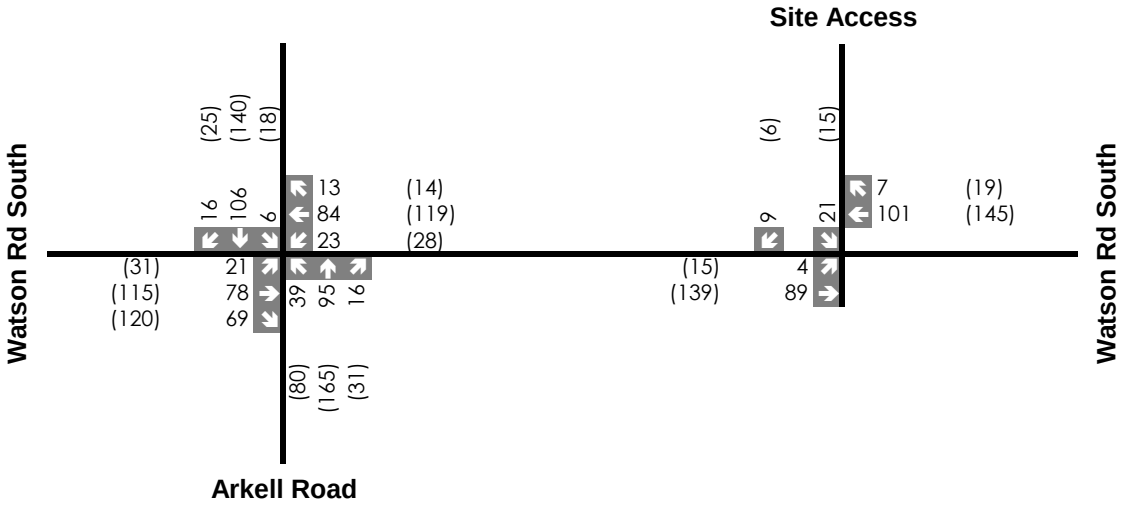
Under the ultimate 2031 future total conditions, the study intersections are projected to operate similarly compared to the corresponding 2031 future background scenario, with minor additional delays attributable to the proposed development traffic.

As shown in **Table 11**, under 2031 future total conditions, the all-way stop-controlled intersection of Arkell Road and Watson Road South is projected to operate below capacity at a LOS "A" and "B" during the weekday a.m. and p.m. peak hours, respectively. Average intersection control delays of 9.5 and 14.3 seconds in the a.m. and p.m. peak hours, respectively and maximum volume-to-capacity ratios of 0.27 (EB) and 0.54 (NB) are expected in the weekday a.m. and p.m. peak hours, respectively.

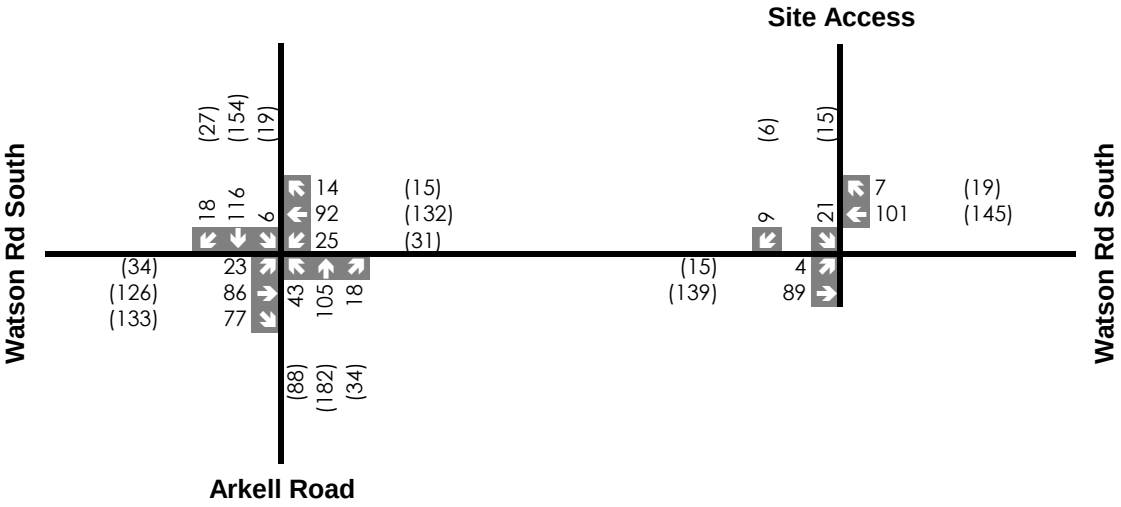
The proposed Access Connection at Watson Road South is forecast to operate below capacity at a LOS "A" and LOS "B" during the a.m. and p.m. peak hours respectively.

Overall, the boundary road network is projected to operate adequately without any capacity constraints under the ultimate 2031 future total scenario. The boundary road network is expected to operate similarly or better under the 2026 horizon year.

Based on the analysis herein, the proposed development is not expected to significantly alter the traffic operations of the study intersections. The proposed development can be supported from a traffic operations perspective.



Legend	Arkell Developments	CROZIER CONSULTING ENGINEERS	Figure 7
xx A.M. Peak Hour Traffic Volumes (xx) P.M. Peak Hour Traffic Volumes {xx} Weekend Peak Hour Traffic Volumes	2026 Total Traffic Volumes		Project No. 2433-6646 Date. 45321 Analyst. Parth Bhatt



Legend	Arkell Developments	CROZIER CONSULTING ENGINEERS	Figure 8
xx A.M. Peak Hour Traffic Volumes (xx) P.M. Peak Hour Traffic Volumes {xx} Weekend Peak Hour Traffic Volumes	2031 Total Traffic Volumes		Project No. 2433-6646 Date. 45321 Analyst. Parth Bhatt

7.0 SITE ACCESS SAFETY REVIEW

In the following section, the geometrics of the proposed site accesses were reviewed against the guidelines provided in the Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads (GDGCR).

7.1 Sight Distance Assessment

The available sightlines at the site access connections to Watson Road South and Arkell Road were measured and compared to the standards set out in the Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads (GDGCR). Sight distance was measured from the proposed site accesses using the following assumptions:

- A standard driver eye height of 1.08 metres for a passenger car, and
- A 4.4 metre setback from the approximate extension of the outer curb to represent a vehicle waiting to exit the site.

Intersection sight distance is calculated using equation 9.9.1 from the GDGCR as outlined below:

*ISD = 0.278 * V major * tg*

Where;
ISD = Intersection Sight Distance
V major = design speed of roadway (km/h)
tg = assumed time gap for vehicles to turn from stop onto roadway (s)

The design speed of a Collector Road in a suburban environment is typically 10-20 km/h greater than posted speed limit. The posted speed limit on Watson Road South and Arkell Road at the site frontages are both 50 km/h. Therefore, design speed of 60 km/h was assumed for both. **Table 12** outlines the sight distance analysis for the proposed site accesses.

Table 12: Sight Distance Analysis

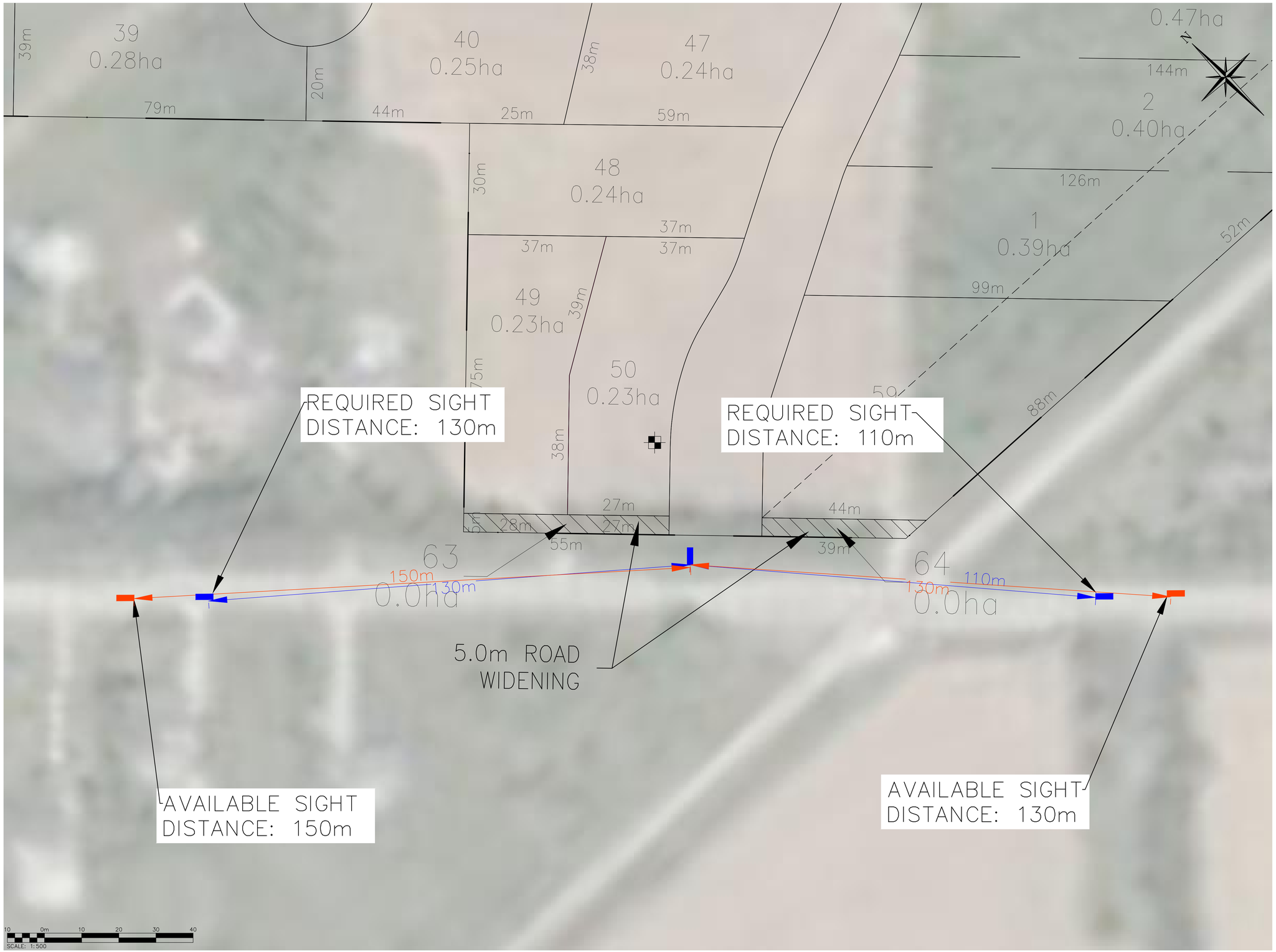
Feature	Site Access at Watson Road South	Emergency Site Access at Arkell Road
Access Type	Full moves	Only Emergency Access
Intersection Control	Stop Control on Minor Road	Stop Control on Minor Road
Speed Limit of Roadway	50 km/h	50 km/h
Assumed Design Speed	60 km/h	60 km/h
Design Vehicle	Passenger Car	Passenger Car
Base Time Gap	6.5 s (for right-turn) [1] 7.5 s (for left turn) [2]	6.5 s (for right-turn) [1] 7.5 s (for left turn) [2]
Vertical Alignment of Roadway	Fairly flat	Fairly flat
Grade of Roadway	Less than 3%	Less than 3%
Horizontal Alignment of Roadway	Straight	Straight
Sight Distance Required [3]	110 m (right turn) 130 m (left turn)	110 m (right turn) 130 m (left turn)
Measured Sight Distance	> 130 m (looking right) > 110 m (looking left)	> 130 m (looking right) > 110 m (looking left)
Minimum Sight Distance Satisfied?	Yes	Yes

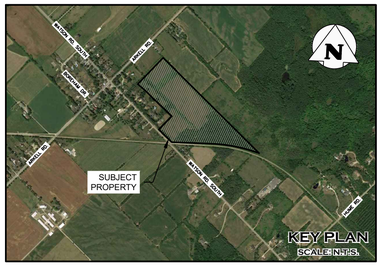
Note 1: Time gap for right-turning passenger cars from a stop onto a two-lane highway with no median and with a grade less than 3%. Value from Table 9.9.5 in the GDGCR.

Note 2: Time gap for left-turning passenger cars from a stop onto a two-lane highway with no median and with a grade less than 3%. Value from Table 9.9.3 in the GDGCR.

Note 3: Sight distance value calculated from Intersection Sight Distance equation 9.9.1 in the GDGCR.

As outlined in **Table 12**, minimum sight distance requirements are satisfied at the location of the access connections to Watson Road South and Arkell Road. **Figure 9** contains Sight Distance Assessment Drawings.





No.	ISSUE	DATE: MM/DD/YYYY
1	ISSUED FOR SUBMISSION	03/08/2024

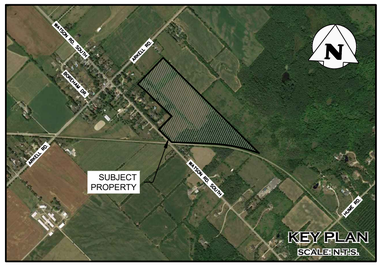
Project
TIMBERWORX CUSTOM HOMES
PARTS OF LOTS 7 & 8, CONCESSION 10
TOWNSHIP OF PUSLINCH

Drawing
SIGHT DISTANCE ASSESSMENT
ACCESS TO WATSON RD. S

CROZIER
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Drawn By	Design By	Project	2433-6646
R.L.			
Check By	Check By	Scale	Drawing
M.I.		1:500	FIG. 9





No.	ISSUE	DATE: MM/DD/YYYY
1	ISSUED FOR SUBMISSION	03/08/2024

Project

TIMBERWORX CUSTOM HOMES
PARTS OF LOTS 7 & 8, CONCESSION 10
TOWNSHIP OF PUSLINCH

Drawing

SIGHT DISTANCE ASSESSMENT
ACCESS TO ARKELL RD.

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Drawn By	R.L.	Design By		Project	2433-6646
Check By	M.I.	Check By		Scale 1:750	Drawing FIG. 10

7.2 Access Location and Spacing Review

The Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads (GDGCR) and Transport Canada's Grade Crossing Standards were used to review access spacing and corner clearance for the proposed site access connections to Watson Road South and Arkell Road. The site access spacing requirements and proposed spacings are presented in **Table 13**.

Table 13: Access Spacing Review

Site Access	Available Spacing	Minimum Spacing Requirements	Evaluation	Source
Private Access connection to Watson Road South	Approximately 500 m (to Arkell Road and Watson Road South Intersection)	Minimum 60m spacing between adjacent intersections along a collector road	Satisfied	TAC-GDGCR Section 9.4.2.2
Private Access connection to Arkell Road	Approximately 250 m (to Arkell Road and Watson Road South Intersection)	Minimum 60m spacing between adjacent intersections along a collector road	Satisfied	TAC-GDGCR Section 9.4.2.2

The site corner clearance requirements, Transport Canada's Grade Crossing requirements and proposed clearances are presented in **Table 14**.

Table 14: Corner Clearance and distance from Grade Crossing Review

Site Access	Available Corner Clearance	Minimum Corner Clearance Requirements	Evaluation	Source
Private Access connection to Watson Road South	Approximately 500 m (to Arkell Road and Watson Road South Intersection)	Minimum 25m corner clearance from stop-controlled intersection	Satisfied	TAC-GDGCR Figure 8.8.2
	Approximately 50 m (to Grade Crossing)	Minimum 30m distance from Grade Crossing	Satisfied	Transport Canada's Grade Crossing Standards
Private Access connection to Arkell Road	Approximately 250 m (to Arkell Road and Watson Road South Intersection)	Minimum 25m corner clearance from stop-controlled intersection	Satisfied	TAC-GDGCR Figure 8.8.2

As presented in **Tables 13 and 14**, the proposed accesses are satisfactory compared to the minimum spacing and corner clearance requirements of the TAC-GDGCR and Transport Canada's Grade Crossing Standards.

8.0 PARKING REVIEW

The Township of Puslinch's Zoning By-Law No. 023-18, section 5.2.2 identifies a requirement of 2 parking spaces per unit for the proposed development. As part of the subdivision plan, the parking supply identified in the By-Law will be provided along with potential on-street visitor parking as applicable.

9.0 CONCLUSIONS AND RECOMMENDATIONS

This study has assessed the transportation impacts of the proposed residential development located on sections of Lots 7, 8 and 9 of Concession 10, in the Township of Puslinch, County of Wellington. The detailed analysis contained within this report has resulted in the following key findings:

- Under 2023 existing traffic conditions, the study intersection of Arkell Road and Watson Road South is operating below capacity with minimal delay during both weekday a.m. and p.m. peak hours.

- The proposed development is expected to generate 40 and 52 two-way primary trips in the a.m. and p.m. peak hours, respectively.

- Under the ultimate 2031 future total conditions:

    - The all-way stop-controlled intersection of Arkell Road and Watson Road South is projected to operate below capacity at a LOS "A" and "B" during the weekday a.m. and p.m. peak hours, respectively. Average intersection control delays of 9.5 and 14.3 seconds in the a.m. and p.m. peak hours, respectively and maximum volume-to-capacity ratios of 0.27 (EB) and 0.54 (NB) are expected in the weekday a.m. and p.m. peak hours, respectively.

    - The proposed site access connection at Watson Road South is forecast to operate at a LOS "A" and "B" during the a.m. and p.m. peak hours respectively.

    - Overall, the nearby road network is projected to operate adequately without any capacity constraints under the ultimate 2031 future total scenario. The nearby road network is expected to operate similarly or better under the 2026 horizon year.

    - These operations are similar to the 2031 and 2026 Future Background traffic operations. Therefore, operations are expected to be similar with or without the proposed development.

- The proposed access connections to Watson Road South and Arkell Road are satisfactory per the Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads (GDGCR) with regards to sight distance, access spacing, corner clearance and Transport Canada's Grade Crossing Standards with regards to access spacing.

Based on the study findings, the development application can be supported from a traffic operations perspective as the boundary road network can accommodate the increase in traffic volumes attributable to the proposed development located on sections of Lots 7, 8 and 9 of Concession 10, in the Township of Puslinch, County of Wellington. Further, the proposed accesses are forecast to be functionally adequate with immaterial impacts to the study intersections.

Prepared by,

C.F. CROZIER & ASSOCIATES INC.

Masoud Imaniboossejin
Engineering Intern

C.F. CROZIER & ASSOCIATES INC.

Brandon Bradt, M.Eng. CEM, P.Eng.
Manager, Transportation Planning

J:\2400\2433 - Timberworx Custom Homes\6646 - Arkell Developments\Reports\Traffic\2024.01.30_Arkell Developments TIS (DRAFT)-MI - Copy.Docx

APPENDIX A

Correspondence

Archived: September 19, 2023 1:46:22 PM
From: julia@salviniconsulting.com
Sent: Mon, 18 Sep 2023 14:41:57 +0000Received: from YT3PR01CA0145.CANPRD01.PROD.OUTLOOK.COM (2603:10b6:b01:83::14) by MN2PR03MB4992.namprd03.prod.outlook.com (2603:10b6:208:1aa::15) with Microsoft SMTP Server (version=TLS1_2, cipher=TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384) id 15.20.6792.26; Mon, 18 Sep 2023 14:41:54 +0000Received: from YT3CAN01FT019.eop
To: 'Lynne Banks'; Parth Bhatt
Subject: RE: Terms of Reference for residential development on sections of Lots 7 and 8 of Concession 10, in the Township of Puslinch, County of Wellington
Importance: Normal

Hi Parth,

Generally I'm okay with the Terms of Reference you've proposed. We will also be circulating to the rail authority to get their comments – I'll be curious to see how the new road connection works relative to the rail crossing.

There are no active developments in the area for you to include specifically so we are okay with the background growth rates recommended by the County.

I look forward to reviewing your study and feel free to reach out with any other questions.
Julia

Julia Salvini (she, her), PEng, FITE
President
julia@salviniconsulting.com
519-591-0426



From: Lynne Banks <lbanks@puslinch.ca>
Sent: Monday, September 18, 2023 10:33 AM
To: Parth Bhatt <pbhatt@cfcrozier.ca>
Cc: julia@salviniconsulting.com
Subject: RE: Terms of Reference for residential development on sections of Lots 7 and 8 of Concession 10, in the Township of Puslinch, County of Wellington

Hi Parth –

I can confirm that Julia Salvini of Salvini Consulting will be reaching out to you directly regarding the TOR.

Thanks –

Lynne

Lynne Banks
Development and Legislative Coordinator
Township of Puslinch
7404 Wellington Rd 34, Puslinch ON N0B 2J0
519-763-1226 ext. 226 Fax 519-736-5846 www.puslinch.ca

From: Parth Bhatt <pbhatt@cfcrozier.ca>
Sent: Thursday, September 7, 2023 9:42 AM
To: Lynne Banks <lbanks@puslinch.ca>; Mike Fowler <mfowler@puslinch.ca>
Cc: Brandon Bradt <bbradt@cfcrozier.ca>; Masoud Imaniboossejin <mimaniboossejin@cfcrozier.ca>
Subject: RE: Terms of Reference for residential development on sections of Lots 7 and 8 of Concession 10, in the Township of Puslinch, County of Wellington

Hi Lynne,

Hope you are doing well. I am following up for the background development information. Did you hear anything ? Let us know

Thanks

Parth

Parth Bhatt, M.Eng., P.Eng.
Project Engineer, Transportation
Office: 416.477.3392
Collingwood | Milton | Toronto | Bradford | Guelph

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LINKEDIN | INSTAGRAM | FACEBOOK | TWITTER

From: Lynne Banks <lbanks@puslinch.ca>
Sent: Tuesday, August 29, 2023 2:09 PM
To: Parth Bhatt <pbhatt@cfcrozier.ca>; Mike Fowler <mfowler@puslinch.ca>
Cc: Brandon Bradt <bbradt@cfcrozier.ca>; Masoud Imaniboossejin <mimaniboossejin@cfcrozier.ca>

Subject: RE: Terms of Reference for residential development on sections of Lots 7 and 8 of Concession 10, in the Township of Puslinch, County of Wellington

Hi Parth –

Our consultant was on vacation for 2 weeks, but is reviewing your proposal now that she is back. I will forward comments to you once I receive them.

Regards –

Lynne

Lynne Banks
Development and Legislative Coordinator
Township of Puslinch
7404 Wellington Rd 34, Puslinch ON N0B 2J0
519-763-1226 ext. 226 Fax 519-736-5846 www.puslinch.ca

From: Parth Bhatt <pbhatt@cfcrozier.ca>
Sent: Thursday, August 24, 2023 10:04 AM
To: Lynne Banks <lbanks@puslinch.ca>; Mike Fowler <mfowler@puslinch.ca>
Cc: Brandon Bradt <bbradt@cfcrozier.ca>; Masoud Imaniboossejin <mimaniboossejin@cfcrozier.ca>
Subject: RE: Terms of Reference for residential development on sections of Lots 7 and 8 of Concession 10, in the Township of Puslinch, County of Wellington

Hi Lynne,

Hope you are doing well. I am following up with this email for my request on background development information. Did you hear anything ? Let us know.

Thanks

Parth

Parth Bhatt, M.Eng., P.Eng.
Project Engineer, Transportation
Office: 416.477.3392
Collingwood | Milton | Toronto | Bradford | Guelph

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From: Parth Bhatt
Sent: Friday, August 18, 2023 4:24 PM
To: Lynne Banks <lbanks@puslinch.ca>; Mike Fowler <mfowler@puslinch.ca>
Cc: Brandon Bradt <bbradt@cfcrozier.ca>; Masoud Imaniboossejin <mimaniboossejin@cfcrozier.ca>
Subject: RE: Terms of Reference for residential development on sections of Lots 7 and 8 of Concession 10, in the Township of Puslinch, County of Wellington

Hi Lynne,

Please find the draft plan of subdivision attached. Thanks

Parth

From: Lynne Banks <lbanks@puslinch.ca>
Sent: Friday, August 18, 2023 3:54 PM
To: Parth Bhatt <pbhatt@cfcrozier.ca>; Mike Fowler <mfowler@puslinch.ca>
Cc: Brandon Bradt <bbradt@cfcrozier.ca>; Masoud Imaniboossejin <mimaniboossejin@cfcrozier.ca>
Subject: RE: Terms of Reference for residential development on sections of Lots 7 and 8 of Concession 10, in the Township of Puslinch, County of Wellington

Hi Parth –

Can you please provide me with a copy of the draft plan of subdivision and I will forward it, and the information below, to the Township's traffic consultant for review and comments regarding anything else that should be considered.

Thanks –

Lynne

Lynne Banks
Development and Legislative Coordinator
Township of Puslinch
7404 Wellington Rd 34, Puslinch ON N0B 2J0
519-763-1226 ext. 226 Fax 519-736-5846 www.puslinch.ca

From: Parth Bhatt <pbhatt@cfcrozier.ca>
Sent: Friday, August 18, 2023 3:19 PM
To: Mike Fowler <mfowler@puslinch.ca>; Lynne Banks <lbanks@puslinch.ca>
Cc: Brandon Bradt <bbradt@cfcrozier.ca>; Masoud Imaniboossejin <mimaniboossejin@cfcrozier.ca>
Subject: RE: Terms of Reference for residential development on sections of Lots 7 and 8 of Concession 10, in the Township of Puslinch, County of Wellington

Hi Mike and Lynne,
Can you please advise if any background developments should be accounted for in our analysis based on email chain below and also let us know if there are any comments on our Terms of Reference ? Thanks
Parth

Parth Bhatt, M.Eng., P.Eng.
Project Engineer, Transportation
Office: 416.477.3392
Collingwood | Milton | Toronto | Bradford | Guelph

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From: Pasquale Costanzo <pasqualec@wellington.ca>
Sent: Friday, August 18, 2023 1:49 PM
To: Parth Bhatt <pbhatt@cfcrozier.ca>; Kooistra, Tim <tkooistra@dillon.ca>
Cc: mfowler@puslinch.ca; Brandon Bradt <bbradt@cfcrozier.ca>; Masoud Imaniboossejin <mimaniboossejin@cfcrozier.ca>; Meagan Ferris <meaganf@wellington.ca>; Lynne Banks <lbanks@puslinch.ca>
Subject: RE: Terms of Reference for residential development on sections of Lots 7 and 8 of Concession 10, in the Township of Puslinch, County of Wellington

Hi Parth,

The Township would be your contact to provide you background developments for your study.

Pasquale Costanzo, C.E.T., CMMII Infrastructure Specialist
Technical Services Supervisor
County of Wellington, Roads Division
T 519.837.2601 x 2250
E pasqualec@wellington.ca

From: Parth Bhatt <pbhatt@cfcrozier.ca>
Sent: Friday, August 18, 2023 12:24 PM
To: Kooistra, Tim <tkooistra@dillon.ca>
Cc: mfowler@puslinch.ca; Pasquale Costanzo <pasqualec@wellington.ca>; Brandon Bradt <bbradt@cfcrozier.ca>; Masoud Imaniboossejin <mimaniboossejin@cfcrozier.ca>
Subject: RE: Terms of Reference for residential development on sections of Lots 7 and 8 of Concession 10, in the Township of Puslinch, County of Wellington

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Hi Tim,

Hope you are doing well. I am following up regarding my email below for the background developments. Let us know if you have the information. Thanks

Parth

Parth Bhatt, M.Eng., P.Eng.
Project Engineer, Transportation
Office: 416.477.3392
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From: Parth Bhatt
Sent: Tuesday, August 15, 2023 11:21 AM
To: Kooistra, Tim <tkooistra@dillon.ca>
Cc: mfowler@puslinch.ca; pasqualec@wellington.ca; Brandon Bradt <bbradt@cfcrozier.ca>; Masoud Imaniboossejin <mimaniboossejin@cfcrozier.ca>
Subject: RE: Terms of Reference for residential development on sections of Lots 7 and 8 of Concession 10, in the Township of Puslinch, County of Wellington

Hi Tim,

Thanks for your feedback and TMC, can you please let us know the background developments that needs to be accounted and provide us with the respective traffic impact studies.

Parth

From: Kooistra, Tim <tkooistra@dillon.ca>
Sent: Tuesday, August 15, 2023 10:47 AM
To: Parth Bhatt <pbhatt@cfcrozier.ca>

Cc: mfowler@puslinch.ca; pasqualec@wellington.ca; Brandon Bradt <bbradt@cfcrozier.ca>; Masoud Imaniboossejin <mimaniboossejin@cfcrozier.ca>
Subject: Re: Terms of Reference for residential development on sections of Lots 7 and 8 of Concession 10, in the Township of Puslinch, County of Wellington

Good morning Parth,

Thank you for reaching out regarding the planned Transportation Impact Assessment you are looking to prepare for a proposed residential subdivision found within the community of Arkell in the Township of Puslinch. As you are aware, Dillon Consulting Limited has been retained by the County of Wellington to review the proposed scope of work for various traffic impact studies that may impact the County road network and associated intersections. As a result, this response is being provided on behalf of the County of Wellington for your consideration.

The scope you have identified is generally acceptable from the County's perspective, noting that the following needs to be considered in the study:

- Rather than having to collect a new turning movement count (TMC) at the Wellington Road 37 and Wellington Road 41 intersection in Arkell, you may be pleased to know that a TMC was completed at this intersection in 2022. This TMC is attached for your reference.
- A 2.0% per annum growth rate is required within the study area.
- The Township of Puslinch will need to identify any other background developments and/or associated traffic impact studies that have been previously submitted that may impact the future traffic volumes that need to be considered in the study.

Thank you,

Tim

Tim Kooistra, C.E.T.
Dillon Consulting Limited
130 Dufferin Avenue Suite 1400
London, Ontario, N6A 5R2
T - 519.438.1288 ext. 1330
F - 519.672.8209
M - 519.851.5403

TKooistra@dillon.ca
www.dillon.ca

On Fri, Aug 11, 2023 at 12:32\u8239 PM Parth Bhatt <pbhatt@cfcrozier.ca> wrote:

> Good Evening Mike, Tim and Pasquale,
>
> C.F. Crozier has been retained to complete a Traffic Impact Study (TIS) for a proposed residential development located on sections of Lots 7 and 8 of Concession 10, in the Township of Puslinch, County of Wellington. The subject lands cover an area of approximately 17 ha and currently consist of agricultural/vegetated land. The property, located on the southeast corner of the intersection at Arkell Road and Watson Road South, is bounded by a residential property to the north, agricultural/vegetated lands to the east, the Guelph Junction Railway to the south, and Watson Road/residential properties to the west.
>
> The elements envisioned for this development include:
>
> - Forty (40) Single detached residential properties (each lot will be 0.2 ha or larger).
> - Associated internal public road network.
> - Proposed Site Accesses via Watson Road South
>
> For additional detail please refer to the preliminary Draft Plan of Subdivision attached here but note that it is subject to change prior to the submission.
> Below are the proposed terms of reference for this developments Traffic impact Study (TIS). The TIS will be completed as per the County of Wellington's Traffic Impact Study Guidelines with the following assumptions:
> Please provide feedback at the earliest possible. Should you have any questions or concerns, please feel free to contact us, we would be happy to discuss.
> Thanks,
> Parth
>
> ---
>
> Based on the preliminary ITE Trip Generation estimates, approximately 32 and 42 new two-way a.m. and p.m. peak hour trips, respectively, are generated by the development.
> The TIS will evaluate the potential impacts of traffic generated by the proposed development during the weekday a.m. and p.m. peak hours. The study will consider the existing 2023, full build-out year (2026 assumed) as well as five years (2031) beyond full build-out in accordance with the County of Wellington's Traffic Impact Study Guidelines.
> The following intersections will be analyzed.
>
> - Watson Road South and Arkell Road
> - Proposed Site Accesses via Watson Road South
>
> - Existing, future background and future total traffic operations will be analyzed using Synchro 11. Standard traffic operations metrics for signalized and unsignalized intersections including delays, volume-to-capacity ratios, and 95th percentile queue length will be analyzed and reported on.
> - Existing counts will be undertaken to establish the 2023 existing traffic volumes.
> - Based on AADT data; otherwise please advise the appropriate growth rates for the roadways listed above.
> - Please advise if any background developments should be accounted for in our analysis.
> - Trip distribution will be derived from a combination of 2016 Transportation Tomorrow Survey (TTS) data and existing travel patterns.
> - Future total traffic operations will be compared to future background traffic operations under the future study horizon(s) to determine what mitigation measures are required on the boundary road network to accommodate the development. These mitigation measures may include auxiliary turn lanes, signalization, etc. as warranted.
> - The proposed site accesses will be reviewed from a safety perspective with regards to design vehicle maneuverability (ie. waste vehicles and fire trucks), driver sight lines, intersection spacing and access configuration. The safety assessment will be based on the standards set out by the Transportation Associates of Canada (TAC) Geometric Design Guide for Canadians Roads (GDGCR) and the Transport Canada Grade Crossing Standards.
> - The minimum vehicle parking requirements will be reviewed per the Township of Puslinch Zoning By-law 023-18 and compare with the proposed supply.
> - The study findings regarding traffic operations, recommendations and conclusions will all be compiled for review.
>
> **Confirmation regarding traffic counts survey**
> We would like to confirm regarding traffic counts survey, as we are currently in month of August, does Township of Puslinch / County of Wellington permit traffic counts done in August as schools are currently closed and usually opens in September ?
>
> **Parth Bhatt**, M.Eng., P.Eng.
> Project Engineer, Transportation
> Office: 416.477.3392
> Collingwood | Milton | Toronto | Bradford | Guelph
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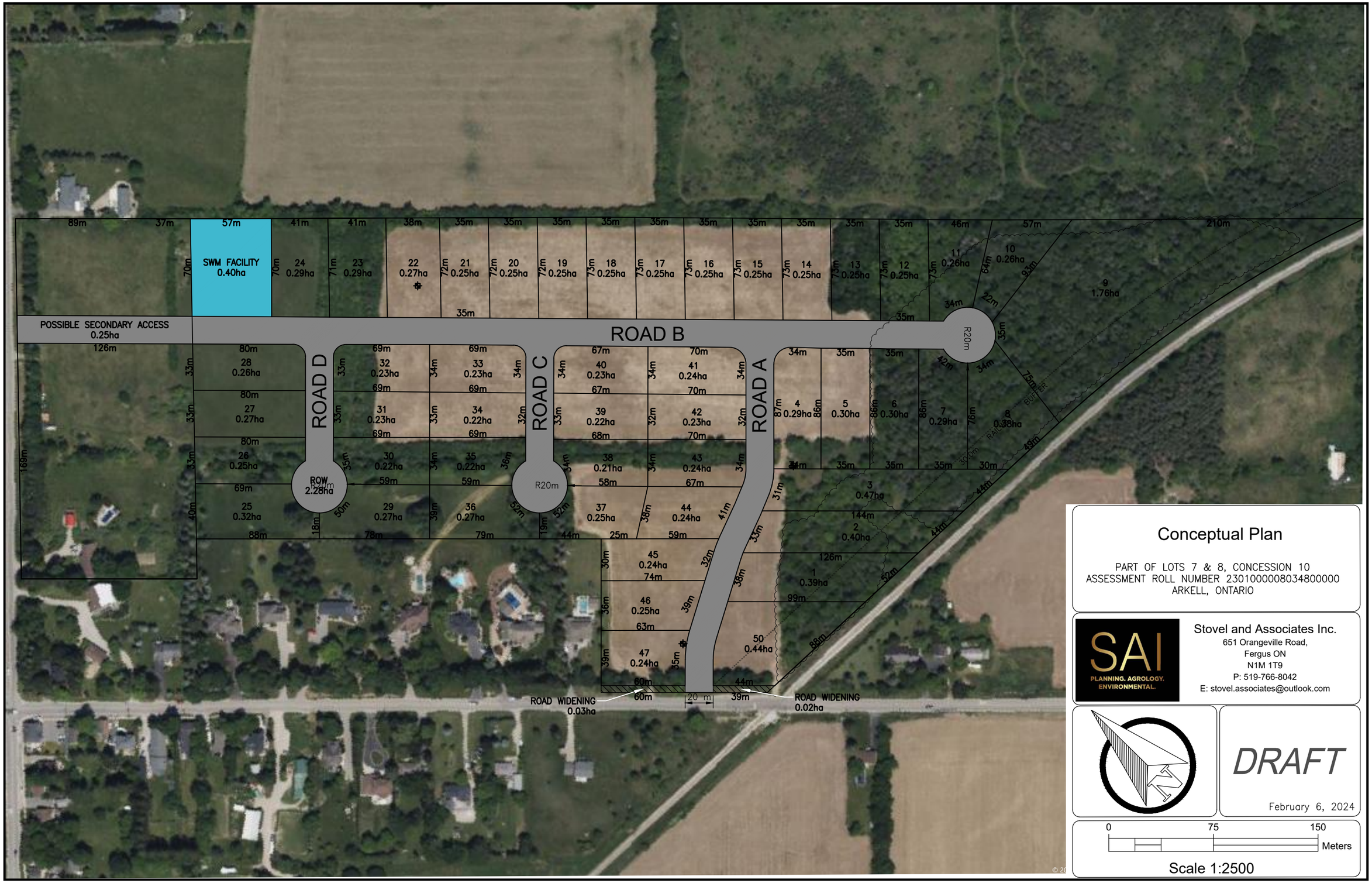
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APPENDIX B

Site Plan



Conceptual Plan

PART OF LOTS 7 & 8, CONCESSION 10
ASSESSMENT ROLL NUMBER 2301000008034800000
ARKELL, ONTARIO

Stovel and Associates Inc.
651 Orangeville Road,
Fergus ON
N1M 1T9
P: 519-766-8042
E: stovel.associates@outlook.com

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DRAFT

February 6, 2024

0 75 150 Meters

Scale 1:2500

APPENDIX C

Traffic Data

WELLINGTON COUNTY TRAFFIC COUNT SUMMARY	
Intersection:	WR 37 at WR 41 (Puslinch)
Site code:	00004137
Count date:	07/28/2022
Counted by:	Shayna - student

North approach:	**WR 37 (major)**				**N/S**	**South approach:**	**WR 37 (major)**			
Hour	Right	Thru	Left	Peds	**totals**	Hour	Right	Thru	Left	Peds
7:00	10	72	6	8	207	7:00	11	81	27	0
8:00	15	97	3	1	250	8:00	13	87	35	1
9:00	0	0	0	0	0	9:00	0	0	0	0
10:00	0	0	0	0	0	10:00	0	0	0	0
11:00	9	62	4	2	207	11:00	22	75	35	1
12:00	21	74	7	1	251	12:00	33	75	41	2
13:00	18	76	4	0	244	13:00	25	88	33	1
14:00	0	0	0	0	0	14:00	0	0	0	0
15:00	0	0	0	0	0	15:00	0	0	0	0
16:00	23	128	10	2	413	16:00	26	152	74	2
17:00	14	122	12	6	352	17:00	22	136	46	3
18:00	18	100	6	1	303	18:00	28	89	62	3
Totals	**128**	**731**	**52**	**21**		**Totals**	**180**	**783**	**353**	**13**

East approach:	**WR 41 (minor)**				**E/W**	**West approach:**	**WR 41 (minor)**			
Hour	Right	Thru	Left	Peds	**totals**	Hour	Right	Thru	Left	Peds
7:00	3	43	9	3	176	7:00	42	65	14	1
8:00	9	72	19	2	255	8:00	64	72	19	1
9:00	0	0	0	0	0	9:00	0	0	0	0
10:00	0	0	0	0	0	10:00	0	0	0	0
11:00	11	49	25	5	182	11:00	39	41	17	4
12:00	7	60	25	3	199	12:00	41	44	22	1
13:00	13	70	21	0	209	13:00	40	47	18	2
14:00	0	0	0	0	0	14:00	0	0	0	0
15:00	0	0	0	0	0	15:00	0	0	0	0
16:00	9	110	24	0	382	16:00	111	100	28	1
17:00	9	87	27	0	300	17:00	66	83	28	6
18:00	8	79	29	4	219	18:00	41	47	15	26
Totals	**69**	**570**	**179**	**17**		**Totals**	**444**	**499**	**161**	**42**

Calculated values for traffic crossing major street									
Hour:	7:00	8:00		11:00	12:00	13:00		16:00	17:00	18:00
Value:	186	222		176	197	201		364	316	257

WR 37 at WR 41 (Puslinch)	
Count date:	07/28/2022
Intersection:	WR 37 at WR 41
Major road:	WR 37
Major road runs:	north/south (one lane each way)
Speed of major road:	80 km/h
Operating conditions:	Free flow

WARRANT #1 MINIMUM VEHICULAR VOLUMES **SATISFIED**

A. All approaches

No. of lanes	Minimum requirements					Hours								
	1 lane each way		2 lanes each way		3+ lanes									
Flow cond'n	f. flow (code 1)	r. flow (code 2)	f. flow (code 3)	r. flow (code 4)	r. flow (code 5)	7:00	8:00	11:00	12:00	13:00	16:00	17:00	18:00	Percentage warrant
100%	480	720	600	900	1125	383	505	389	450	453	795	652	522	100%
80%	385	575	480	720	900									NO
All approaches	100% fulfilled					0	100	0	0	0	100	100	100	400
	80% fulfilled					0	0	80	80	80	0	0	0	240
	Actual % if below 80%					80	0	0	0	0	0	0	0	80
													Total:	720
													Actual average (total/8):	90

B. Minor street both approaches

100%	120	170	120	170	170	176	255	182	199	209	382	300	219	100%
80%	95	135	95	135	135									YES
Both approaches	100% fulfilled					100	100	100	100	100	100	100	100	800
	80% fulfilled					0	0	0	0	0	0	0	0	0
	Actual % if below 80%					0	0	0	0	0	0	0	0	0
													Total:	800
													Actual average (total/8):	100

WR 37 at WR 41 (Puslinch)	
Count date:	07/28/2022
Intersection:	WR 37 at WR 41
Major road:	WR 37
Major road runs:	north/south (one lane each way)
Speed of major road:	80 km/h
Operating conditions:	Free flow

WARRANT #2 DELAY TO CROSS TRAFFIC **NOT SATISFIED**

A. Major street both approaches

No. of lanes	Minimum requirements					Hours								
	1 lane each way		2 lanes each way		3+ lanes									
Flow cond'n	f. flow (code 1)	r. flow (code 2)	f. flow (code 3)	r. flow (code 4)	r. flow (code 5)	7:00	8:00	11:00	12:00	13:00	16:00	17:00	18:00	Percentage warrant
100%	480	720	600	900	1125	207	250	207	251	244	413	352	303	100%
80%	385	575	480	720	900									NO
All approaches	100% fulfilled					0	0	0	0	0	0	0	0	0
	80% fulfilled					0	0	0	0	0	80	0	0	80
	Actual % if below 80%					43	52	43	52	51	0	73	63	378
													Total:	458
													Actual average (total/8):	57

B. Traffic crossing major street

100%	50	75	50	75	75	186	222	176	197	201	364	316	257	100%
80%	40	60	40	60	60									YES
All approaches	100% fulfilled					100	100	100	100	100	100	100	100	800
	80% fulfilled					0	0	0	0	0	0	0	0	0
	Actual % if below 80%					0	0	0	0	0	0	0	0	0
													Total:	800
													Actual average (total/8):	100

WR 37 at WR 41 (Puslinch)	
Count date:	07/28/2022
Intersection:	WR 37 at WR 41
Major road:	WR 37
Major road runs:	north/south (one lane each way)
Speed of major road:	80 km/h
Operating conditions:	Free flow

WARRANT #3 ACCIDENT EXPERIENCE

A. Reportable accidents within a 12 month period averaged over 36 consecutive months susceptible to correction by a traffic signal			
Minimum requirements per year	Actual number of accidents in 36 months	Average number of accidents per year	Fulfilled
5	2	0.67	13%
B. Adequate trial of less restrictive remedies has failed to reduce accident frequency			No
C. Either Warrant 1 or Warrant 2 satisfied 80% or more			Yes

WARRANT #4 COMBINATION WARRANT (used if no warrant satisfied 100%)

Minimum requirements	Warrant satisfied 80% or more	Fulfilled
At least two warrants satisfied 80%	Warrant 1 (Minimum Vehicular Volume)	Yes
	Warrant 2 (Delay to Cross Traffic)	No
	Warrant 3 (Accident Experience)	No

CONCLUSION

Traffic signal is not warranted

APPENDIX D

Level of Service Definitions

Level of Service Definitions

Two-Way Stop Controlled Intersections

Level of Service	Control Delay per Vehicle (seconds)	Interpretation
A	≤ 10	EXCELLENT. Large and frequent gaps in traffic on the main roadway. Queuing on the minor street is rare.
B	> 10 and ≤ 15	VERY GOOD. Many gaps exist in traffic on the main roadway. Queuing on the minor street is minimal.
C	> 15 and ≤ 25	GOOD. Fewer gaps exist in traffic on the main roadway. Delay on minor approach becomes more noticeable.
D	> 25 and ≤ 35	FAIR. Infrequent and shorter gaps in traffic on the main roadway. Queue lengths develop on the minor street.
E	> 35 and ≤ 50	POOR. Very infrequent gaps in traffic on the main roadway. Queue lengths become noticeable.
F	> 50	UNSATISFACTORY. Very few gaps in traffic on the main roadway. Excessive delay with significant queue lengths on the minor street.

Adapted from Highway Capacity Manual 2000, Transportation Research Board

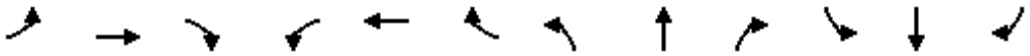
Signalized Intersections

Level of Service	Control Delay per Vehicle (seconds)	Interpretation
A	≤ 10	EXCELLENT. Extremely favourable progression with most vehicles arriving during the green phase. Most vehicles do not stop and short cycle lengths may contribute to low delay.
B	> 10 and ≤ 20	VERY GOOD. Very good progression and/or short cycle lengths with slightly more vehicles stopping than LOS "A" causing slightly higher levels of average delay.
C	> 20 and ≤ 35	GOOD. Fair progression and longer cycle lengths lead to a greater number of vehicles stopping than LOS "B".
D	> 35 and ≤ 55	FAIR. Congestion becomes noticeable with higher average delays resulting from a combination of long cycle lengths, high volume-to-capacity ratios and unfavourable progression.
E	> 55 and ≤ 80	POOR. Lengthy delays values are indicative of poor progression, long cycle lengths and high volume-to-capacity ratios. Individual cycle failures are common with individual movement failures also common.
F	> 80	UNSATISFACTORY. Indicative of oversaturated conditions with vehicular demand greater than the capacity of the intersection.

Adapted from Highway Capacity Manual 2000, Transportation Research Board

APPENDIX E

Detailed Capacity Analysis Reports



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	19	73	65	19	73	9	36	89	13	3	99	15
Future Volume (vph)	19	73	65	19	73	9	36	89	13	3	99	15
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor												
Frt		0.944			0.988			0.987			0.983	
Flt Protected		0.994			0.991			0.987			0.999	
Satd. Flow (prot)	0	1748	0	0	1824	0	0	1815	0	0	1829	0
Flt Permitted		0.994			0.991			0.987			0.999	
Satd. Flow (perm)	0	1748	0	0	1824	0	0	1815	0	0	1829	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		415.4			515.6			455.7			424.1	
Travel Time (s)		29.9			37.1			32.8			30.5	
Confl. Peds. (#/hr)	2		1	1		2	1		1	1		1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	21	79	71	21	79	10	39	97	14	3	108	16
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	171	0	0	110	0	0	150	0	0	127	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Stop			Stop	

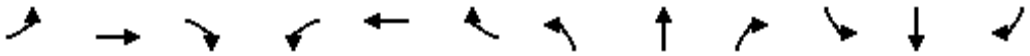
Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 31.6%		ICU Level of Service A	
Analysis Period (min) 15			

Intersection	
Intersection Delay, s/veh	8.8
Intersection LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	19	73	65	19	73	9	36	89	13	3	99	15
Future Vol, veh/h	19	73	65	19	73	9	36	89	13	3	99	15
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	21	79	71	21	79	10	39	97	14	3	108	16
Number of Lanes	0	1	0	0	1	0	0	1	0	0	1	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	1	1	1	1
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	1	1	1	1
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	1	1	1	1
HCM Control Delay	8.8	8.6	9	8.7
HCM LOS	A	A	A	A

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	26%	12%	19%	3%
Vol Thru, %	64%	46%	72%	85%
Vol Right, %	9%	41%	9%	13%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	138	157	101	117
LT Vol	36	19	19	3
Through Vol	89	73	73	99
RT Vol	13	65	9	15
Lane Flow Rate	150	171	110	127
Geometry Grp	1	1	1	1
Degree of Util (X)	0.197	0.214	0.146	0.166
Departure Headway (Hd)	4.738	4.506	4.781	4.7
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	755	795	748	760
Service Time	2.783	2.546	2.826	2.747
HCM Lane V/C Ratio	0.199	0.215	0.147	0.167
HCM Control Delay	9	8.8	8.6	8.7
HCM Lane LOS	A	A	A	A
HCM 95th-tile Q	0.7	0.8	0.5	0.6



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	29	102	113	24	112	9	75	155	27	10	131	23
Future Volume (vph)	29	102	113	24	112	9	75	155	27	10	131	23
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor												
Frt		0.938			0.991			0.986			0.981	
Flt Protected		0.994			0.992			0.986			0.997	
Satd. Flow (prot)	0	1737	0	0	1831	0	0	1811	0	0	1822	0
Flt Permitted		0.994			0.992			0.986			0.997	
Satd. Flow (perm)	0	1737	0	0	1831	0	0	1811	0	0	1822	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		415.4			513.9			455.7			424.1	
Travel Time (s)		29.9			37.0			32.8			30.5	
Confl. Peds. (#/hr)			1	1			2		2	2		2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	32	111	123	26	122	10	82	168	29	11	142	25
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	266	0	0	158	0	0	279	0	0	178	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Stop			Stop	

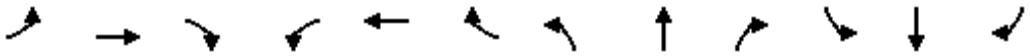
Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 50.2%		ICU Level of Service A	
Analysis Period (min) 15			

Intersection	
Intersection Delay, s/veh	11.4
Intersection LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	29	102	113	24	112	9	75	155	27	10	131	23
Future Vol, veh/h	29	102	113	24	112	9	75	155	27	10	131	23
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	32	111	123	26	122	10	82	168	29	11	142	25
Number of Lanes	0	1	0	0	1	0	0	1	0	0	1	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	1	1	1	1
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	1	1	1	1
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	1	1	1	1
HCM Control Delay	11.5	10.5	12.3	10.6
HCM LOS	B	B	B	B

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	29%	12%	17%	6%
Vol Thru, %	60%	42%	77%	80%
Vol Right, %	11%	46%	6%	14%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	257	244	145	164
LT Vol	75	29	24	10
Through Vol	155	102	112	131
RT Vol	27	113	9	23
Lane Flow Rate	279	265	158	178
Geometry Grp	1	1	1	1
Degree of Util (X)	0.418	0.384	0.247	0.272
Departure Headway (Hd)	5.383	5.211	5.631	5.484
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	668	690	635	652
Service Time	3.427	3.258	3.682	3.534
HCM Lane V/C Ratio	0.418	0.384	0.249	0.273
HCM Control Delay	12.3	11.5	10.5	10.6
HCM Lane LOS	B	B	B	B
HCM 95th-tile Q	2.1	1.8	1	1.1



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	21	78	69	21	78	10	39	95	14	4	106	16
Future Volume (vph)	21	78	69	21	78	10	39	95	14	4	106	16
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor												
Frt		0.945			0.988			0.987			0.983	
Flt Protected		0.994			0.990			0.987			0.999	
Satd. Flow (prot)	0	1750	0	0	1822	0	0	1815	0	0	1829	0
Flt Permitted		0.994			0.990			0.987			0.999	
Satd. Flow (perm)	0	1750	0	0	1822	0	0	1815	0	0	1829	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		415.4			515.6			455.7			424.1	
Travel Time (s)		29.9			37.1			32.8			30.5	
Confl. Peds. (#/hr)	2		1	1		2	1		1	1		1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	23	85	75	23	85	11	42	103	15	4	115	17
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	183	0	0	119	0	0	160	0	0	136	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Stop			Stop	

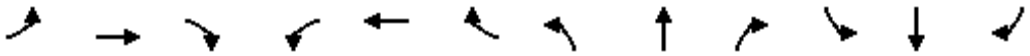
Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 36.7%		ICU Level of Service A	
Analysis Period (min) 15			

Intersection	
Intersection Delay, s/veh	9
Intersection LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	21	78	69	21	78	10	39	95	14	4	106	16
Future Vol, veh/h	21	78	69	21	78	10	39	95	14	4	106	16
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	23	85	75	23	85	11	42	103	15	4	115	17
Number of Lanes	0	1	0	0	1	0	0	1	0	0	1	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	1	1	1	1
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	1	1	1	1
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	1	1	1	1
HCM Control Delay	9	8.8	9.2	8.9
HCM LOS	A	A	A	A

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	26%	12%	19%	3%
Vol Thru, %	64%	46%	72%	84%
Vol Right, %	9%	41%	9%	13%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	148	168	109	126
LT Vol	39	21	21	4
Through Vol	95	78	78	106
RT Vol	14	69	10	16
Lane Flow Rate	161	183	118	137
Geometry Grp	1	1	1	1
Degree of Util (X)	0.215	0.232	0.16	0.182
Departure Headway (Hd)	4.809	4.579	4.856	4.775
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	743	780	735	748
Service Time	2.862	2.629	2.911	2.83
HCM Lane V/C Ratio	0.217	0.235	0.161	0.183
HCM Control Delay	9.2	9	8.8	8.9
HCM Lane LOS	A	A	A	A
HCM 95th-tile Q	0.8	0.9	0.6	0.7



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	31	109	120	26	119	10	80	165	29	11	140	25
Future Volume (vph)	31	109	120	26	119	10	80	165	29	11	140	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor												
Frt		0.938			0.991			0.986			0.981	
Flt Protected		0.994			0.992			0.986			0.997	
Satd. Flow (prot)	0	1737	0	0	1831	0	0	1811	0	0	1822	0
Flt Permitted		0.994			0.992			0.986			0.997	
Satd. Flow (perm)	0	1737	0	0	1831	0	0	1811	0	0	1822	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		415.4			513.9			455.7			424.1	
Travel Time (s)		29.9			37.0			32.8			30.5	
Confl. Peds. (#/hr)			1	1			2		2	2		2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	34	118	130	28	129	11	87	179	32	12	152	27
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	282	0	0	168	0	0	298	0	0	191	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Stop			Stop	

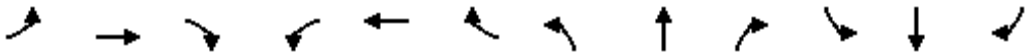
Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 52.8%		ICU Level of Service A	
Analysis Period (min) 15			

Intersection	
Intersection Delay, s/veh	12.1
Intersection LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	31	109	120	26	119	10	80	165	29	11	140	25
Future Vol, veh/h	31	109	120	26	119	10	80	165	29	11	140	25
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	34	118	130	28	129	11	87	179	32	12	152	27
Number of Lanes	0	1	0	0	1	0	0	1	0	0	1	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	1	1	1	1
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	1	1	1	1
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	1	1	1	1
HCM Control Delay	12.3	11	13.2	11.1
HCM LOS	B	B	B	B

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	29%	12%	17%	6%
Vol Thru, %	60%	42%	77%	80%
Vol Right, %	11%	46%	6%	14%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	274	260	155	176
LT Vol	80	31	26	11
Through Vol	165	109	119	140
RT Vol	29	120	10	25
Lane Flow Rate	298	283	168	191
Geometry Grp	1	1	1	1
Degree of Util (X)	0.457	0.421	0.271	0.3
Departure Headway (Hd)	5.525	5.36	5.798	5.644
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	649	670	617	633
Service Time	3.58	3.417	3.863	3.707
HCM Lane V/C Ratio	0.459	0.422	0.272	0.302
HCM Control Delay	13.2	12.3	11	11.1
HCM Lane LOS	B	B	B	B
HCM 95th-tile Q	2.4	2.1	1.1	1.3



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	23	86	77	23	86	11	43	105	16	4	116	18
Future Volume (vph)	23	86	77	23	86	11	43	105	16	4	116	18
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor												
Frt		0.944			0.988			0.987			0.982	
Flt Protected		0.994			0.990			0.987			0.999	
Satd. Flow (prot)	0	1748	0	0	1822	0	0	1815	0	0	1827	0
Flt Permitted		0.994			0.990			0.987			0.999	
Satd. Flow (perm)	0	1748	0	0	1822	0	0	1815	0	0	1827	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		415.4			515.6			455.7			424.1	
Travel Time (s)		29.9			37.1			32.8			30.5	
Confl. Peds. (#/hr)	2		1	1		2	1		1	1		1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	25	93	84	25	93	12	47	114	17	4	126	20
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	202	0	0	130	0	0	178	0	0	150	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Stop			Stop	

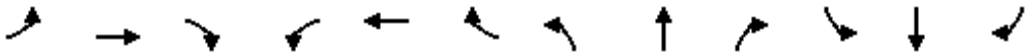
Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 39.3%		ICU Level of Service A	
Analysis Period (min) 15			

Intersection	
Intersection Delay, s/veh	9.3
Intersection LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	23	86	77	23	86	11	43	105	16	4	116	18
Future Vol, veh/h	23	86	77	23	86	11	43	105	16	4	116	18
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	25	93	84	25	93	12	47	114	17	4	126	20
Number of Lanes	0	1	0	0	1	0	0	1	0	0	1	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	1	1	1	1
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	1	1	1	1
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	1	1	1	1
HCM Control Delay	9.4	9.1	9.6	9.2
HCM LOS	A	A	A	A

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	26%	12%	19%	3%
Vol Thru, %	64%	46%	72%	84%
Vol Right, %	10%	41%	9%	13%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	164	186	120	138
LT Vol	43	23	23	4
Through Vol	105	86	86	116
RT Vol	16	77	11	18
Lane Flow Rate	178	202	130	150
Geometry Grp	1	1	1	1
Degree of Util (X)	0.243	0.263	0.18	0.204
Departure Headway (Hd)	4.912	4.679	4.971	4.885
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	726	762	716	729
Service Time	2.982	2.744	3.042	2.957
HCM Lane V/C Ratio	0.245	0.265	0.182	0.206
HCM Control Delay	9.6	9.4	9.1	9.2
HCM Lane LOS	A	A	A	A
HCM 95th-tile Q	0.9	1.1	0.7	0.8



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	34	120	133	29	132	11	88	182	32	12	154	27
Future Volume (vph)	34	120	133	29	132	11	88	182	32	12	154	27
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor												
Frt		0.937			0.991			0.986			0.981	
Flt Protected		0.994			0.992			0.986			0.997	
Satd. Flow (prot)	0	1735	0	0	1831	0	0	1811	0	0	1822	0
Flt Permitted		0.994			0.992			0.986			0.997	
Satd. Flow (perm)	0	1735	0	0	1831	0	0	1811	0	0	1822	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		415.4			513.9			455.7			424.1	
Travel Time (s)		29.9			37.0			32.8			30.5	
Confl. Peds. (#/hr)			1	1			2		2	2		2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	37	130	145	32	143	12	96	198	35	13	167	29
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	312	0	0	187	0	0	329	0	0	209	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Stop			Stop	

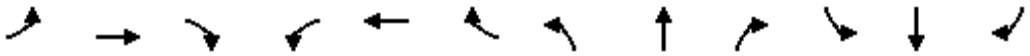
Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 57.0%		ICU Level of Service B	
Analysis Period (min) 15			

Intersection	
Intersection Delay, s/veh	13.7
Intersection LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	34	120	133	29	132	11	88	182	32	12	154	27
Future Vol, veh/h	34	120	133	29	132	11	88	182	32	12	154	27
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	37	130	145	32	143	12	96	198	35	13	167	29
Number of Lanes	0	1	0	0	1	0	0	1	0	0	1	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	1	1	1	1
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	1	1	1	1
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	1	1	1	1
HCM Control Delay	14	12	15.2	12.2
HCM LOS	B	B	C	B

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	29%	12%	17%	6%
Vol Thru, %	60%	42%	77%	80%
Vol Right, %	11%	46%	6%	14%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	302	287	172	193
LT Vol	88	34	29	12
Through Vol	182	120	132	154
RT Vol	32	133	11	27
Lane Flow Rate	328	312	187	210
Geometry Grp	1	1	1	1
Degree of Util (X)	0.526	0.486	0.316	0.346
Departure Headway (Hd)	5.772	5.612	6.089	5.933
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	620	636	585	600
Service Time	3.855	3.697	4.188	4.027
HCM Lane V/C Ratio	0.529	0.491	0.32	0.35
HCM Control Delay	15.2	14	12	12.2
HCM Lane LOS	C	B	B	B
HCM 95th-tile Q	3.1	2.7	1.3	1.5



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	21	78	69	23	84	13	39	95	16	6	106	16
Future Volume (vph)	21	78	69	23	84	13	39	95	16	6	106	16
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor												
Frt		0.945			0.985			0.986			0.983	
Flt Protected		0.994			0.990			0.987			0.997	
Satd. Flow (prot)	0	1750	0	0	1816	0	0	1813	0	0	1826	0
Flt Permitted		0.994			0.990			0.987			0.997	
Satd. Flow (perm)	0	1750	0	0	1816	0	0	1813	0	0	1826	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		415.4			515.6			455.7			424.1	
Travel Time (s)		29.9			37.1			32.8			30.5	
Confl. Peds. (#/hr)	2		1	1		2	1		1	1		1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	23	85	75	25	91	14	42	103	17	7	115	17
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	183	0	0	130	0	0	162	0	0	139	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Stop			Stop	

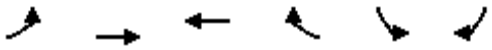
Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 36.9%		ICU Level of Service A	
Analysis Period (min) 15			

Intersection	
Intersection Delay, s/veh	9.1
Intersection LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	21	78	69	23	84	13	39	95	16	6	106	16
Future Vol, veh/h	21	78	69	23	84	13	39	95	16	6	106	16
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	23	85	75	25	91	14	42	103	17	7	115	17
Number of Lanes	0	1	0	0	1	0	0	1	0	0	1	0

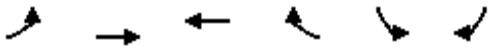
Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	1	1	1	1
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	1	1	1	1
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	1	1	1	1
HCM Control Delay	9.1	9	9.3	9
HCM LOS	A	A	A	A

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	26%	12%	19%	5%
Vol Thru, %	63%	46%	70%	83%
Vol Right, %	11%	41%	11%	12%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	150	168	120	128
LT Vol	39	21	23	6
Through Vol	95	78	84	106
RT Vol	16	69	13	16
Lane Flow Rate	163	183	130	139
Geometry Grp	1	1	1	1
Degree of Util (X)	0.219	0.234	0.176	0.186
Departure Headway (Hd)	4.835	4.606	4.859	4.814
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	739	774	734	740
Service Time	2.893	2.661	2.918	2.873
HCM Lane V/C Ratio	0.221	0.236	0.177	0.188
HCM Control Delay	9.3	9.1	9	9
HCM Lane LOS	A	A	A	A
HCM 95th-tile Q	0.8	0.9	0.6	0.7



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	4	89	101	7	21	9
Future Volume (vph)	4	89	101	7	21	9
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.991		0.959	
Flt Protected		0.998			0.966	
Satd. Flow (prot)	0	1859	1846	0	1726	0
Flt Permitted		0.998			0.966	
Satd. Flow (perm)	0	1859	1846	0	1726	0
Link Speed (k/h)		50	50		30	
Link Distance (m)		515.6	23.5		109.1	
Travel Time (s)		37.1	1.7		13.1	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	4	97	110	8	23	10
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	101	118	0	33	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		0.0	0.0		3.6	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		4.8	4.8		4.8	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25			15	25	15
Sign Control		Free	Free		Stop	

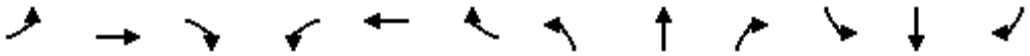
Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 17.9%		ICU Level of Service A	
Analysis Period (min) 15			



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	4	89	101	7	21	9
Future Volume (Veh/h)	4	89	101	7	21	9
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	4	97	110	8	23	10
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	118				219	114
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	118				219	114
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				97	99
cM capacity (veh/h)	1470				767	939

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	101	118	33
Volume Left	4	0	23
Volume Right	0	8	10
cSH	1470	1700	812
Volume to Capacity	0.00	0.07	0.04
Queue Length 95th (m)	0.1	0.0	1.0
Control Delay (s)	0.3	0.0	9.6
Lane LOS	A		A
Approach Delay (s)	0.3	0.0	9.6
Approach LOS			A

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	17.9%	ICU Level of Service	A
Analysis Period (min)	15		



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	31	115	120	28	119	14	80	165	31	18	140	25
Future Volume (vph)	31	115	120	28	119	14	80	165	31	18	140	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor												
Frt		0.939			0.988			0.985			0.982	
Flt Protected		0.994			0.991			0.986			0.995	
Satd. Flow (prot)	0	1739	0	0	1824	0	0	1809	0	0	1820	0
Flt Permitted		0.994			0.991			0.986			0.995	
Satd. Flow (perm)	0	1739	0	0	1824	0	0	1809	0	0	1820	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		415.4			513.9			455.7			424.1	
Travel Time (s)		29.9			37.0			32.8			30.5	
Confl. Peds. (#/hr)			1	1			2		2	2		2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	34	125	130	30	129	15	87	179	34	20	152	27
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	289	0	0	174	0	0	300	0	0	199	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Stop			Stop	

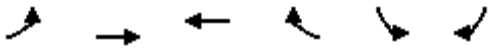
Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 53.5%		ICU Level of Service A	
Analysis Period (min) 15			

Intersection	
Intersection Delay, s/veh	12.4
Intersection LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	31	115	120	28	119	14	80	165	31	18	140	25
Future Vol, veh/h	31	115	120	28	119	14	80	165	31	18	140	25
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	34	125	130	30	129	15	87	179	34	20	152	27
Number of Lanes	0	1	0	0	1	0	0	1	0	0	1	0

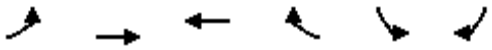
Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	1	1	1	1
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	1	1	1	1
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	1	1	1	1
HCM Control Delay	12.7	11.3	13.5	11.4
HCM LOS	B	B	B	B

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	29%	12%	17%	10%
Vol Thru, %	60%	43%	74%	77%
Vol Right, %	11%	45%	9%	14%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	276	266	161	183
LT Vol	80	31	28	18
Through Vol	165	115	119	140
RT Vol	31	120	14	25
Lane Flow Rate	300	289	175	199
Geometry Grp	1	1	1	1
Degree of Util (X)	0.466	0.436	0.284	0.316
Departure Headway (Hd)	5.588	5.425	5.849	5.716
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	642	659	611	625
Service Time	3.651	3.488	3.921	3.787
HCM Lane V/C Ratio	0.467	0.439	0.286	0.318
HCM Control Delay	13.5	12.7	11.3	11.4
HCM Lane LOS	B	B	B	B
HCM 95th-tile Q	2.5	2.2	1.2	1.4



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	15	139	145	19	15	6
Future Volume (vph)	15	139	145	19	15	6
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.984		0.959	
Flt Protected		0.995			0.966	
Satd. Flow (prot)	0	1853	1833	0	1726	0
Flt Permitted		0.995			0.966	
Satd. Flow (perm)	0	1853	1833	0	1726	0
Link Speed (k/h)		50	50		30	
Link Distance (m)		513.9	23.5		109.1	
Travel Time (s)		37.0	1.7		13.1	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	16	151	158	21	16	7
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	167	179	0	23	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		0.0	0.0		3.6	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		4.8	4.8		4.8	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25			15	25	15
Sign Control		Free	Free		Stop	

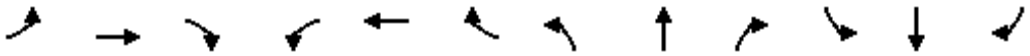
Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 29.8%		ICU Level of Service A	
Analysis Period (min) 15			



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	15	139	145	19	15	6
Future Volume (Veh/h)	15	139	145	19	15	6
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	16	151	158	21	16	7
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	179				352	168
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	179				352	168
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				97	99
cM capacity (veh/h)	1397				639	876

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	167	179	23
Volume Left	16	0	16
Volume Right	0	21	7
cSH	1397	1700	696
Volume to Capacity	0.01	0.11	0.03
Queue Length 95th (m)	0.3	0.0	0.8
Control Delay (s)	0.8	0.0	10.3
Lane LOS	A		B
Approach Delay (s)	0.8	0.0	10.3
Approach LOS			B

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	29.8%	ICU Level of Service	A
Analysis Period (min)	15		



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	23	86	77	25	92	14	43	105	18	6	116	18
Future Volume (vph)	23	86	77	25	92	14	43	105	18	6	116	18
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor												
Frt		0.944			0.986			0.985			0.982	
Flt Protected		0.994			0.991			0.987			0.998	
Satd. Flow (prot)	0	1748	0	0	1820	0	0	1811	0	0	1826	0
Flt Permitted		0.994			0.991			0.987			0.998	
Satd. Flow (perm)	0	1748	0	0	1820	0	0	1811	0	0	1826	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		415.4			515.6			455.7			424.1	
Travel Time (s)		29.9			37.1			32.8			30.5	
Confl. Peds. (#/hr)	2		1	1		2	1		1	1		1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	25	93	84	27	100	15	47	114	20	7	126	20
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	202	0	0	142	0	0	181	0	0	153	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Stop			Stop	

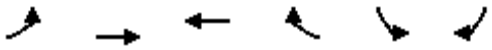
Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 39.5%		ICU Level of Service A	
Analysis Period (min) 15			

Intersection	
Intersection Delay, s/veh	9.5
Intersection LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	23	86	77	25	92	14	43	105	18	6	116	18
Future Vol, veh/h	23	86	77	25	92	14	43	105	18	6	116	18
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	25	93	84	27	100	15	47	114	20	7	126	20
Number of Lanes	0	1	0	0	1	0	0	1	0	0	1	0

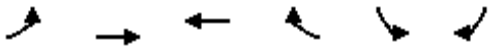
Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	1	1	1	1
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	1	1	1	1
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	1	1	1	1
HCM Control Delay	9.5	9.3	9.7	9.3
HCM LOS	A	A	A	A

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	26%	12%	19%	4%
Vol Thru, %	63%	46%	70%	83%
Vol Right, %	11%	41%	11%	13%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	166	186	131	140
LT Vol	43	23	25	6
Through Vol	105	86	92	116
RT Vol	18	77	14	18
Lane Flow Rate	180	202	142	152
Geometry Grp	1	1	1	1
Degree of Util (X)	0.248	0.265	0.197	0.208
Departure Headway (Hd)	4.942	4.712	4.978	4.926
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	720	756	715	721
Service Time	3.016	2.78	3.053	3.003
HCM Lane V/C Ratio	0.25	0.267	0.199	0.211
HCM Control Delay	9.7	9.5	9.3	9.3
HCM Lane LOS	A	A	A	A
HCM 95th-tile Q	1	1.1	0.7	0.8



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	4	89	101	7	21	9
Future Volume (vph)	4	89	101	7	21	9
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.991		0.959	
Flt Protected		0.998			0.966	
Satd. Flow (prot)	0	1859	1846	0	1726	0
Flt Permitted		0.998			0.966	
Satd. Flow (perm)	0	1859	1846	0	1726	0
Link Speed (k/h)		50	50		30	
Link Distance (m)		515.6	23.5		109.1	
Travel Time (s)		37.1	1.7		13.1	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	4	97	110	8	23	10
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	101	118	0	33	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		0.0	0.0		3.6	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		4.8	4.8		4.8	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25			15	25	15
Sign Control		Free	Free		Stop	

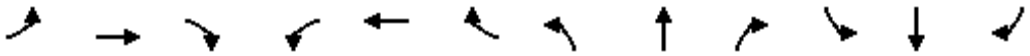
Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 17.9%		ICU Level of Service A	
Analysis Period (min) 15			



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	4	89	101	7	21	9
Future Volume (Veh/h)	4	89	101	7	21	9
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	4	97	110	8	23	10
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	118				219	114
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	118				219	114
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				97	99
cM capacity (veh/h)	1470				767	939

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	101	118	33
Volume Left	4	0	23
Volume Right	0	8	10
cSH	1470	1700	812
Volume to Capacity	0.00	0.07	0.04
Queue Length 95th (m)	0.1	0.0	1.0
Control Delay (s)	0.3	0.0	9.6
Lane LOS	A		A
Approach Delay (s)	0.3	0.0	9.6
Approach LOS			A

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	17.9%	ICU Level of Service	A
Analysis Period (min)	15		



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	34	126	133	31	132	15	88	182	34	19	154	27
Future Volume (vph)	34	126	133	31	132	15	88	182	34	19	154	27
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor												
Frt		0.939			0.989			0.985			0.982	
Flt Protected		0.994			0.991			0.986			0.995	
Satd. Flow (prot)	0	1739	0	0	1826	0	0	1809	0	0	1820	0
Flt Permitted		0.994			0.991			0.986			0.995	
Satd. Flow (perm)	0	1739	0	0	1826	0	0	1809	0	0	1820	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		415.4			513.9			455.7			424.1	
Travel Time (s)		29.9			37.0			32.8			30.5	
Confl. Peds. (#/hr)			1	1			2		2	2		2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	37	137	145	34	143	16	96	198	37	21	167	29
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	319	0	0	193	0	0	331	0	0	217	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Stop			Stop	

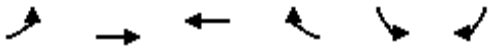
Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 57.7%		ICU Level of Service B	
Analysis Period (min) 15			

Intersection	
Intersection Delay, s/veh	14.3
Intersection LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	34	126	133	31	132	15	88	182	34	19	154	27
Future Vol, veh/h	34	126	133	31	132	15	88	182	34	19	154	27
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	37	137	145	34	143	16	96	198	37	21	167	29
Number of Lanes	0	1	0	0	1	0	0	1	0	0	1	0

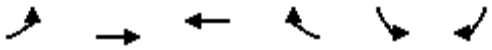
Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	1	1	1	1
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	1	1	1	1
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	1	1	1	1
HCM Control Delay	14.8	12.5	15.9	12.7
HCM LOS	B	B	C	B

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	29%	12%	17%	10%
Vol Thru, %	60%	43%	74%	77%
Vol Right, %	11%	45%	8%	14%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	304	293	178	200
LT Vol	88	34	31	19
Through Vol	182	126	132	154
RT Vol	34	133	15	27
Lane Flow Rate	330	318	193	217
Geometry Grp	1	1	1	1
Degree of Util (X)	0.546	0.513	0.336	0.369
Departure Headway (Hd)	5.953	5.794	6.255	6.114
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	608	624	575	587
Service Time	3.975	3.814	4.304	4.164
HCM Lane V/C Ratio	0.543	0.51	0.336	0.37
HCM Control Delay	15.9	14.8	12.5	12.7
HCM Lane LOS	C	B	B	B
HCM 95th-tile Q	3.3	2.9	1.5	1.7



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	15	139	145	19	15	6
Future Volume (vph)	15	139	145	19	15	6
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.984		0.959	
Flt Protected		0.995			0.966	
Satd. Flow (prot)	0	1853	1833	0	1726	0
Flt Permitted		0.995			0.966	
Satd. Flow (perm)	0	1853	1833	0	1726	0
Link Speed (k/h)		50	50		30	
Link Distance (m)		513.9	23.5		109.1	
Travel Time (s)		37.0	1.7		13.1	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	16	151	158	21	16	7
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	167	179	0	23	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		0.0	0.0		3.6	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		4.8	4.8		4.8	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25			15	25	15
Sign Control		Free	Free		Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 29.8%		ICU Level of Service A	
Analysis Period (min) 15			



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	15	139	145	19	15	6
Future Volume (Veh/h)	15	139	145	19	15	6
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	16	151	158	21	16	7
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	179				352	168
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	179				352	168
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				97	99
cM capacity (veh/h)	1397				639	876

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	167	179	23
Volume Left	16	0	16
Volume Right	0	21	7
cSH	1397	1700	696
Volume to Capacity	0.01	0.11	0.03
Queue Length 95th (m)	0.3	0.0	0.8
Control Delay (s)	0.8	0.0	10.3
Lane LOS	A		B
Approach Delay (s)	0.8	0.0	10.3
Approach LOS			B

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	29.8%	ICU Level of Service	A
Analysis Period (min)	15		

APPENDIX F

TTS Data

Wed Aug 16 2023 22:26:10 GMT-0400 (Eastern Daylight Time) - Run Time: 2393ms

Cross Tabulation Query Form - Trip - 2016 v1.1

Row: 2006 GTA zone of origin - gta06_orig
Column: 2006 GTA zone of destination - gta06_dest

Filters:
2006 GTA zone of destination - gta06_dest In 8303
and
Start time of trip - start_time In 0630-0930
and
Trip purpose of destination - purp_dest In H

Trip 2016
Table:

	8303
8057	15
8171	24
8195	24

Wed Aug 16 2023 22:42:01 GMT-0400 (Eastern Daylight Time) - Run Time: 2432ms

Cross Tabulation Query Form - Trip - 2016 v1.1

Row: 2006 GTA zone of destination - gta06_dest
Column: 2006 GTA zone of origin - gta06_orig

Filters:
2006 GTA zone of origin - gta06_orig In 8303
and
Start time of trip - start_time In 0630-0930
and
Trip purpose of origin - purp_orig In H

Trip 2016
Table:

	8303
52	12
3357	36
4126	13
7016	24
8035	12
8057	36
8086	24
8091	12
8092	22
8107	36
8151	12
8165	30
8195	24
8199	49

Wed Aug 16 2023 22:56:15 GMT-0400 (Eastern Daylight Time) - Run Time: 2512ms

Cross Tabulation Query Form - Trip - 2016 v1.1

Row: 2006 GTA zone of origin - gta06_orig
Column: 2006 GTA zone of destination - gta06_dest

Filters:
2006 GTA zone of destination - gta06_dest In 8303
and
Start time of trip - start_time In 1530-1830
and
Trip purpose of destination - purp_dest In H

Trip 2016
Table:

	8303
52	12
3357	36
4143	24
7016	24
8029	36
8035	12
8048	21
8057	36
8086	24
8107	36
8165	30
8195	24
8307	15

Wed Aug 16 2023 23:15:50 GMT-0400 (Eastern Daylight Time) - Run Time: 2427ms

Cross Tabulation Query Form - Trip - 2016 v1.1

Row: 2006 GTA zone of destination - gta06_dest
Column: 2006 GTA zone of origin - gta06_orig

Filters:
2006 GTA zone of origin - gta06_orig In 8303
and
Start time of trip - start_time In 1530-1830
and
Trip purpose of origin - purp_orig In H

Trip 2016
Table:

	8303
8029	36
8048	21
8057	15
8082	72
8169	12
8195	24

FUNCTIONAL SERVICING AND STORMWATER MANAGEMENT REPORT

ARKELL SUBDIVISION RESIDENTIAL DEVELOPMENT

TOWNSHIP OF PUSLINCH

PREPARED FOR:

TIMBERWORX CUSTOM HOMES, SLOOT CONSTRUCTION, JOHN SLOOT INVESTMENTS

PREPARED BY:

C.F. CROZIER & ASSOCIATES INC.
55 WYNDHAM STREET NORTH, SUITE 215
GUELPH, ON N1H 7T8

MARCH 2024

CFCA FILE NO. 2433-6646

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CROZIER

Revision Number	Date	Comments
Rev. 0	March 2024	Issued for First Submission (ZBA)

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Figure 2: Pre-development Drainage Plan
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1.0 Introduction

C.F. Crozier & Associates Inc. (Crozier) was retained by Timberworx Custom Homes, Sloot Construction, and John Sloot Investments (Owners) to prepare a Functional Servicing and Stormwater Management Report in support of the Zoning By-Law Amendment Application for the residential development located at lots 7, 8, 9, Concession 10, Township of Puslinch, County of Wellington (Site; see Figure 1). The purpose of this report is to demonstrate that the proposed development is feasible from a functional servicing and stormwater management perspective and conforms with the requirements of the Township of Puslinch (Township), Wellington County (County), and the Grand River Conservation Authority (GRCA).

The relevant background studies and reports include:

- Township of Puslinch Municipal Development Standards (September 2019)
- Hydrogeological and Predictive Nitrate Assessment prepared by R.J. Burnside & Associates Ltd. (July 2006)
- Preliminary Stormwater Management Report prepared by Richardson Foster Ltd. (August 2006)
- Groundwater Supply Assessment prepared by ARL Groundwater Resources Ltd. (March 2023)
- 1669 tp Logs – Arkell prepared by Chung & Vander Doelen Engineering Ltd (December 2023)
- The Ontario Building Code (OBC) (2012)
- Ministry of Transportation Drainage Management Manual (1997)
- Ministry of Environment Stormwater Management Planning and Design Manual (March 2003)
- Golden Horseshoe CA Erosion and Sediment Control Guideline for Urban Construction (2006)
- TRCA/CVC Low Impact Development Stormwater Management Planning and Design Guide (2010)

This report has been prepared to support the first submission of the Zoning By-Law Amendment Application for the proposed residential development.

2.0 Site Description

The Site encompasses an area of 20.45 ha with a developable area of approximately 17.45 ha. The Site currently consists of a single detached dwelling, garage, existing woodlot, and agricultural fields. The Site is bounded by agricultural fields to the north, Arkell Road to the West, Guelph Junction Railway (GJR) to the East, Watson Road, and existing detached homes to the South.

According to the Conceptual Plan prepared by Stovel and Associates Inc. (February 6, 2024) included in Appendix A, it is understood that the Site will consist of the following elements:

- Fifty (50) residential lots with associated onsite sewage systems and private wells.
- One (1) stormwater management facility for flood control.
- One (1) bioswale to act as a bypass for drainage external to the Site and one (1) bioswale to act infiltrate and convey stormwater during minor and major storm events.
- Three (3.00) hectares of land to remain undeveloped.
- An access road connecting to Watson Road in the southwest and a secondary access road connecting to Arkell Road in the northwest.

3.0 Soil and Groundwater Conditions

Chung & Vander Doelen Engineering Limited (CVD) was retained by the Owners to excavate test pits across the property. Ten (10) test pits were excavated in December 2023 to depths of up to 6.10 m below ground surface (mbgs). According to CVD's test pit logs, subsurface conditions generally consisted of 250 to 450 mm of topsoil underlain by a thin layer of silt to silty sand and gravel followed by sand and gravel with trace silt to the maximum depth of investigation (6.10 mbgs). All test pits were dry at completion.

The sand and gravel is expected to be the receiving soil for the onsite sewage systems. Based on the grain size analysis of the sand and gravel, this material is classified a GP soil per the Unified Soil Classification System (USCS). According to Supplementary Standard SB-6 of the OBC, GP soils are described as poorly graded gravels and gravel-sand mixtures with little to no fines with a percolation rate of less than 1 min/cm. A conservative percolation rate of 15 min/cm was assigned for the onsite sewage system design.

In 2006, R.J. Burnside & Associates Limited (R.J. Burnside) completed a hydrogeological assessment on the property. As part of this assessment, ten (10) boreholes were advanced, two (2) of which were installed as groundwater monitoring wells. The stratigraphy encountered was similar to CVD's observations during the 2023 test pitting program, which was described as a later of topsoil (200 to 400 mm thick, or up to 1.5 mbgs in some locations), underlain by sandy gravel or sand and gravel. Groundwater was encountered between 7.43 and 10.37 mbgs, or 333.02 to 334.53 masl in January 2006. Refer to the Hydrogeological and Predictive Nitrate Assessment (R.J. Burnside, 2006) for additional details.

4.0 Water Servicing

4.1 Existing Water Servicing

There are no municipal water services available in the vicinity of the Site. Surrounding properties are serviced by private water supply wells.

4.2 Proposed Water Servicing

Each lot will be serviced an individual water supply well. A groundwater supply assessment was completed by ARL Groundwater Resources Ltd. (ARL) to assess the suitability of servicing each lot by a water supply well and to meet the requirements of MECP Guideline D-5-5 (provided under separate cover). ARL concluded that the Gasport formation aquifer can support the water quantity requirements for the development. Refer to the Groundwater Supply Assessment Report (ARL, 2003) for additional details.

Conceptual well locations have been included on the Onsite Sewage Servicing Schematic (Drawing C102). However, the depth, size, and location of the wells will be determined during detailed design of each individual lot.

Required fire flow calculations will be completed following zoning approvals. However, preliminary calculations were completed to estimate the required fire storage volume for the proposed development. The fire storage volume was calculated using the Ontario Fire Marshalls Fire Protection Water Supply Guideline (1999), as required in the OBC.

The fire storage volume was calculated assuming a house footprint of 240 m^2 and a height of 6 m, Group C (residential) occupancy. Table 1 summarizes the preliminary fire storage volumes calculated for the proposed development.

Table 1: Fire Storage Volume Requirements

Lot	**Total Area** (m^2)	**Height** (m)	**Volume** (m^3)	**K**[1]	**S_{side}**[2]	**Required Fire Storage Volume, Q** (L)
35	240	6	1440	23	1.4	81,000

1. K values represent the water supply coefficient based upon building occupancy.
2. S_{side} values determined from distance to other structures using Figure 1 in Section A-3.2.5.7 of the OBC.

A storage volume of 81,000L is the required minimum fire storage volume that must be supplied at a rate of 45 L/s for a duration of 0.5 hour. The fire flows determined from the OBC fire flow method is a conservative estimate and is for comparison purposes.

5.0 Sanitary Servicing

There are no municipal sanitary services available in the vicinity of the Site. Surrounding properties are privately serviced via onsite sewage systems. Therefore, each lot within the proposed development will be serviced by individual onsite sewage systems.

5.1 Sanitary Design Calculations

The proposed development will consist of fifty (50) residential lots with private servicing. It is Crozier's understanding that the proposed residential dwellings will be three (3) to four (4) bedrooms with the possibility of two (2) bedrooms in the basement. For the purposes of this assessment, preliminary sewage system design flows were calculated for a six (6) bedroom dwelling with 240m² of finished floor area, four (4) bathroom groups, two (2) powder rooms, two (2) basement rough-ins and additional fixtures for a total of 62 fixture units.

The preliminary sewage system design flows were calculated in accordance with OBC, Part 8 and are presented below in the Table 2.

Table 2: Preliminary Sewage System Daily Design Flows

Unit Type	Number of Bedrooms	Floor Area (m²)	Number of Fixture Units	Base Flow (L/day)	Additional Flow – Floor Area (L/day)	Additional Flow – Fixture Units (L/day)	Total Flow Per Unit (L/day)
240 m² Residential Dwelling	6	240	62	2,500	400	2,075	4,575

As shown, the preliminary sewage system design flows are 4,575 L/day per lot. These flows were calculated based on the information provided at the time of this report. If details of the proposed dwellings change (e.g., number of bedrooms, fixtures, and floor area) during detailed design, the sewage system design flows may change, which may affect the size of the onsite sewage systems and the serviceability of the development.

Properties with a total daily design sanitary sewage flow exceeding 10,000 L/day are subject to Section 53 of the Ontario Water Resources Act and require an Environmental Compliance Approval (ECA) issued by the Ministry of Environment, Conservation and Parks (MECP). Given the preliminary sewage system design flow is less than 10,000 L/day per individual lot, an ECA is not required. Building permits will be required for each sewage system prior to construction.

5.2 Proposed Sanitary Servicing

Sanitary servicing for the proposed development will be provided through individual Class 4 onsite sewage systems. The onsite sewage system will consist of an advanced treatment unit discharging to a leaching bed constructed as a Type A dispersal bed.

5.3 Proposed Sewage System

Crozier prepared nitrate loading calculations to determine the effluent concentration of nitrate-nitrogen each sewage system must achieve for the proposed development to meet MECP Guideline D-5-4 and are provided under separate cover. At least a 50% reduction of nitrate-nitrogen (effluent concentration of 20 mg/L) is required to meet 10 mg/L of nitrate-nitrogen at the downgradient property boundary. A typical conventional onsite sewage system produces an

effluent concentration of nitrate-nitrogen of approximately 40 mg/L. This is insufficient to meet D-5-4 requirements, therefore, advanced treatment with denitrification will be required.

The proposed sewage system will consist of a Level IV treatment unit meeting the CAN/BNQ 3680-600 standard with 50% nitrate-nitrogen reduction, discharging treated effluent to a Type A dispersal bed. A Waterloo Biofilter system (or equivalent) with recirculation is proposed. Sewage will flow from the dwelling to a Waterloo Biofilter anaerobic digester tank. Effluent from the digester tank is pumped to the Waterloo Biofilter basket tank, which is equipped with a patented foam media that effectively treats wastewater prior to discharge to the leaching bed. A portion of the treated effluent is recirculated to the anaerobic digester, effecting 50% nitrate-nitrogen reduction.

Treated effluent from the Waterloo Biofilter will be discharged to a Type A dispersal bed sized in accordance with Section 8.7.7. of the OBC. The Type A dispersal bed consists of a stone layer equipped with perforated distribution pipe, underlain by a sand layer. Table 3 below summarizes the preliminary sizing of the Type A Dispersal Bed.

Table 3: Preliminary Type A Dispersal Bed Sizing

Unit Type	**Total Flow Per Unit** (L/day)	**Minimum Stone Area** (m^2)	**Provided Stone Area** (m^2)	**Minimum Sand Area** (m^2)	**Provided Sand Area** (m^2)
240 m^2 Residential Dwelling	4,575	91.5	104	80.74	104

The Onsite Sewage Servicing Schematic (Drawing C102) illustrates the proposed onsite sewage servicing for the proposed development. The conceptual figure illustrates a Waterloo Biofilter configuration; however, it is noted that any treatment unit meeting CAN/BNQ certification requirements with 50% nitrate-nitrogen removal may be considered. The details, size, and location of the onsite sewage systems will be determined once individual home designs and building permit applications are prepared.

6.0 Drainage Conditions

The drainage conditions for the Site in both pre-development and post-development conditions are outlined in the following sections.

6.1 Existing Drainage Conditions

The Site currently consists of an existing detached residential dwelling and accessory buildings, vacant grassed agricultural fields, and forested areas. The Site generally slopes from south to north and drains from Guelph Junction Railway (GJR) towards Arkell Road and ultimately outlets to a culvert on Arkell Road. Downstream of Arkell Road lands drain to the Eramosa River.

As discussed, in Section 3, test pits have been completed by CVD site suggesting that native soils are very coarse, and groundwater elevations are well below anticipated basement levels. These preliminary findings are consistent with other building sites in the area.

Additional monitoring is required but initial indications are that soil conditions are conducive to the type of development proposed and that infiltration measures should be considered as part of the stormwater management strategy.

Under pre-development conditions drainage has been split into seven (7) catchments as shown on the Pre-development Drainage Plan (Figure 2).

Most of the runoff is external to the site and enters the site from the lands north and south of the GJR. The external drainage primarily consists of agricultural fields and woodlot. Catchment Ext. 1 located north of the railroad is known as Starky Hill Conservation Area. Runoff from Starkey Hill concentrates at the toe of the embankment adjacent to GJR. This runoff continues to drain overland across the subject property before reaching the outlet at Arkell Road. Catchment Ext. 2 located south of the railroad consists of woodlot and agricultural fields. The drainage flows from the southeast to the northwest before entering the rectangular culvert situated underneath the railroad to the south of the property. Catchment Ext. 2 much like catchment Ext. 1 continues to drain overland across the subject property before reaching the culvert at Arkell Road.

The catchments internal to the site include 100, 101, 102, 103 & 104 consists of residential dwellings, grassed agricultural lands, and woodlot. The catchments listed above drain overland from south to north of the property before reaching the outlet at Arkell Road.

Table 4 describes the pre-development catchment areas and land-use as illustrated in Figure 2.

Table 4: Pre-Development Hydrologic Parameters

Catchment ID	**Land-Use Description**	**Impervious Area** (ha)	**Pervious Area** (ha)	**Percent Impervious** (%)	**Outlet**
Ext. 1	Conservation lands and residential	0.03	24.37	0.1	300 mm dia. Culvert on Arkell Road
Ext. 2	Woodlot, agriculture, and residential	1.43	19.21	6.9	
100	Vacant grassed agricultural fields, residential, grassed lands	1.02	6.72	13.2	
101	Vacant grassed agricultural fields	0.00	4.63	0.0	
102	Grassed lands and woodlot	0.00	0.79	0.0	
103	Woodlot and vacant agricultural fields	0.11	11.62	1.0	
104	Grassed lands and residential	0.11	0.70	13.7	
Total Area (ha) = 70.74		**2.70**	**68.04**	**3.8**	

Considering the size of the study area (70.74 ha), a preliminary hydrologic model was prepared to determine the peak flows from each catchment and establish a target release rate to govern the site following development. The peak flow rates for the 2 through to 100-year storm events under pre-development conditions can be seen in Table 5 below.

Table 5: Pre-Development Peak Flows

Catchment ID	Outlet	Peak Flow Rates (L/s)					
		2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Ext. 1	Arkell Road (Culvert)	35.4	86.2	133.9	209.8	280.3	360.1
Ext. 2	Arkell Road (Culvert)	90.5	214.3	328.5	499.2	655.3	828.3
100	Arkell Road (Culvert)	24.1	54.2	81.6	123.3	161.3	203.8
101	Arkell Road (Culvert)	10.5	23.8	36.0	54.7	72.1	91.6
102	Arkell Road (Culvert)	2.4	5.9	9.4	14.6	19.6	25.2
103	Arkell Road (Culvert)	18.6	44.8	69.3	108.1	144.0	184.7
104	Arkell Road (Culvert)	5.2	11.6	17.7	26.3	34.4	43.5

The target pre-development flow for the development is the sum of the peak flows of the Catchments 101 & 103. The remainder of the catchments are predominantly external to the subject property and runoff generated from these catchments will be conveyed towards the outlet culvert on Arkell Road via a separate bypass swale system. The target release rates for the development are summarized in Table 6 below.

Table 6: Target Release Rates

Catchment ID	Outlet	Target Flow Rates (L/s)					
		2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
101 and 103	Arkell Road (Culvert)	28.7	67.6	104.0	160.9	213.7	273.3

6.2 Proposed Drainage Conditions

Based on the Conceptual Plan prepared by Stovel and Associates Inc, dated February 6, 2024, the proposed development will consist of fifty (50) single detached residential lots, paved internal roadways (Road A, B, C & D), a stormwater management facility, and 3 hectares (ha) of undeveloped land. Access to the site will be provided from the proposed entrances on Arkell Road and Watson Road South.

6.2.1 Post-development Drainage Catchment Areas

The proposed Site grading divides the Site into six (6) drainage catchment areas and two (2) external drainage areas to the north and south of GJR which are unaffected by the proposed development. All drainage culminates at the same outlet (Arkell Road). Referring to the Post-Development Drainage Plan (Figure 3), the catchment areas are described as follows:

- Catchment Ext. 1(A = 24.40) consists of drainage from Starky Hill conservation lands and woodlots. Runoff generated within this catchment is directed to the north of GJR where it concentrates at the toe of railroad embankment and continues south before entering the subject property where it will be collected by a bypass swale. The swale will direct the flow northwest before reaching the northern perimeter of the subject property and the culvert on Arkell Road.

- Catchment Ext. 2 (A = 20.64) consists of drainage from the existing cultivated lands and woodlot. Runoff drains to the south of the GJR draining before passing through the rectangular culvert crossing underneath GJR and then being picked up by the bypass swale. The flow follows the swale along the western property line flowing from south to north before reaching the outlet culvert on Arkell Road.

- Catchment 201 (A = 13.61) consists of drainage from proposed residential lots and internal roads (roads A, B, C, D). Runoff from the residential lots and internal roadways are conveyed to storm sewers before being directed to the northeastern bioswale.

- Catchment 202 (A = 6.20) consists of drainage form existing residential lots and Watson Road South. All the runoff generated in this catchment will be conveyed into the bioswale along the southwest property line before reaching the outlet culvert located at Arkell Road.

- Catchment 203 (A = 0.39) consists of drainage from the existing woodlot that sits within lot number nine. Runoff generated in this catchment drains north to south before concentrating at the toe of the railroad embankment before being intercepted by the proposed bioswale.

- Catchment 204 (A = 2.66) consists of drainage from the rear yards of proposed residential lots number 10 through to 24. As well as a portion of the stormwater management facility (SWMF) and the northeast portion of the undeveloped lands adjacent to Arkell Road. Runoff generated within this catchment is conveyed to the bioswale along the northwestern property line before reaching the culvert located at Arkell Road.

- Catchment 205 (A = 0.75) consists of drainage from undeveloped land and neighbouring residential dwelling. Runoff within the catchment will drain overland uncontrolled before reaching the outlet culvert located at Arkell Road.

- Catchment 206 (A = 2.11) consists of drainage from the existing woodlot and proposed residential lots. Runoff generated in this catchment will concentrate at the toe of the railroad embankment before being intercepted by the proposed bioswale that safely conveys it towards the outlet.

The post-development catchments land use description and respective percent imperviousness are shown in Table 7 below.

Table 7: Post-Development Hydrologic Parameters

Catchment ID	**Description**	**Impervious Area** (ha)	**Pervious Area** (ha)	**Percent Impervious** (%)	**Outlet**
1	Conservation lands and existing residential	0.03	24.37	0.1	300 mm dia. Culvert on Arkell Road
2	Woodlot, agriculture, and existing residential	1.43	19.21	6.9	
201	Internal roadway, residential, SWMF, and undeveloped land	4.82	8.79	35.4	
202	Existing residential dwelling and Watson Road South	1.19	5.01	19.2	
203	Existing woodlot	0.05	0.34	12.8	
204	Swale bypass, rear yards of residential lots, SWMF, and undeveloped lands	0.75	1.91	28.2	
205	Undeveloped land and neighbouring residential dwelling	0.11	0.64	14.9	
206	Residential and existing woodlot	0.08	2.03	3.8	
Total Area (ha) = 70.76		**8.46**	**62.30**	**12.0**	

Drainage from Catchments Ext. 1, Ext. 2, 202, 203, 205 and 206 will discharge to the bypass swale in the southwest before leaving the site via the outlet culvert at Arkell Road. Any minor land use changes within these catchments will be naturally attenuated and mitigated in the long bypass swale (approximately 830 m long) which exhibits excellent infiltration capacity.

Finally, drainage from Catchments 201 and 204 will be controlled via a storm sewer network, swale system with a series of control weirs, and a stormwater management facility (SWMF) in the form of a dry pond. The post-development peak flows from Catchments 201 and 204 will be controlled to pre-development peak flows or less. Uncontrolled post-development peak flows for the 2 through to the 100-year peak flows are summarized in Table 8 below.

Table 8: Post-Development Peak Flows (Unmitigated)

Catchment ID	Outlet	Peak Flow Rates (L/s)					
		2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Ext. 1	Arkell Road (Culvert)	40.5	100.8	157.7	247.4	331.5	426.7
Ext. 2	Arkell Road (Culvert)	90.5	214.3	328.5	499.2	655.3	828.3
201	Arkell Road (Culvert)	693.3	979.8	1224.9	1453.4	1674.0	1898.5
202	Arkell Road (Culvert)	25.0	57.1	86.2	130.2	170.5	215.5
203	Arkell Road (Culvert)	2.7	6.4	9.9	14.8	19.4	24.6
204	Arkell Road (Culvert)	70.1	97.9	122.3	145.4	169.0	193.6
205	Arkell Road (Culvert)	5.1	11.6	17.7	26.2	34.3	43.2
206	Arkell Road (Culvert)	7.2	18.1	28.6	44.2	59.0	75.6

7.0 Stormwater Management

Stormwater management and Site drainage for the proposed development must adhere to the policies and standards of the Township of Puslinch, Grand River Conservation Authority (GRCA), and Ministry of Environment and Climate Change (MECP, formerly MOE). It is important to note that efforts have been made to preserve and maintain the rural character of the property and passive stormwater management practices have been incorporated throughout the design.

The stormwater management criteria for the development is summarized below:

Water Quality Control

The Puslinch Municipal Development requires as a minimum the "Enhanced" level of protection (I.e. 80% TSS removal) as described in the Ministry of Environment Stormwater Management Planning and Design Manual (2003).

Water Balance

According to the Puslinch Municipal Development Standards an annual water budget shall be prepared for the development site as described in the MOE SWMPD Manual (March 2003).

Low impact development best management practices shall be designed in accordance with the MOE SWMPD Manual, and the TRCA/CVC Low Impact Development Stormwater Management Planning and Design Guide (2010).

Erosion Control

According to the Puslinch Municipal Development Standards an Erosion and Sediment Control Plan will be provided, showing sediment and erosion control measures proposed to mitigate the effect of the construction on surrounding areas and infrastructure.

Water Quantity Control

According to the Township of Puslinch Municipal Development Standards Manual (2019), water quantity controls are required for the Site. The water quantity requirements include controlling the post-development peak flow event to the pre-development peak flow event for design storms up to and including the 100-year event.

Upon development, all runoff generated within the internal roadway or runoff that mixes with the roadway runoff will be conveyed to proposed bioswales and a dry pond for quantity and quality control. The bioswales have been designed based on a hydraulic conductivity of 255 mm/hr for hydrologic soil group A (low runoff potential), which was derived from: Table 9.6; Hydrology of Floods in Canada: A Guide to Planning and Design (National Research Council of Canada, 1989).

7.1 Stormwater Quality Control

Stormwater quality controls for the proposed development will be achieved by retaining, treating, and infiltrating runoff in a treatment train, consisting of a bioswale system and a dry pond. Runoff from the proposed development will be conveyed through the internal road network before entering the storm sewer that discharges to both the bioswale and dry pond. Runoff from the remainder of the site consists of natural heritage and landscaped areas and is therefore not subject to water quality treatment requirements.

The bioswale system treating runoff from the proposed development was sized to maximize the storage provided for quantity control while facilitating infiltration in the swale.

Table 9 summarizes the water quality storage required for enhanced 80% long term suspended solids removal and the provided water quality storage in the proposed bioswale system.

Table 9: Provided Water Quality Storage to Achieve Enhanced Water Quality Protection

Catchment	25 mm Runoff Required Treatment Volume (m^3)	MOE Table 3.2 Enhanced Water Quality Storage Requirements (m^3)	Total Provided Treatment Volume (m^3)
201 & 204	1140	407	610

At a minimum, a total of 1140 m^3 of runoff is required to be treated and infiltrated to remove 80% of TSS and achieve "Enhanced Protection". The proposed bioswale system falls short of this requirement and the outstanding treatment capacity will be provided downstream of the bioswale system in the form of a dry pond.

The bioswale system accepts runoff from the internal storm sewer network. To optimize the amount of runoff infiltrating into the water table, runoff is retained behind weir structures (0.7 m tall) and spaced at varying intervals that are dictated based on the existing slope/gradient. The ponded runoff behind the control weirs will infiltrate into the water table in accordance with the CVC/TRCA Low Impact Development SWM Planning Design Guide (Version 1.0, 2010).

The bioswale system treatment capacity is governed by the surface ponding volume within the various control weirs. Further calculations and details regarding the control weirs will be provided at a later submission date.

7.2 Water Balance

Water balance and erosion control measures will be designed to satisfy all relevant criteria and constraints. The above will be demonstrated and discussed in detail in a later submission.

7.3 Stormwater Quantity Controls

Governing Design Storm – 3-hour Chicago

The 3-hour Chicago design storm was assessed to determine quantity control requirements per Puslinch Municipal Development Standards. The quantity control storage volume provided includes both the proposed bioswale system and the dry pond.

The required preliminary storage volumes and uncontrolled peak flow rates are presented in Table 10.

Table 10: Preliminary Storage Volume Requirements (3-hour Chicago)

Storm	Pre-Dev. Uncontrolled Peak Flow Rate[1] (L/s)	Post-Dev. Uncontrolled Peak Flow Rate[2] (L/s)	Total Preliminary Storage Volume Required (m^3)
2-year 3-hour Chicago	28.7	763.3	1256.2
5-year 3-hour Chicago	67.6	1077.3	1825.0
10-year 3-hour Chicago	104.0	1346.6	2202.1
25-year 3-hour Chicago	160.9	1598.2	2719.2
50-year 3-hour Chicago	213.7	1842.8	3154.9
100-year 3-hour Chicago	273.3	2092.1	3630.0

1. Includes runoff directed to outlet culvert located at Arkell Road (Catchments 101 and 103).
2. Includes runoff directed to outlet culvert located at Arkell Road (Catchments 201 and 204).

The maximum storage required for the 3-hour Chicago storm distribution is 3630 m^3 during the 100-year storm event and the quantity control will be provided for the required storage volume using both the bioswale system and the dry pond.

8.0 Erosion and Sediment Controls During Construction

Erosion and sediment controls will be implemented prior to the commencement of any site servicing works for the development and will be maintained throughout construction until the Site is stabilized or as directed by the Site Engineer and/or Township of Puslinch.

Controls will be inspected after each significant rainfall event and maintained in proper working condition. A Preliminary Erosion and Sediment Control Plan outlining the site-specific erosion and sediment controls will be provided to applicable review agencies for subsequent submissions. This plan will include silt fencing, a mud mat, and more robust measures, such as check dams, in areas of concentrated flow.

Further details on the erosion and control measures to be included have been summarized below:

Sediment Control Silt Fence

Sediment Control Silt Fence will be installed on the perimeter of the Site where sheet flow can be identified. Additional Sediment Control Silt Fence may be added based on field decisions by the Site Engineer and Owner prior to, during, and following construction.

Mud Mat

A rock mud mat will be installed at the entrance to the Site off Watson Road South. The rock mud mat will help to prevent mud tracking. The primary construction entrance will have to be verified prior to construction commencing.

Rock Check Dams

Rock check dams installed according to OPSD 219.210 should be installed in the proposed swale to protect from erosion conveyance during construction.

9.0 Conclusions & Recommendations

This report was prepared in support of the Zoning By-Law Amendment Application for the property located at lots 7, 8, 9, Concession 10, Township of Puslinch, County of Wellington. The proposed development can be serviced for water, sanitary, and stormwater management in accordance with the Township of Puslinch, Wellington County, and the Grand River Conservation Authority requirements and standards. Our conclusions and recommendations include:

Proposed Water and Sanitary Servicing

1. Municipal servicing infrastructure is not available in the vicinity of the site, and therefore the proposed development will be serviced by individual onsite sewage systems and water supply wells.

2. The preliminary sewage system design flows are expected to be approximately 4,575 L/d for each lot. Given the preliminary sewage system design flow is less than 10,000 L/day per individual lot, an ECA issued by the MECP will not be required. Each onsite sewage system will consist of an advanced treatment unit discharging to a leaching bed constructed as a Type A dispersal bed with a footprint of approximately 368 m^2. The advanced treatment system will consist of a Level IV treatment unit meeting the CAN/BNQ 3680-600 standard and must achieve the denitrification requirement of at least 50% nitrate-nitrogen reduction to meet MECP Guideline D-5-4.

3. Individual lots will be serviced with private drilled wells in accordance with O. Reg. 903 for potable water supply.

Stormwater Management

1. A passive stormwater management approach is proposed to preserve and maintain the rural character of the property using bioswale systems.

2. Water quality controls, erosion protection, and water balance for the proposed development will be provided by roadside bioswale systems. The bioswale system and dry pond treatment train will provide water quality treatment that exceeds the "Enhanced Protection" criteria by retaining, treating, and infiltrating runoff volume equal to, or greater than, the runoff volume generated during a 25 mm rainfall event. The water quality storage provided in the bioswale system and dry pond provides active storage to simultaneously provide the necessary quantity controls for the Site.

3. No additional water quantity storage is required beyond what is provided in the bioswale system and dry pond. The post-development peak flows are less than pre-development peak flows at outlet culvert located at Arkell Road for the 2-year to 100-year design storm events.

4. Runoff generated from catchments Ext. 1, Ext. 2, 202, 203, 205, and 206 will drain uncontrolled overland before being intercepted by the proposed conveyance swale that safely directs in towards the outlet culvert located at Arkell Road. This flow routing will maintain the existing drainage conditions of the subject property.

5. Water balance and erosion control measures will be designed to satisfy all relevant criteria and constraints. The above will be demonstrated and discussed in detail in a later submission.

Based on the above conclusions, we recommend the approval of the Zoning By-Law Amendment Application from the perspective of functional servicing and stormwater management.

Respectfully submitted,

C.F. CROZIER & ASSOCIATES INC.

[redacted]

Aidan Offley
Engineering Intern, Land Development

C.F. CROZIER & ASSOCIATES INC.

[redacted]

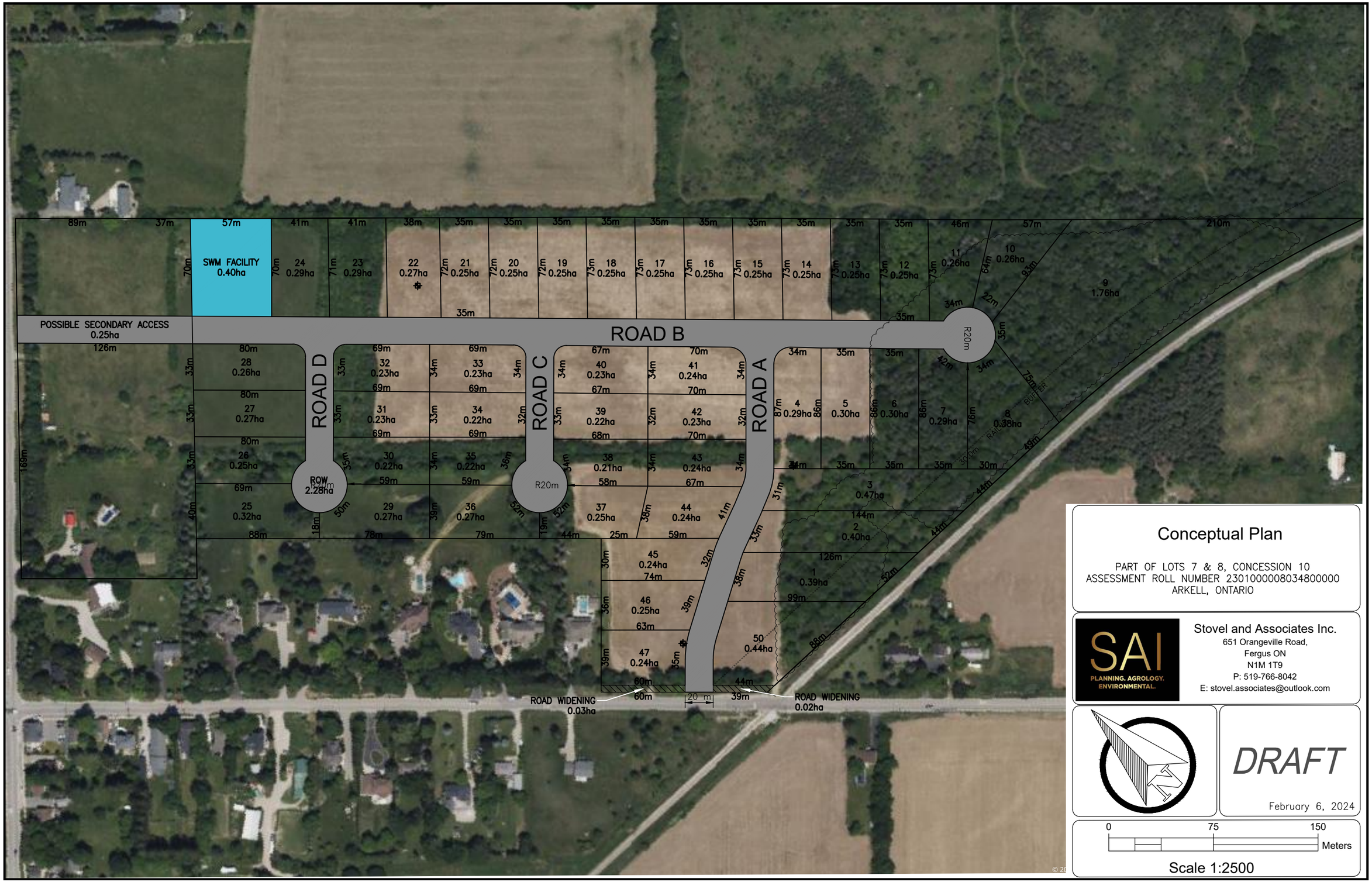
Tony Elias, P.Eng.
Senior Project Manager, Land Development

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APPENDIX A

Background Information



Conceptual Plan

PART OF LOTS 7 & 8, CONCESSION 10
ASSESSMENT ROLL NUMBER 2301000008034800000
ARKELL, ONTARIO

Stovel and Associates Inc.
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SAI
PLANNING. AGROLOGY. ENVIRONMENTAL.

DRAFT

February 6, 2024

0 75 150 Meters

Scale 1:2500

APPENDIX B

Design Calculations

Proposed By-Pass Swale (North)

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00300	m/m
Normal Depth	1.00	m
Left Side Slope	3.00	m/m (H:V)
Right Side Slope	3.00	m/m (H:V)
Bottom Width	1.50	m

Results

Discharge	5.68	m^3/s
Flow Area	4.50	m^2
Wetted Perimeter	7.82	m
Hydraulic Radius	0.58	m
Top Width	7.50	m
Critical Depth	0.73	m
Critical Slope	0.01208	m/m
Velocity	1.26	m/s
Velocity Head	0.08	m
Specific Energy	1.08	m
Froude Number	0.52	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	1.00	m
Critical Depth	0.73	m
Channel Slope	0.00300	m/m

Proposed By-Pass Swale (North)

GVF Output Data

Critical Slope	0.01208	m/m

Proposed By-Pass Swale (South)

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00300	m/m
Normal Depth	0.85	m
Left Side Slope	3.00	m/m (H:V)
Right Side Slope	3.00	m/m (H:V)
Bottom Width	1.50	m

Results

Discharge	3.96	m^3/s
Flow Area	3.44	m^2
Wetted Perimeter	6.88	m
Hydraulic Radius	0.50	m
Top Width	6.60	m
Critical Depth	0.61	m
Critical Slope	0.01268	m/m
Velocity	1.15	m/s
Velocity Head	0.07	m
Specific Energy	0.92	m
Froude Number	0.51	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.85	m
Critical Depth	0.61	m
Channel Slope	0.00300	m/m

Proposed By-Pass Swale (South)

GVF Output Data

Critical Slope	0.01268	m/m

Project:	Arkell Subdivision	**Date:**	2024-01-22
Project No.:	2433-6743	**Revised:**	2024-02-28
Description:	Catchment 201 & 204 Water Quality Storage Requirements	**Designed By:**	AO
		Checked By:	TE

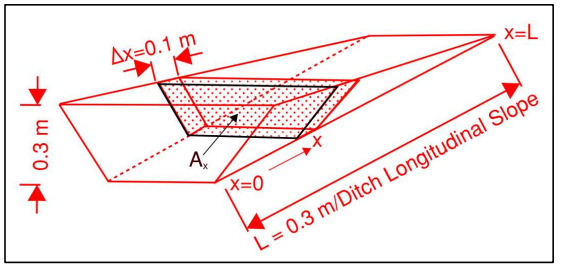
Catchment 201 & 204 Water Quality Storage Requirements

Bioswale Catchment Area (ha):	16.27	Catchment 200 & 204
Imperviousness Level (%):	34.22	
MOE Table 3.2		
Storage Volume for enhanced 80% long term SS removal (m^3/ha):	25	
Design Storage Volume per MOE Table 3.2 (m^3):	407	= Bioswale Catchment Area * 25
VO Results Volume:		
25 mm Runoff (mm):	7.01	
Design Storage Volume per VO Results (m^3):	1140	
Design Storage Required (m^3):	**1140**	
Design Storage Provided (m^3):	**672**	See Weir Control Sizing Calculation Sheet

Project:	Arkell Subdivision	**Date:**	2024-01-22
Project No.:	2433-6743	**Revised:**	2024-02-28
Description:	Bioswale Control Weir Sizing	**Designed By:**	AO
		Checked By:	TE

Bioswale Weir Control Sizing - Catchment 200 & 204

Ditch Bottom Width =	1.5	m
Ditch Top Width =	7.50	m
Roadside Ditch Side Slope =	3:1	
Lot Line Ditch Slope =	3:1	
Ditch Height =	1.00	m
Proposed Control Weir Height =	0.70	m
Road Segment Length =	100	
Proposed Longitudinal Ditch Slope =	4%	
Control Weir Spacing =	14	m
Number of Control Weir Ponding Areas =	7	
Weir Control Ponding Storage per Area (V) =	17.43	m^3/area
Surface Ponding Volume Provided =	**121.99**	**m^3**



$$V = \int_{x=0}^{x=L} dV \cong A_{x=\Delta x}\Delta x + A_{x=2\Delta x}\Delta x + A_{x=3\Delta x}\Delta x + \ldots + A_{x=L}\Delta x$$

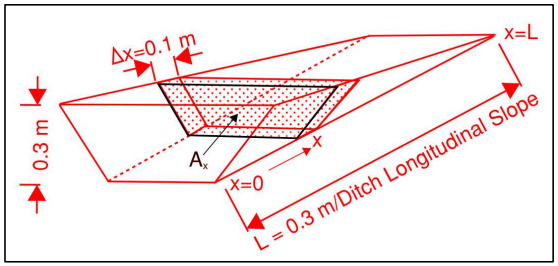
where $\Delta x = 0.1$ m and A_x = *Cross sectional area of retained water @ x*

> Required Storage = **1,140** **m^3**

Project:	Arkell Subdivision	**Date:**	2024-01-22
Project No.:	2433-6743	**Revised:**	2024-02-28
Description:	Bioswale Control Weir Sizing	**Designed By:**	AO
		Checked By:	TE

Bioswale Weir Control Sizing - Catchment 200 & 204

Ditch Bottom Width =	1.5	m
Ditch Top Width =	7.50	m
Roadside Ditch Side Slope =	3:1	
Lot Line Ditch Slope =	3:1	
Ditch Height =	1.00	m
Proposed Control Weir Height =	0.70	m
Road Segment Length =	100	
Proposed Longitudinal Ditch Slope =	3%	
Control Weir Spacing =	20	m
Number of Control Weir Ponding Areas =	5	
Weir Control Ponding Storage per Area (V) =	23.27	m^3/area
Surface Ponding Volume Provided =	**116.36**	**m^3**



$$V = \int_{x=0}^{x=L} dV \cong A_{x=\Delta x}\Delta x + A_{x=2\Delta x}\Delta x + A_{x=3\Delta x}\Delta x + \ldots + A_{x=L}\Delta x$$

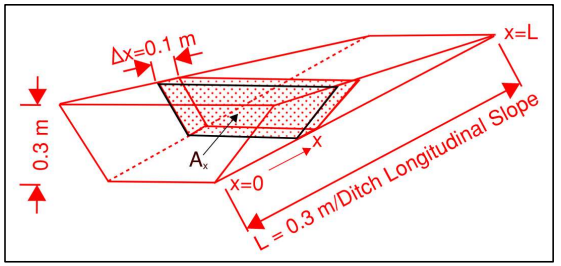
where $\Delta x = 0.1$ m and A_x = *Cross sectional area of retained water @ x*

> Required Storage = **1,140** **m^3**

Project:	Arkell Subdivision	**Date:**	2024-01-22
Project No.:	2433-6743	**Revised:**	2024-02-28
Description:	Bioswale Control Weir Sizing	**Designed By:**	AO
		Checked By:	TE

Bioswale Weir Control Sizing - Catchment 200 & 204

Ditch Bottom Width =	1.5	m
Ditch Top Width =	7.50	m
Roadside Ditch Side Slope =	3:1	
Lot Line Ditch Slope =	3:1	
Ditch Height =	1.00	m
Proposed Control Weir Height =	0.70	m
Road Segment Length =	100	
Proposed Longitudinal Ditch Slope =	1%	
Control Weir Spacing =	50	m
Number of Control Weir Ponding Areas =	2	
Weir Control Ponding Storage per Area (V) =	99.17	m^3/area
Surface Ponding Volume Provided =	**99.17**	**m^3**



$$V = \int_{x=0}^{x=L} dV \cong A_{x=\Delta x}\Delta x + A_{x=2\Delta x}\Delta x + A_{x=3\Delta x}\Delta x + \ldots + A_{x=L}\Delta x$$

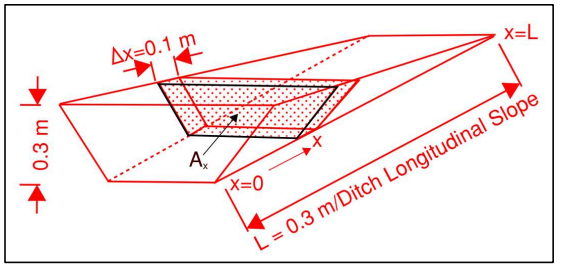
where $\Delta x = 0.1$ m and A_x = *Cross sectional area of retained water @ x*

> Required Storage = **1,140** **m^3**

Project:	Arkell Subdivision	**Date:**	2024-01-22
Project No.:	2433-6743	**Revised:**	2024-02-28
Description:	Bioswale Control Weir Sizing	**Designed By:**	AO
		Checked By:	TE

Bioswale Weir Control Sizing - Catchment 200 & 204

Ditch Bottom Width =	1.5	m
Ditch Top Width =	7.50	m
Roadside Ditch Side Slope =	3:1	
Lot Line Ditch Slope =	3:1	
Ditch Height =	1.00	m
Proposed Control Weir Height =	0.70	m
Road Segment Length =	100	
Proposed Longitudinal Ditch Slope =	1%	
Control Weir Spacing =	0	m
Number of Control Weir Ponding Areas =	1	
Weir Control Ponding Storage per Area (V) =	83.88	m^3/area
Surface Ponding Volume Provided =	**83.88**	**m^3**



$$V = \int_{x=0}^{x=L} dV \cong A_{x=\Delta x}\Delta x + A_{x=2\Delta x}\Delta x + A_{x=3\Delta x}\Delta x + \ldots + A_{x=L}\Delta x$$

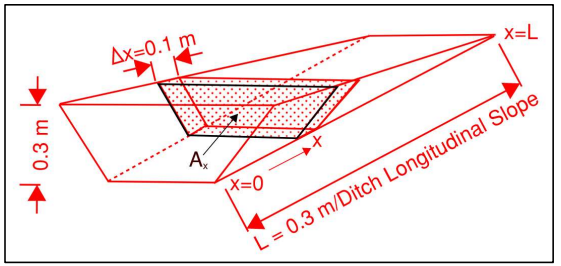
where $\Delta x = 0.1$ m and A_x = *Cross sectional area of retained water @ x*

> Required Storage = **1,140** **m^3**

Project:	Arkell Subdivision	**Date:**	2024-01-22
Project No.:	2433-6743	**Revised:**	2024-02-28
Description:	Bioswale Control Weir Sizing	**Designed By:**	AO
		Checked By:	TE

Bioswale Weir Control Sizing - Catchment 200 & 204

Ditch Bottom Width =	1.5	m
Ditch Top Width =	7.50	m
Roadside Ditch Side Slope =	3:1	
Lot Line Ditch Slope =	3:1	
Ditch Height =	1.00	m
Proposed Control Weir Height =	0.70	m
Road Segment Length =	100	
Proposed Longitudinal Ditch Slope =	0.31%	
Control Weir Spacing =	0	m
Number of Control Weir Ponding Areas =	1	
Weir Control Ponding Storage per Area (V) =	174.00	m^3/area
Surface Ponding Volume Provided =	**174.00**	**m^3**



$$V = \int_{x=0}^{x=L} dV \cong A_{x=\Delta x}\Delta x + A_{x=2\Delta x}\Delta x + A_{x=3\Delta x}\Delta x + \ldots + A_{x=L}\Delta x$$

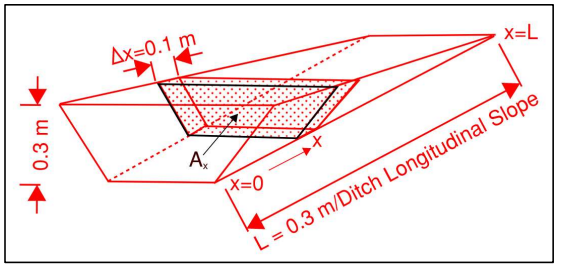
where $\Delta x = 0.1$ m and A_x = *Cross sectional area of retained water @ x*

> Required Storage = **1,140** **m^3**

Project:	Arkell Subdivision	**Date:**	2024-01-22
Project No.:	2433-6743	**Revised:**	2024-02-28
Description:	Bioswale Control Weir Sizing	**Designed By:**	AO
		Checked By:	TE

Bioswale Weir Control Sizing - Catchment 200 & 204

Ditch Bottom Width =	1.5	m
Ditch Top Width =	7.50	m
Roadside Ditch Side Slope =	3:1	
Lot Line Ditch Slope =	3:1	
Ditch Height =	1.00	m
Proposed Control Weir Height =	0.70	m
Road Segment Length =	100	
Proposed Longitudinal Ditch Slope =	1%	
Control Weir Spacing =	0	m
Number of Control Weir Ponding Areas =	1	
Weir Control Ponding Storage per Area (V) =	76.85	m^3/area
Surface Ponding Volume Provided =	**76.85**	**m^3**



$$V = \int_{x=0}^{x=L} dV \cong A_{x=\Delta x}\Delta x + A_{x=2\Delta x}\Delta x + A_{x=3\Delta x}\Delta x + \ldots + A_{x=L}\Delta x$$

where $\Delta x = 0.1$ m and A_x = *Cross sectional area of retained water @ x*

> Required Storage = **1,140** **m^3**

CROZIER CONSULTING ENGINEERS

Project:	Arkell Subdivision	**Date:**	2024-01-22
Project No.:	2433-6743	**Revised:**	2024-02-28
Description:	Bioswale Sizing	**Designed By:**	AO
		Checked By:	TE

Roadside Bioswale Sizing - Catchment 200 & 204

Parameter	Value	Units	Comment
Provided Bioswale Design Parameters			
Surface Ponding Volume Provided Behind Weir Control Structures =	**672**	**m^3**	
Percolation Rate =	255.0	mm/hr	Table 9.6; Hydrology of Floods in Canada: A Guide to Planning and Design (National Research Council of Canada, 1989)
Safety Correction Factor =	2.00		
Design Percolation Rate **(P)** =	127.50	mm/hr	
LID Length =	**600**	**m**	
LID Width =	**1.5**	**m**	
Provided footprint **(A)** =	**900**	**m^2**	= Length * width
Gravel Storage Depth =	0.40	m	**A = 1000 * V / [P*n* t]** Equation 4.3 (MOE SWM Planning and Design Manual, 2003)
Void Space Ratio **(n)** =	0.40		
Total Bioswale Gravel Storage Volume Provided (V) =	**144**	m^3	≥ Surface Ponding Storage = **672** **m^3**
Infiltration Rate =	**45.9**	m^3/hr	
Retention Time (t) =	**3**	hours	

NOTES:

1. Surface storage and filter media storage not included in bioswale volume calculation to be conservative.

CROZIER CONSULTING ENGINEERS

Project: Arkell Subdivision
Project No.: 2433-6646
Date: 2024-02-28
Designed By: AO
Checked By: TE

Orifice Design - Dry Pond

Depth Increment (m) =	0.050
Bottom of Dry Pond (masl) =	338.50
Top of Dry Pond (masl) =	340.00

Orifice: $Q=CA(2gH)^{0.5}$	**Orifice 1 (ED)**	**Broad Crested Weir**
Discharge Coef., Cd=	0.62	1.84
Orifice Diameter (mm) =	85	575
Area of Orifice (m^2) =	0.0057	INC
Orifice (Side/Bottom) =	Side	-
Invert (m) =	338.50	339.55

Storage Rating Curve

	Water Elev. (m)	Depth (m)	Orifice 1 check for inlet E.L. control	Head 1 (m)	Volume (m3)	Orifice1 Q (Side) L/s	Weir Discharge L/s	Total Flow L/s
Dry Pond Invert/Orifice 1 (ED)	338.50	0.00	0.00	0.00	0	0.0000	0.00	0.00
	338.55	0.05	0.05	0.01	5.22	1.3496	0.00	1.35
	338.60	0.10	0.10	0.06	26.68	3.7368	0.00	3.74
	338.65	0.15	0.15	0.11	69.82	5.1094	0.00	5.11
	338.70	0.20	0.20	0.16	134.06	6.1846	0.00	6.18
	338.75	0.25	0.25	0.21	218.96	7.0987	0.00	7.10
	338.80	0.30	0.30	0.26	318.26	7.9078	0.00	7.91
	338.85	0.35	0.35	0.31	422.69	8.6415	0.00	8.64
	338.90	0.40	0.40	0.36	529.06	9.3177	0.00	9.32
	338.95	0.45	0.45	0.41	637.39	9.9479	0.00	9.95
	339.00	0.50	0.50	0.46	747.73	10.5406	0.00	10.54
	339.05	0.55	0.55	0.51	860.1	11.1016	0.00	11.10
	339.10	0.60	0.60	0.56	974.52	11.6357	0.00	11.64
	339.15	0.65	0.65	0.61	1090.98	12.1462	0.00	12.15
ED Storage Volume	339.17	0.67	0.67	0.62	1127.21	12.2981	0.00	12.30
	339.20	0.70	0.70	0.66	1209.51	12.6362	0.00	12.64
	339.25	0.75	0.75	0.71	1330.14	13.1079	0.00	13.11
	339.30	0.80	0.80	0.76	1452.83	13.5631	0.00	13.56
	339.35	0.85	0.85	0.81	1577.58	14.0036	0.00	14.00
	339.40	0.90	0.90	0.86	1704.44	14.4307	0.00	14.43
	339.45	0.95	0.95	0.91	1833.43	14.8454	0.00	14.85
	339.50	1.00	1.00	0.96	1964.59	15.2489	0.00	15.25
Broad Crested Weir	339.55	1.05	1.05	1.01	2097.88	15.6420	0.00	15.64
	339.60	1.10	1.10	1.06	2233.23	16.0254	11.83	27.85
	339.65	1.15	1.15	1.11	2370.57	16.3999	33.46	49.86
	339.70	1.20	1.20	1.16	2509.93	16.7660	61.46	78.23
	339.75	1.25	1.25	1.21	2651.31	17.1243	94.63	111.75
	339.80	1.30	1.30	1.26	2794.67	17.4752	132.25	149.73
Approx. 100-year WSEL	339.85	1.35	1.35	1.31	2939.96	17.8193	173.85	191.67
	339.90	1.40	1.40	1.36	3087.21	18.1568	219.07	237.23
	339.95	1.45	1.45	1.41	3236.45	18.4881	267.66	286.14
Top of Dry Pond (HWL)	340.00	1.50	1.50	1.46	3236.45	18.8137	319.38	338.19

Project:	Arkell Subdivision
Project No.:	2433-6646
File:	Extended Detention
Design by:	AO
Check by:	TE
Date:	February 28, 2024

EXTENDED DETENTION SPECIFICATIONS - SWM FACILITY DESIGN

Extended Detention Volume		1127
t (drawdown time - seconds, *hours in italics*)	*48.0*	172800
h (maximum head acting on orifice for extended detention- m)		0.67
C (discharge coefficient)		0.62
Ap (average surface area for extended detention - sqm)		1642

t = 2*Ap*(h^0.5)/(C*Ao*(g*2)^0.5)

Ao = 0.005666007 m dmax = 85 mm

Extended Detention Orifice Diameter (as designed) d = **85** mm

Note: Extended detention calculations and formula above from MOE SWM Planning & Design Manual (2003)

ONSITE SEWAGE SYSTEM RESIDENTIAL CALCULATION SHEET

CROZIER CONSULTING ENGINEERS

Project Name: Arkell Development
Project Number: 2433-6646
Date: 2024-02-26
Designed By: ZS
Checked By: KR

input required

House Details: 6 bedroom
240.00 m2

References

Description		Number of Units	Additional Flow per Unit (L)	Total Flow (L/day)
Base Flow				2500
Additional Flow				
i) Each bedroom over 5		1	500	500
ii) Area over 200m^2,				
A) Each 10m^2 over 200m^2 to 400m^2		4	100	400
B) Each 10m^2 over 400m^2 to 600m^2		0	75	0
C) Each 10m^2 over 600m^2		0	50	0
	Total Additional Sewage Flow from Area			400
iii) Fixture Units over 20		42	50	2075
			Addition flow (greatest of i,ii,iii)	**2075**
			Total Daily Design Sanitary Sewage Flow (L/day):	**4575**

Pre-Treatment Options

Required septic tank size = 9150 L minimum

Propose Level IV Treatment (Y/N): Y

Native Percolation time, T = 15 min/cm

Imported Sand Percolation time = 10 min/cm

Treatment: **WBP Model AD35**, 3500 L/d
Treatment: **ADIPC-9000**
Basket Biofilter Tank: **BT-9000**
Orangeville Precast Concrete Ltd.

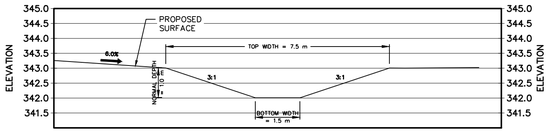
T-time estimated by Crozier

Option #1 - Type A Dispersal Bed

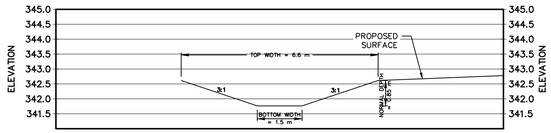
	Required			Provided	
Stone area =	92	m^2	(Q/50)	104	m^2
Sand area =	81	m^2	(QT/400)	104	m^2

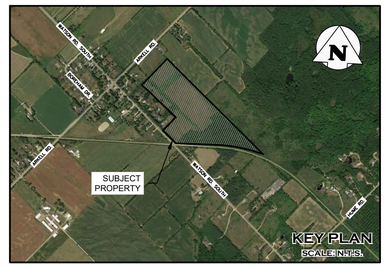
DRAWINGS & FIGURES

CROSS SECTION A – A'
PROFILE VIEW
SCALE: H=1:100
V=1:100



CROSS SECTION B – B'
PROFILE VIEW
SCALE: H=1:100
V=1:100

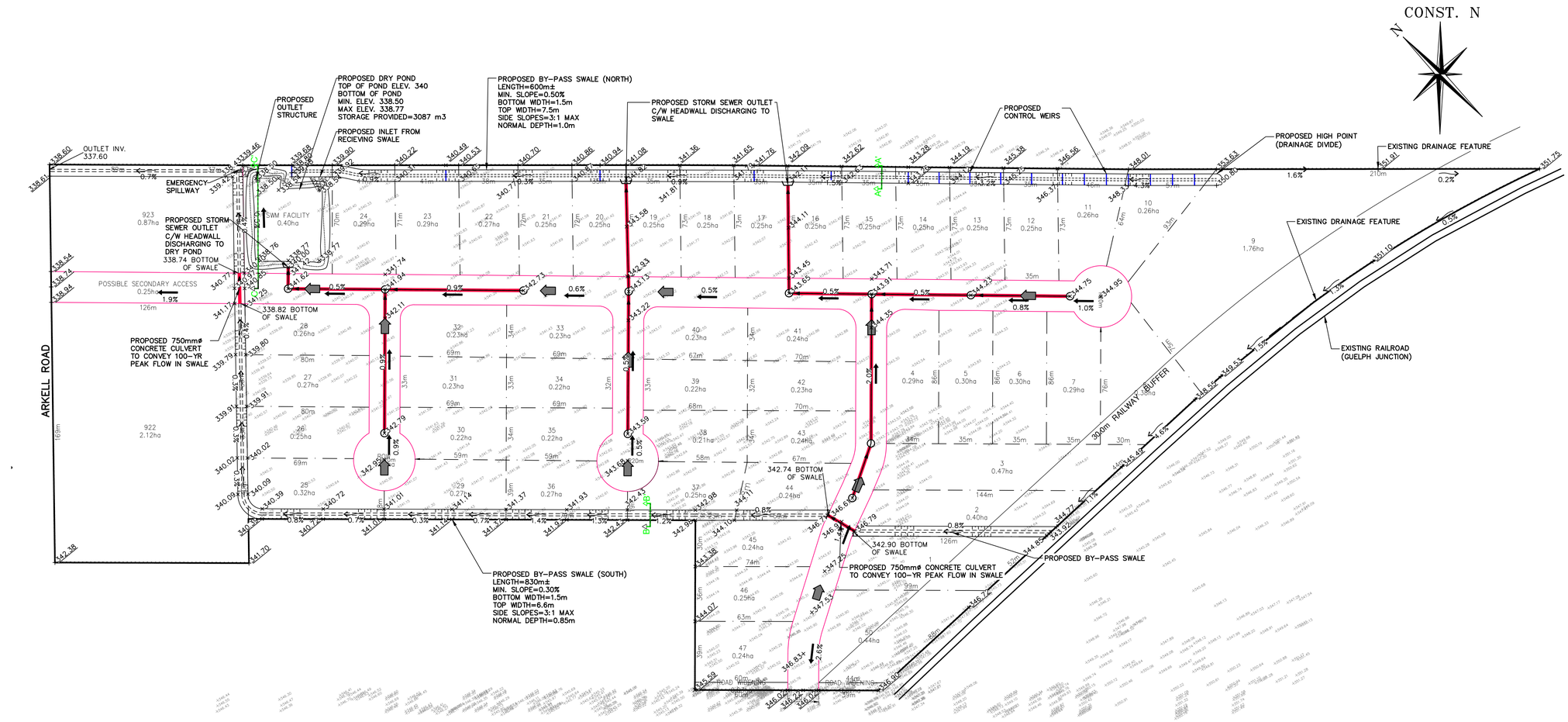




LEGEND

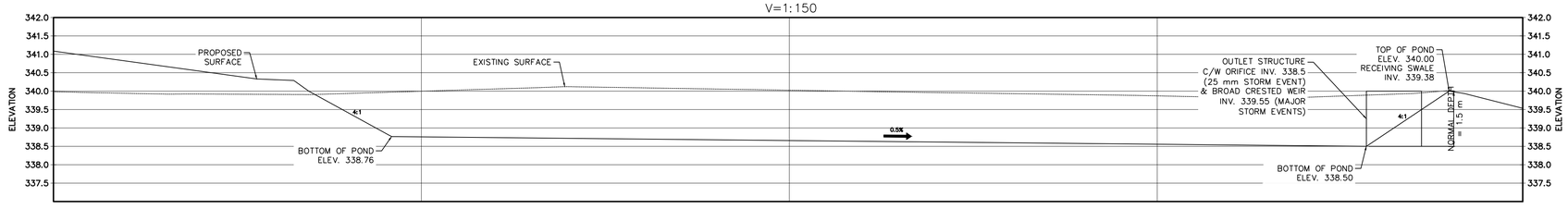
- PROPERTY LINE
- EXISTING CONTOUR (0.5m)
- EXISTING CONTOUR (1.0m)
- 215.00 EXISTING GRADE
- ×215.00 PROPOSED GRADE
- ×215.00 PROPOSED GRADE (TO MATCH EXISTING)
- 2.0% PROPOSED MINOR FLOW DIRECTION
- PROPOSED SLOPE (3:1 MAX.)
- PROPOSED CONTROL WEIR
- EXISTING OVERLAND FLOW DIRECTION
- PROPOSED OVERLAND FLOW DIRECTION
- 2.0% PROPOSED SWALE FLOW DIRECTION
- PROPOSED LOT–LINE
- MISSING SURVEY
- PROPOSED CATCHBASIN
- PROPOSED CATCHBASIN MANHOLE
- PROPOSED STORM MANHOLE
- PROPOSED STORM SEWER & MANHOLE
- PROPOSED SINGLE / DOUBLE CATCHBASIN

REFER TO TOWNSHIP OF PUSLINCH STANDARD DRAWING STD–102 "TYPICAL URBAN CROSS–SECTION" FOR DIMENSIONS AND DETAILS OF PROPOSED ROAD CROSS–SECTION.



50 0m 50 100
SCALE: 1:1500

CROSS–SECTION C – C'
PROFILE VIEW
SCALE: H=1:150
V=1:150



No.	ISSUE / REVISION	YYYY/MMM/DD
1	ISSUED FOR INTERNAL COORDINATION	2024/FEB/28
0	ISSUED FOR PRE–CONSULTATION	2023/AUG/31

SITE PLAN NOTES:

DESIGN ELEMENTS ARE BASED ON SITE PLAN BY STOVEL AND ASSOCIATES INC.
PROJECT No. XXX
DRAWING No. XXX
DATE RECEIVED 2023/AUG/23

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ALL EXISTING UNDERGROUND UTILITIES TO BE VERIFIED IN THE FIELD BY THE CONTRACTOR PRIOR TO CONSTRUCTION.

Project
WATSON ROAD SOUTH
TOWN OF PUSLINCH

Drawing
PRELIMINARY GRADING AND SERVICING PLAN

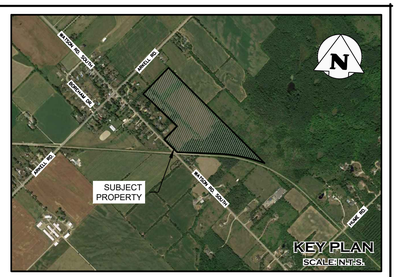
Stamp
PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

Stamp
CROZIER CONSULTING ENGINEERS

Drawn	Design	Project No.
A.O.	A.O.	2433–6646
Check	Check	Scale / Dwg.
J.B.	T.E.	1:1500 / C101



WATSON ROAD SOUTH

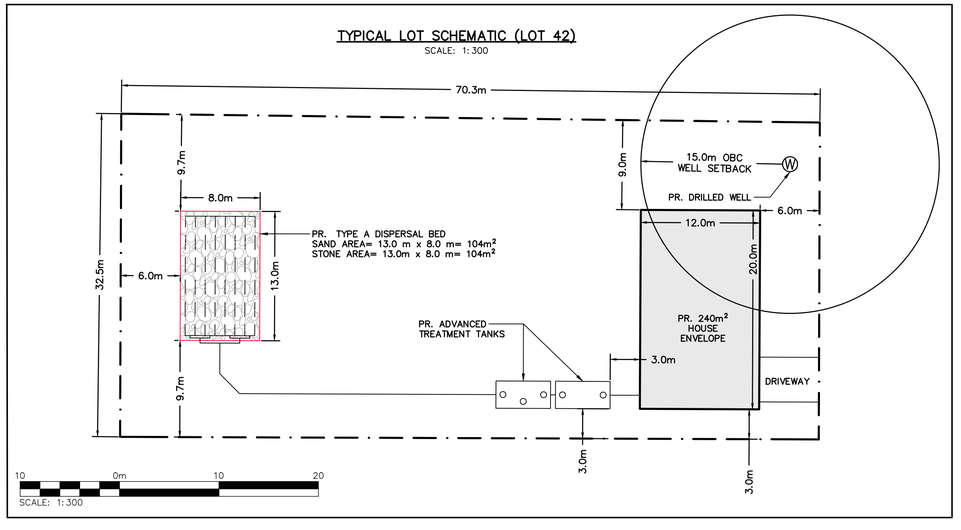


LEGEND

- PROPERTY LINE
- EXISTING CONTOUR (0.5m)
- EXISTING CONTOUR (1.0m)
- 9 — LOT NUMBER
- ×215.00 — EXISTING GRADE
- ×215.00 — PROPOSED GRADE
- ×215.00 — PROPOSED GRADE (TO MATCH EXISTING)
- PROPOSED SLOPE (3:1 MAX.)
- PROPOSED LOT–LINE
- CONCEPTUAL 240 m² BUILDING ENVELOPE
- PROPOSED TYPE A DISPERSAL BED 104 m²
- (W) — CONCEPTUAL PROPOSED DRILLED WELL LOCATION C/W 15.0m OBC SETBACK

TYPICAL LOT SCHEMATIC (LOT 42)

SCALE: 1:300



ONSITE SEWAGE SYSTEM DESIGN TYPICAL LOT NOTES

PROPOSED 6 BEDROOM, 240 m² HOME WITH SIXTY–TWO (62) FIXTURE UNITS	BASE FLOW (6 BEDROOMS)= 2,500 L/DAY ADDITIONAL FLOOR AREA (40 m2)= 400 L/DAY ADDITIONAL FIXTURE UNITS (42)= 2,075 L/DAY Q TOTAL (2,500+2,075)= 4,575 L/DAY
SOIL PERCOLATION RATE	T = 15 min/cm (ESTIMATED BY C.F. CROZIER)
PROPOSED TREATMENT UNIT	WATERLOO BIOFILTER AD–BA50
TYPE A DISPERSAL BED STONE AREA	MINIMUM SIZE=Q/50=4,575/50 = 91.5m² PROVIDED 13m x 8m = 104m²
TYPE A DISPERSAL BED SAND AREA	MINIMUM SIZE=QT/850= 4,575*15/850 = 80.7m² PROVIDED 13m x 8m = 104m²

No.	ISSUE / REVISION	YYYY/MMM/DD
1	ISSUED FOR INTERNAL COORDINATION	2024/FEB/28
0	ISSUED FOR PRE–CONSULTATION	2023/AUG/31

SITE PLAN NOTES:

DESIGN ELEMENTS ARE BASED ON SITE PLAN BY STOVEL AND ASSOCIATES INC.
PROJECT No. XXX
DRAWING No. XXX
DATE RECEIVED 2023/AUG/23

DRAWING NOTES:

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF C.F. CROZIER & ASSOCIATES INC. AND THE REPRODUCTION OF ANY PART OF IT WITHOUT PRIOR WRITTEN CONSENT OF THIS OFFICE IS STRICTLY PROHIBITED.

THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS, LEVELS, AND DATUMS ON SITE AND REPORT ANY DISCREPANCIES OR OMISSIONS TO THIS OFFICE PRIOR TO CONSTRUCTION.

THIS DRAWING IS TO BE READ AND UNDERSTOOD IN CONJUNCTION WITH ALL OTHER PLANS AND DOCUMENTS APPLICABLE TO THIS PROJECT. DO NOT SCALE THIS DRAWING.

ALL EXISTING UNDERGROUND UTILITIES TO BE VERIFIED IN THE FIELD BY THE CONTRACTOR PRIOR TO CONSTRUCTION.

Project

WATSON ROAD SOUTH
TOWN OF PUSLINCH

Drawing

ONSITE SEWAGE SERVICING SCHEMATIC

Stamp

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

Stamp

CROZIER
CONSULTING ENGINEERS

Drawn	Design	Project No.	
K.G.	K.G.	2433–6646	
Check	Check	Scale	Dwg.
M.B.	M.B.	1:1500	C102

55 Wyndham Street, North, Suite 215
Guelph, ON
N1H 7T8

T. 548.708.0022
cfcrozier.ca

MEMO

DATE	March 20, 2024 **PROJECT NO.** 2433-6646
RE	D-5-4 Assessment – Residential Development at Lots 7, 8, 9, Concession 10 Township of Puslinch
TO	Rob Stovel - Stovel & Associates
FROM	Jessica Doherty, P.Eng. - C.F. Crozier & Associates Inc.
CC	Katherine Rentsch, P.Eng. - C.F. Crozier & Associates Inc.

C.F. Crozier & Associates Inc. (Crozier) was retained by Timberworx Custom Homes, Sloot Construction, and John Sloot Investments (Owners) to complete a nitrate impact assessment for the proposed residential development located at Lots 7, 8, 9, Concession 10 in the Township of Puslinch (Site). The Site encompasses an area of 20.45 ha and is located at the southeast corner of the intersection of Arkell Road and Watson Road South. The Site is proposed to be developed as a residential subdivision with between thirty-five (35) to fifty (50) residential lots. Each lot will be serviced with an onsite sewage system and private water supply well. This memo has been prepared to assess potential impacts from the proposed onsite sewage systems in accordance with Ministry of the Environment, Conservation and Parks (MECP) Procedure D-5-4.

Geological and Hydrogeological Conditions

According to Ontario Geological Survey (OGS) mapping, surficial geology within the vicinity of the Site consists of glaciofluvial sand and gravel deposits. Chung & Vander Doelen Engineering Limited (CVD) was retained by the Owners to excavate test pits across the property. Twelve (12) test pits were excavated in December 2023 to depths of up to 6.10 m below ground surface (mbgs). According to CVD's test pit logs, subsurface conditions generally consisted of 250 to 450 mm of topsoil underlain by a thin layer of silt to silty sand and gravel followed by sand and gravel with trace silt to the maximum depth of investigation (6.10 mbgs). CVD's test pit logs are enclosed. These findings are generally consistent with the surficial materials reported in the geological mapping.

In 2006, R.J. Burnside & Associates Limited (R.J. Burnside) completed a hydrogeological assessment on the property. As part of this assessment, ten (10) boreholes were advanced, two (2) of which were installed as groundwater monitoring wells. The stratigraphy encountered was similar to CVD's observations during the 2023 test pitting program, which was described as a later of topsoil (200 to 400 mm thick, or up to 1.5 mbgs in some locations), underlain by sandy gravel or sand and gravel. Groundwater was encountered between 7.43 and 10.37 mbgs, or 333.02 to 334.53 masl in January 2006. Groundwater samples were collected in January 2006 from the two (2) monitoring wells (MW1 and MW2). Concentrations of nitrate ranged from 3.34 mg/L (MW1) to 4.18 mg/L (MW2). Monitoring well logs and the analytical laboratory report are enclosed. Refer to the Hydrogeological and Predictive Nitrate Assessment (R.J. Burnside, 2006) for additional details.

The material in this memo reflects best judgment in light of the information available at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. C.F. Crozier & Associates Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

In 2023, ARL Groundwater Resources Ltd. (ARL) completed a groundwater supply assessment for the property, which included a review of the hydrogeological conditions across the Site and assessed the suitability of servicing the development with individual water supply wells. The Groundwater Supply Assessment Report (ARL, March 2023) included a review of local water well records, which identified twelve (12) wells in the vicinity of the property. ARL interpreted that these wells were installed within bedrock, of either the upper Guelph Formation or the lower Goat Island/Gasport Formation. The Guelph Formation (upper bedrock aquifer) is described as unconfined to semi-confined aquifer; whereas the Gasport Formation (lower bedrock aquifer) is considered semi-confined to confined due to the overlying aquitard (Eramosa Formation). The Gasport Formation will be the target aquifer for the new private water supply wells. Refer to the Groundwater Supply Assessment Report (ARL, March 2023) for additional details.

Nitrate Impact Assessment

Municipal sanitary services are not available in the vicinity of the Site; therefore, it is proposed that each residential lot will be serviced by an onsite sewage system. The subdivision will contain between 35 to 50 residential lots. Since the development will contain more than five (5) units with individual onsite sewage systems, an assessment in accordance with MECP Procedure D-5-4 Technical Guidelines for Individual Onsite Sewage Systems: Water Quality Impact Risk Assessment (Procedure D-5-4) is required. This analysis evaluates the cumulative impact of the proposed sewage systems on the local groundwater regime. The potential for impacts to occur depends on the local hydrogeological setting, the volume of effluent discharged as well as the concentration of nutrients discharged in the effluent. The nutrient of concern is typically nitrate-nitrogen.

Procedure D-5-4 outlines a three-step assessment process as follows.

- Step 1 – Assessment considers the minimum lot size for each private lot.
    - For developments where the lot size is one hectare or larger, it is assumed that the attenuative processes will be sufficient to reduce nitrate nitrogen to an acceptable concentration below the adjacent property. If smaller lots are proposed, the assessment proceeds to Step 2.
- Step 2 – System Isolation.
    - This considers the relationship between the individual onsite sewage systems and the groundwater. Developments are considered to be a low risk where it can be demonstrated that the effluent is hydrogeologically isolated from existing or potential supply aquifers. Where it cannot be demonstrated that the systems are isolated from existing or potential groundwater supplies, it is necessary to progress to the third step of the assessment.
- Step 3 – If lots smaller than 1.0 ha are proposed, and system isolation cannot be demonstrated a detailed examination of contaminant loading to the groundwater must be completed.
    - A predictive contaminant attenuation calculation must be completed that demonstrates that the proposed development will not cause concentrations of nitrate nitrogen in the groundwater to exceed the Ontario Drinking Water Quality Standards (ODWQS) value of 10 mg/L at the downgradient development boundary.

Each lot will be below 1 ha, therefore Step 1 cannot be satisfied and Step 2 must be completed. As discussed above, hydrogeological information for the area indicates that there are some water supply wells in the vicinity of the Site installed in the upper unconfined to semi-confined aquifer (Guelph Formation). Therefore, the assessment must progress to Step 3, the predictive contaminant attenuation assessment. It should be noted that the new water supply wells for the development will target the lower semi-confined to confined aquifer (Gasport Formation).

Crozier has completed a mass balance calculation to predict the concentration of nitrate-nitrogen at the development boundary, using the following general assumptions, per D-5-4 guidelines:

- The concentration of nitrate in the effluent is 40 mg/L, typical for conventional septic tank/leaching beds system without advanced treatment.
- The average volume of effluent generated by each dwelling is 1,000 L/day, consistent with MECP Procedure D-5-4.
- The only dilution mechanism is by infiltration of surface precipitation. A conservative infiltration value of 200 mm/year has been assigned, based on the MECP annual infiltration rate for the sandy gravelly soils encountered on the Site.
- Based on the assumption that the entire property area is available for dilution purposes, a background concentration of nitrate (as N) in the groundwater was calculated using the average nitrate groundwater sample concentrations from the 2006 groundwater analytical results for the wells on the Site of 3.76 mg/L.

Using this approach, the resulting concentration of nitrate-nitrogen was calculated for 35, 40, and 50 lot scenarios at the Site development boundary. The calculations were completed considering a conventional system (e.g., conventional septic tank and leaching bed system) or an advanced treatment system (e.g., CAN/BNQ certified Level IV treatment system) with 50% nitrogen removal (i.e., effluent concentration of 20 mg/L) and 75% nitrogen removal (i.e., effluent concentration of 10 mg/L). Results are summarized below in Tables 1 through 3. Detailed calculations are enclosed.

Table 1: D-5-4 Impact Assessment – Conventional System

Lot Scenario	35 Lots	40 Lots	50 Lots
Nitrate Concentration in Wastewater (mg/L)	40		
Total Average Nitrate Loading (mg/day)	1,400,000	1,600,000	2,000,000
Nitrate Concentration at Downgradient Development Boundary (mg/L)	12.40	13.31	14.96

Table 2: D-5-4 Impact Assessment – Advanced Treatment System with 50% Nitrogen Removal

Lot Scenario	35 Lots	40 Lots	50 Lots
Nitrate Concentration in Wastewater (mg/L)	20		
Total Average Nitrate Loading (mg/day)	700,000	800,000	1,000,000
Nitrate Concentration at Downgradient Development Boundary (mg/L)	7.63	8.04	8.78

Table 3: D-5-4 Impact Assessment – Advanced Treatment System with 75% Nitrogen Removal

Lot Scenario	35 Lots	40 Lots	50 Lots
Nitrate Concentration in Wastewater (mg/L)	10		
Total Average Nitrate Loading (mg/day)	350,000	400,000	500,000
Nitrate Concentration at Downgradient Development Boundary (mg/L)	5.25	5.40	5.69

Per MECP Procedure D-5-4, the maximum allowable concentration of nitrate-nitrogen at the development boundary is 10 mg/L. In all lot scenarios, the predicted nitrate-nitrogen concentration at the downgradient property boundary is below 10 mg/L when advanced treatment systems with at least 50% nitrogen removal are incorporated. There are a number of Level IV CAN/BNQ certified treatment systems that can meet the denitrification requirements, including Waterloo Biofilter recirculating basket systems, among others.

Therefore, per MECP Procedure D-5-4, the proposed development can accommodate 50 residential lots with onsite sewage systems that include advanced treatment with at least 50% nitrogen removal.

Conclusions

The Site is proposed to be developed as a residential subdivision with between 35 to 50 residential lots and each lot will be serviced with an onsite sewage system and private water supply well. Impact assessment calculations were prepared in accordance with MECP Procedure D-5-4 requirements, which show that the proposed development can accommodate 50 residential lots with onsite sewage systems that include an advanced treatment system with 50% nitrogen removal.

Should you have any questions or require further information, please do not hesitate to contact the undersigned.

Respectfully submitted,

C.F. CROZIER & ASSOCIATES INC.

[redacted]

Jessica Doherty, P.Eng.
Project Manager

Encl. Test Pit Logs (CVD)
Monitoring Well Logs (MW1 and MW2; R.J. Burnside)
AGAT Analytical Laboratory Report
D-5-4 Impact Assessment Calculations – 35, 40 and 50 Lots

J:\2400\2433 - Timberworx Custom Homes\6646 - Arkell Developments\Memos\2024.03.20 MECP D-5-4 Assessment.docx



Test Pit Location Map

Part of Lots 7,8 & 9 Concession 10

Township of Puslinch, Wellington County

Arkell, Ontario

Notes

1. This is not a Plan of Survey.
2. Distances shown on this plan are adjusted ground distances and can be converted to grid distances by multiplying by an averaged combined scale factor of 0.999573.
3. Coordinates on this plan are UTM, ZONE 17, NAD83 (CSRS-2010) Adjustment and are based on gps observations from a network of permanent gps reference stations.
4. Aerial Imagery Provided By Microsoft Corporation @ 2023 Maxar CNES (2024) Distribution Airbus DS.

Legend

Subject Property

Existing Property Line

Test Pit Location

SAI
PLANNING. AGROLOGY. ENVIRONMENTAL.

Stovel and Associates Inc.
651 Orangeville Road,
Fergus ON
N1M 1T9
P: 519-766-8042
E: stovel.associates@outlook.com

N

DRAFT

January 8, 2024

0 100 200 Meters

Scale 1:3500

FILE No: 1669

TEST PIT No. 1

Client: **Timberworx Custom Homes**

Project: **Arkell Subdivision**

Location: **Pt of Lots 7, 8 and 9, Conc. 10, Arkell, Ontario**

EQUIPMENT DATA

Machine: **Excavator**
Method: **Excavator**
Size:
Date: **Dec 19 23** TO **Dec 19 23**

ELEV./ DEPTH (m)	DESCRIPTION	DEPTH (m)	SYMBOL	SAMPLE ID	SAMPLE TYPE	N-VALUE	SHEAR STRENGTH (kPa) / PENETRATION RESISTANCE	WATER CONTENT (%)	WELL DATA	DEPTH (m)	REMARKS
Ground Elevation:							FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □ 50 100 150 200; STANDARD ● DYN. CONE ○ 20 40 60 80	W_P W W_L 10 20 30			
	250 mm TOPSOIL										
0.25	trace topsoil ------ compact, brown SAND AND GRAVEL trace silt occ. to frequent cobbles and boulders damp to moist	0.5 1.0 1.5 2.0		1	BS			○		0.5 1.0 1.5 2.0	minor collapsing of sidewalls during test pit advancement
	------ dense	2.5								2.5	
3.00	End of Test Pit	3.0								3.0	test pit dry at completion
		3.5 4.0 4.5 5.0 5.5 6.0								3.5 4.0 4.5 5.0 5.5 6.0	

PROJECT MANAGER: **RVD**

CHUNG & VANDER DOELEN ENGINEERING LTD.
311 Victoria Street North
Kitchener, Ontario N2H 5E1
ph. (519) 742-8979, fx. (519) 742-7739

FILE No: 1669

TEST PIT No. 2

Client: **Timberworx Custom Homes**

Project: **Arkell Subdivision**

Location: **Pt of Lots 7, 8 and 9, Conc. 10, Arkell, Ontario**

EQUIPMENT DATA

Machine: **Excavator**
Method: **Excavator**
Size:
Date: **Dec 19 23** TO **Dec 19 23**

SOIL LITHOLOGY

SAMPLE

SHEAR STRENGTH (kPa)
FIELD VANE: Peak ⊗ Rem. ×
LAB TEST: Unc. ■ P.P. □
50 100 150 200
PENETRATION RESISTANCE
STANDARD ● DYN. CONE ○
20 40 60 80

WATER CONTENT (%)
W_P W W_L
10 20 30

ELEV./ DEPTH (m)	DESCRIPTION Ground Elevation:	DEPTH (m)	SYMBOL	SAMPLE ID	TYPE	N-VALUE	WELL DATA	DEPTH (m)	REMARKS
	450 mm TOPSOIL								
0.45	loose, brown, SILT, trace sand, trace clay, trace topsoil moist	0.5		1	BS			0.5	minor collapsing of sidewalls during test pit advancement
0.75	compact, brown SAND AND GRAVEL trace silt occ. cobbles damp to moist	1.0		2	BS			1.0	
		1.5						1.5	
		2.0						2.0	
	------ occ. boulders	2.5						2.5	
		3.0						3.0	
		3.5						3.5	
	------ dense	4.0						4.0	
		4.5						4.5	
4.90	End of Test Pit	5.0						5.0	test pit dry at completion
		5.5						5.5	
		6.0						6.0	

PROJECT MANAGER: **RVD**

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FILE No: 1669

TEST PIT No. 3

Client: **Timberworx Custom Homes**

Project: **Arkell Subdivision**

Location: **Pt of Lots 7, 8 and 9, Conc. 10, Arkell, Ontario**

EQUIPMENT DATA

Machine: **Excavator**
Method: **Excavator**
Size:
Date: **Dec 19 23** TO **Dec 19 23**

ELEV./ DEPTH (m)	DESCRIPTION Ground Elevation:	DEPTH (m)	SYMBOL	SAMPLE ID	SAMPLE TYPE	N-VALUE	SHEAR STRENGTH (kPa) / PENETRATION RESISTANCE	WATER CONTENT (%)	WELL DATA	DEPTH (m)	REMARKS
	330 mm TOPSOIL						FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □ 50 100 150 200 PENETRATION RESISTANCE STANDARD ● DYN. CONE ○ 20 40 60 80	W_P W W_L 10 20 30			
0.33	trace topsoil --- compact, brown SAND AND GRAVEL trace silt occ. cobbles damp to moist --- dense occ. boulders	0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0		1 2	BS BS			○ ○		0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0	occasional to frequent collapsing of sidewalls during test pit advancement
4.30	End of Borehole	4.5 5.0 5.5 6.0								4.5 5.0 5.5 6.0	test pit dry at completion

PROJECT MANAGER: **RVD**

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FILE No: 1669

TEST PIT No. 4

Client: **Timberworx Custom Homes**

Project: **Arkell Subdivision**

Location: **Pt of Lots 7, 8 and 9, Conc. 10, Arkell, Ontario**

EQUIPMENT DATA

Machine: **Excavator**
Method: **Excavator**
Size:
Date: **Dec 19 23** TO **Dec 19 23**

ELEV./ DEPTH (m)	DESCRIPTION Ground Elevation:	DEPTH (m)	SYMBOL	SAMPLE ID	SAMPLE TYPE	N-VALUE	SHEAR STRENGTH (kPa) / PENETRATION RESISTANCE	WATER CONTENT (%)	WELL DATA	DEPTH (m)	REMARKS
	330 mm TOPSOIL						FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □ 50 100 150 200 PENETRATION RESISTANCE STANDARD ● DYN. CONE ○ 20 40 60 80	W_P W W_L 10 20 30			
0.33	trace topsoil ------ compact, brown SAND AND GRAVEL trace silt occ. cobbles damp to moist	0.5 1.0 1.5		1	BS			○		0.5 1.0 1.5	
	------ occ. boulders ------ silt seam ------	2.0 2.5 3.0 3.5		2	BS			○		2.0 2.5 3.0 3.5	frequent collapsing of sidewalls during test pit advancement
		4.0 4.5 5.0 5.5								4.0 4.5 5.0 5.5	
6.10	End of Borehole	6.0								6.0	test pit dry at completion

PROJECT MANAGER: **RVD**

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Kitchener, Ontario N2H 5E1
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FILE No: 1669

TEST PIT No. 5

Client: **Timberworx Custom Homes**

Project: **Arkell Subdivision**

Location: **Pt of Lots 7, 8 and 9, Conc. 10, Arkell, Ontario**

EQUIPMENT DATA

Machine: **Excavator**
Method: **Excavator**
Size:
Date: **Dec 19 23** TO **Dec 19 23**

ELEV./ DEPTH (m)	DESCRIPTION	DEPTH (m)	SYMBOL	SAMPLE ID	SAMPLE TYPE	N-VALUE	WELL DATA	DEPTH (m)	REMARKS
	Ground Elevation:								
	300 mm TOPSOIL								
0.30	loose, brown SILT, some sand, trace clay moist	0.5		1	BS			0.5	frequent collapsing of sidewalls during test pit advancement
0.60	compact to dense brown SAND AND GRAVEL trace silt occ. to frequent cobbles and boulders damp to moist	1.0		2	BS			1.0	
		1.5						1.5	
		2.0						2.0	
		2.5						2.5	
		3.0						3.0	
		3.5						3.5	
		4.0						4.0	
		4.5						4.5	
		5.0						5.0	
		5.5						5.5	
		6.0						6.0	
6.10	End of Test Pit								test pit dry at completion

SHEAR STRENGTH (kPa)
FIELD VANE: Peak ⊗ Rem. ×
LAB TEST: Unc. ■ P.P. □
50 100 150 200
PENETRATION RESISTANCE
STANDARD ● DYN. CONE ○
20 40 60 80

WATER CONTENT (%)
W_P W W_L
10 20 30

PROJECT MANAGER: **RVD**

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Kitchener, Ontario N2H 5E1
ph. (519) 742-8979, fx. (519) 742-7739

FILE No: 1669

TEST PIT No. 6

Client: **Timberworx Custom Homes**

Project: **Arkell Subdivision**

Location: **Pt of Lots 7, 8 and 9, Conc. 10, Arkell, Ontario**

EQUIPMENT DATA

Machine: **Excavator**
Method: **Excavator**
Size:
Date: **Dec 19 23** TO **Dec 19 23**

ELEV./ DEPTH (m)	DESCRIPTION Ground Elevation:	DEPTH (m)	SYMBOL	SAMPLE ID	TYPE	N-VALUE	SHEAR STRENGTH (kPa) FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □ 50 100 150 200 PENETRATION RESISTANCE STANDARD ● DYN. CONE ○ 20 40 60 80	WATER CONTENT (%) W_P W W_L 10 20 30	WELL DATA	DEPTH (m)	REMARKS
	350 mm TOPSOIL										
0.35	compact to dense brown SAND AND GRAVEL trace silt occ. cobbles damp to moist ------ silt seam ------ occ. boulders	0.5		1	BS			○		0.5	occasional collapsing of sidewalls during test pit advancement
		1.0		2	BS			○		1.0	
		1.5								1.5	
		2.0								2.0	
		2.5								2.5	
		3.0								3.0	
		3.5		3	BS			○		3.5	
		4.0								4.0	
		4.5								4.5	
		5.0								5.0	
		5.5								5.5	
		6.0								6.0	
6.10	End of Borehole										test pit dry at completion

PROJECT MANAGER: **RVD**

CHUNG & VANDER DOELEN ENGINEERING LTD.
311 Victoria Street North
Kitchener, Ontario N2H 5E1
ph. (519) 742-8979, fx. (519) 742-7739

CVD TEST PIT 1669 ARKELL SUBDIVISON - TEST PITS.GPJ CVD_ENG.GDT 24-1-5

FILE No: 1669

TEST PIT No. 7

Client: **Timberworx Custom Homes**

Project: **Arkell Subdivision**

Location: **Pt of Lots 7, 8 and 9, Conc. 10, Arkell, Ontario**

EQUIPMENT DATA

Machine: **Excavator**
Method: **Excavator**
Size:
Date: **Dec 19 23** TO **Dec 19 23**

ELEV./ DEPTH (m)	DESCRIPTION Ground Elevation:	DEPTH (m)	SYMBOL	SAMPLE ID	TYPE	N-VALUE	SHEAR STRENGTH (kPa) FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □ 50 100 150 200 PENETRATION RESISTANCE STANDARD ● DYN. CONE ○ 20 40 60 80	WATER CONTENT (%) W_P W W_L 10 20 30	WELL DATA	DEPTH (m)	REMARKS
	300 mm TOPSOIL										
0.30	trace topsoil ------ compact, brown SAND AND GRAVEL trace to some silt frequent cobbles and boulders damp to moist	0.5		1	BS			○		0.5	frequent collapsing of sidewalls during test pit advancement
		1.0		2	BS			○		1.0	
		1.5								1.5	
		2.0								2.0	
		2.5		3	BS			○		2.5	
		3.0								3.0	
		3.5								3.5	
		4.0								4.0	
		4.5								4.5	
		5.0								5.0	
		5.5								5.5	
		6.0								6.0	
6.10	End of Test Pit										test pit dry at completion

PROJECT MANAGER: **RVD**

CHUNG & VANDER DOELEN ENGINEERING LTD.
311 Victoria Street North
Kitchener, Ontario N2H 5E1
ph. (519) 742-8979, fx. (519) 742-7739

Enclosure No.: 8
Sheet 1 of 1

FILE No: 1669

TEST PIT No. 8

Client: **Timberworx Custom Homes**

Project: **Arkell Subdivision**

Location: **Pt of Lots 7, 8 and 9, Conc. 10, Arkell, Ontario**

EQUIPMENT DATA

Machine: **Excavator**
Method: **Excavator**
Size:
Date: **Dec 19 23** TO **Dec 19 23**

ELEV./ DEPTH (m)	DESCRIPTION Ground Elevation:	DEPTH (m)	SYMBOL	SAMPLE ID	SAMPLE TYPE	N-VALUE	SHEAR STRENGTH (kPa) FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □ 50 100 150 200 PENETRATION RESISTANCE STANDARD ● DYN. CONE ○ 20 40 60 80	WATER CONTENT (%) W_P W W_L 10 20 30	WELL DATA	DEPTH (m)	REMARKS
	300 mm TOPSOIL										
0.30	some silt to silty trace topsoil ------ compact, brown SAND AND GRAVEL trace silt frequent cobbles and boulders damp to moist	0.5		1	BS			○		0.5	frequent collapsing of sidewalls during test pit advancement
		1.0		2	BS			○		1.0	
		1.5								1.5	
		2.0								2.0	
		2.5								2.5	
		3.0								3.0	
		3.5								3.5	
	------ dense	4.0								4.0	
		4.5								4.5	
		5.0								5.0	
		5.5								5.5	
		6.0								6.0	
6.10	End of Test Pit										test pit dry at completion

PROJECT MANAGER: **RVD**

CHUNG & VANDER DOELEN ENGINEERING LTD.
311 Victoria Street North
Kitchener, Ontario N2H 5E1
ph. (519) 742-8979, fx. (519) 742-7739

FILE No: 1669

TEST PIT No. 9

Client: **Timberworx Custom Homes**

Project: **Arkell Subdivision**

Location: **Pt of Lots 7, 8 and 9, Conc. 10, Arkell, Ontario**

EQUIPMENT DATA

Machine: **Excavator**
Method: **Excavator**
Size:
Date: **Dec 19 23** TO **Dec 19 23**

ELEV./ DEPTH (m)	DESCRIPTION	DEPTH (m)	SYMBOL	SAMPLE ID	SAMPLE TYPE	N-VALUE	SHEAR STRENGTH (kPa) / PENETRATION RESISTANCE	WATER CONTENT (%)	WELL DATA	DEPTH (m)	REMARKS
Ground Elevation:	250 mm TOPSOIL						FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □ (50 100 150 200) PENETRATION RESISTANCE STANDARD ● DYN. CONE ○ (20 40 60 80)	W_P W W_L (10 20 30)			
0.25	some silt to silty trace topsoil --- compact to dense brown SAND AND GRAVEL trace silt occ. cobbles and boulders damp to moist	0.5		1	BS			○		0.5	occasional collapsing of sidewalls during test pit advancement
		1.0		2	BS			○		1.0	
		1.5								1.5	
		2.0		3	BS			○		2.0	
		2.5								2.5	
		3.0								3.0	
		3.5								3.5	
		4.0								4.0	
		4.5								4.5	
		5.0								5.0	
		5.5								5.5	
		6.0								6.0	
6.10	End of Test Pit										test pit dry at completion

PROJECT MANAGER: **RVD**

CHUNG & VANDER DOELEN ENGINEERING LTD.
311 Victoria Street North
Kitchener, Ontario N2H 5E1
ph. (519) 742-8979, fx. (519) 742-7739

FILE No: 1669

TEST PIT No. 10

Client: **Timberworx Custom Homes**

Project: **Arkell Subdivision**

Location: **Pt of Lots 7, 8 and 9, Conc. 10, Arkell, Ontario**

EQUIPMENT DATA

Machine: **Excavator**
Method: **Excavator**
Size:
Date: **Dec 19 23** TO **Dec 19 23**

SOIL LITHOLOGY

ELEV./ DEPTH (m)	DESCRIPTION	DEPTH (m)	SYMBOL	SAMPLE ID	SAMPLE TYPE	N-VALUE
	Ground Elevation:					
	300 mm TOPSOIL					
0.30	some silt to silty, trace topsoil ------ compact to dense brown SAND AND GRAVEL trace silt occ. to frequent cobbles and boulders damp to moist	0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0		1 2	BS BS	
6.10	End of Test Pit					

SHEAR STRENGTH (kPa)
FIELD VANE: Peak ⊗ Rem. ×
LAB TEST: Unc. ■ P.P. □
50 100 150 200
PENETRATION RESISTANCE
STANDARD ● DYN. CONE ○
20 40 60 80

WATER CONTENT (%)
W_P W W_L
10 20 30

WELL DATA

DEPTH (m)	REMARKS
0.5	occasional collapsing of sidewalls during test pit advancement
6.0	test pit dry at completion

PROJECT MANAGER: **RVD**

CHUNG & VANDER DOELEN
ENGINEERING LTD.
311 Victoria Street North
Kitchener, Ontario N2H 5E1
ph. (519) 742-8979, fx. (519) 742-7739

FILE No: 1669

TEST PIT No. 11

Client: **Timberworx Custom Homes**

Project: **Arkell Subdivision**

Location: **Pt of Lots 7, 8 and 9, Conc. 10, Arkell, Ontario**

EQUIPMENT DATA

Machine: **Excavator**
Method: **Excavator**
Size:
Date: **Dec 19 23** TO **Dec 19 23**

ELEV./ DEPTH (m)	DESCRIPTION Ground Elevation:	DEPTH (m)	SYMBOL	SAMPLE ID	SAMPLE TYPE	N-VALUE	SHEAR STRENGTH (kPa) FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □ 50 100 150 200 PENETRATION RESISTANCE STANDARD ● DYN. CONE ○ 20 40 60 80	WATER CONTENT (%) W_P W W_L 10 20 30	WELL DATA	DEPTH (m)	REMARKS
	300 mm TOPSOIL										
0.30	some silt to silty trace topsoil/rootlets ------ compact, brown SAND AND GRAVEL trace silt occ. cobbles and boulders damp to moist	0.5		1	BS			○		0.5	occasional collapsing of sidewalls during test pit advancement
		1.0								1.0	
		1.5		2	BS			○		1.5	
		2.0								2.0	
		2.5								2.5	
		3.0								3.0	
		3.5		3	BS			○		3.5	
		4.0								4.0	
		4.5								4.5	
		5.0								5.0	
		5.5								5.5	
		6.0								6.0	
6.10	End of Test Pit										test pit dry at completion

PROJECT MANAGER: **RVD**

CHUNG & VANDER DOELEN
ENGINEERING LTD.
311 Victoria Street North
Kitchener, Ontario N2H 5E1
ph. (519) 742-8979, fx. (519) 742-7739

FILE No: 1669

TEST PIT No. 12

Client: **Timberworx Custom Homes**

Project: **Arkell Subdivision**

Location: **Pt of Lots 7, 8 and 9, Conc. 10, Arkell, Ontario**

EQUIPMENT DATA

Machine: **Excavator**
Method: **Excavator**
Size:
Date: **Dec 19 23** TO **Dec 19 23**

ELEV./ DEPTH (m)	DESCRIPTION Ground Elevation:	DEPTH (m)	SYMBOL	SAMPLE ID	TYPE	N-VALUE	SHEAR STRENGTH (kPa) FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □ 50 100 150 200 PENETRATION RESISTANCE STANDARD ● DYN. CONE ○ 20 40 60 80	WATER CONTENT (%) W_P W W_L 10 20 30	WELL DATA	DEPTH (m)	REMARKS
	450 mm TOPSOIL			1	BS			○			
0.45	trace topsoil/rootlets --- compact to dense brown SAND AND GRAVEL trace silt occ. to frequent cobbles and boulders damp to moist	0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5		2 3	BS BS			○ ○		0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5	occasional collapsing of sidewalls during test pit advancement
6.10	End of Test Pit	6.0								6.0	test pit dry at completion

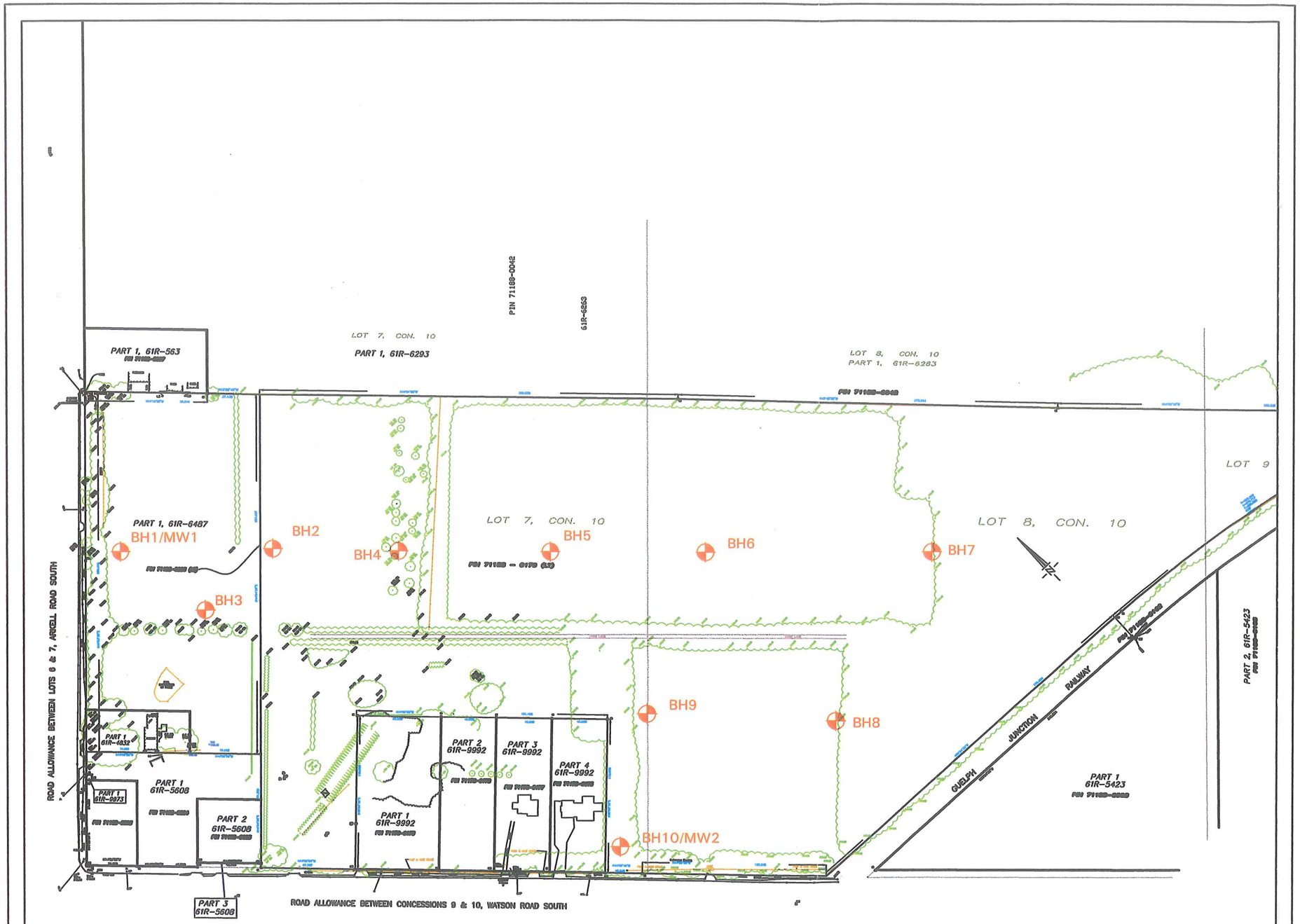
PROJECT MANAGER: **RVD**

CHUNG & VANDER DOELEN ENGINEERING LTD.
311 Victoria Street North
Kitchener, Ontario N2H 5E1
ph. (519) 742-8979, fx. (519) 742-7739

FIGURE 6

KUKOVICA SUBDIVISION
HYDROGEOLOGICAL ASSESSMENT

BOREHOLE / MONITORING WELL LOCATION PLAN



Legend

MONITORING WELL LOCATION

Base Plan Provided by: Van Harten Surveying Inc., Land Surveyors and Engineers, February 2006

0 20 40 60 80 100 120 140 160 180 200 220 240

Meters

1:3,000
February 2006
Project Number: PTA 10312

Prepared by: C. Reynolds

Verified by: D. Marks

BURNSIDE

XREF: PTA10312 SP BASE.DWG

PTA10312 SP.DWG

REFERENCE No: G2547-6-2

BOREHOLE No: 1

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS
405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 2

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: B.R.F.

DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	MONITORING WELL	SAMPLE NUMBER	SAMPLE TYPE	'N' BLOWS/0.3m	PENETRATION RESISTANCE BLOWS/0.3m (20 40 60 80)	WATER CONTENT % (5 10 15 20 25)	UNIT WEIGHT
0.0	Ground Surface	340.5								
0.3	300mm Topsoil	340.2								
	brown, compact to very dense SANDY GRAVEL trace silt, occasional cobble, moist to dry				1	SS	17			
					2	SS	61			
					3	SS	45			
					4	SS	52			
					5	SS	57	150mm		
					6	SS	42			
7.7		332.8								
	brown, very dense SILT some clay, some sand, trace gravel, occasional cobble & boulder, moist				7	SS	79			
9.4		331.1								
9.5	grey Dolostone Rock Fragments wet	331.0			8	SS	50	100mm		
	Auger Refusal/Boulder/Bedrock									

Bentonite Hole Plug
51mm OD Trilock Pipe
W.L. @ 333.3m (February 2, 2006)
Industrial Sand
Screen

DRILLED BY: Aardvark Drilling Inc.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow-Stem Auger

DATUM: Geodetic

DRILL DATE: January 12, 2006

SHEET: 1 of 1

REFERENCE No: G2547-6-2

BOREHOLE No: 10

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

CLIENT: 1648253 Ontario Inc.

PROJECT: Proposed Residential Development

ENCLOSURE No: 11

LOCATION: Pt. Lots 7, 8 & 9, Con. 10, Twp. of Puslinch, ON

SUPERVISOR: MN

SUBSURFACE PROFILE					SAMPLE					
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	MONITORING WELL	NUMBER	TYPE	'N' BLOWS/0.3m	PENETRATION RESISTANCE BLOWS/0.3m (20 40 60 80)	WATER CONTENT % (5 10 15 20 25)	UNIT WEIGHT
0.0	Ground Surface	344.9								
0.8	800mm Topsoil	344.1								
	brown, very dense GRAVEL AND SAND some silt, occasional cobble, dry				1	SS	65			
					2	SS	64			
					3	SS	50	50mm		
					4	SS	40			
					5	SS	76	275mm		
6.9		338.0								
	brown, very dense GRAVELLY, SILTY SAND TILL dry				6	SS	52			
					7	SS	91			
					8	SS	74			
10.1		334.8								
11.0	brown, very dense SAND AND SILT trace clay, trace gravel, saturated	333.9			9	SS	68			
11.7	brown, very dense GRAVELLY, SILTY SAND TILL moist	333.2								
12.6	brown, very dense SAND some silt, trace gravel, wet	332.3			10	SS	86	250mm		
	End of Borehole									

Bentonite Hole Plug
Industrial Sand
Auger Cuttings
W.L. @ 334.9m (February 2, 2006)
51mm OD Trilock Pipe
Screen

DRILLED BY: Aardvark Drilling Inc.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow-Stem Auger

DATUM: Geodetic

DRILL DATE: January 16, 2006

SHEET: 1 of 1

AGAT® Laboratories

Certificate of Analysis

AGAT WORK ORDER: 06T154459

PROJECT NO: 10312.0

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: David Wilson

Water Quality Assessment

DATE SAMPLED: January 26 2006 **DATE RECEIVED:** January 30 2006 **DATE REPORTED:** February 07 2006 **SAMPLE TYPE:** Water

	Unit	G / S	M.D.L.	MW1 494294	M.D.L	MW2 494295
Electrical Conductivity	uS/cm		2	808	2	792
pH	N/A			8.05		8.05
Saturation pH			N/A	6.93	N/A	6.84
Total Dissolved Solids	mg/L		20	414	20	450
Total Hardness (as CaCO3)	mg/L		10	291	10	348
Alkalinity (as CaCO3)	mg/L		10	294	10	299
Bicarbonate (as CaCO3)	mg/L		10	294	10	299
Carbonate (as CaCO3)	mg/L		10	<10	10	<10
Hydroxide	mg/L		10	<10	10	<10
Fluoride	mg/L	1.5	0.05	0.08	0.05	0.09
Chloride	mg/L		0.10	70.9	0.10	51.0
Bromide	mg/L		0.05	<0.05	0.05	0.18
Nitrate as N	mg/L	10.0	0.05	3.34	0.05	4.18
Nitrite as N	mg/L	1.0	0.05	<0.05	0.05	0.09
Sulphate	mg/L		0.10	15.3	0.10	27.0
Calcium	mg/L		0.05	71.5	0.05	79.6
Magnesium	mg/L		0.05	27.3	0.05	36.3
Sodium	mg/L	20	0.05	**38.9**	0.05	16.5
Potassium	mg/L		0.05	9.68	0.05	2.11
Ammonia (as N)	mg/L		0.05	0.76	0.05	1.01
Orthophosphate as P	mg/L		0.10	<0.10	0.10	<0.10
Total Organic Carbon *	mg/L		5	154	1	21
Reactive Silica *	mg/L		0.05	7.54	0.05	10.2
Colour	Colour Units		5	<5	5	<5
Turbidity	NTU		0.5	3.8	0.5	2.0
Aluminum	mg/L		0.004	0.020	0.004	0.015
Arsenic	mg/L	0.025	0.003	<0.003	0.003	<0.003
Barium	mg/L	1.0	0.002	0.032	0.002	0.021
Boron	mg/L	5.0	0.010	0.025	0.010	0.076
Cadmium	mg/L	0.005	0.002	<0.002	0.002	<0.002
Chromium	mg/L	0.05	0.003	<0.003	0.003	<0.003

Certified By: Jonathan Takeuchi

AGAT® Laboratories

Certificate of Analysis

AGAT WORK ORDER: 06T154459
PROJECT NO: 10312.0

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: David Wilson

Water Quality Assessment

DATE SAMPLED: January 26 2006 **DATE RECEIVED:** January 30 2006 **DATE REPORTED:** February 07 2006 **SAMPLE TYPE:** Water

	Unit	G / S	M.D.L.	MW1 494294	M.D.L	MW2 494295
Copper	mg/L		0.003	0.004	0.003	0.004
Iron	mg/L		0.005	0.349	0.005	0.341
Lead	mg/L	0.01	0.002	<0.002	0.002	<0.002
Manganese	mg/L		0.002	0.018	0.002	0.140
Mercury	mg/L	0.001	0.0001	<0.0001	0.0001	<0.0001
Molybdenum	mg/L		0.002	<0.002	0.002	0.012
Nickel	mg/L		0.003	<0.003	0.003	<0.003
Total Phosphorus	mg/L		0.05	0.11	0.05	0.59
Selenium	mg/L	0.01	0.004	<0.004	0.004	<0.004
Silver	mg/L		0.002	<0.002	0.002	<0.002
Strontium	mg/L		0.005	0.093	0.005	0.137
Thallium	mg/L		0.006	<0.006	0.006	<0.006
Titanium	mg/L		0.001	<0.001	0.001	<0.001
Uranium	mg/L	0.02	0.001	<0.001	0.001	<0.001
Vanadium	mg/L		0.001	<0.001	0.001	<0.001
Zinc	mg/L		0.004	0.016	0.004	0.022
% Difference/Ion Balance	%			4.0		5.54
Langlier Index				1.12		1.21

Comments: M.D.L. - Method Detection Limit; G / S - Guideline / Standard: Refers to ODWS-Schedule 23

494294 * Analysis performed at AGAT Laboratories Calgary.

494295 * Analysis performed at AGAT Laboratories Calgary.

Certified By: Joshy Takeuchi

CROZIER CONSULTING ENGINEERS

Project Name:	Arkell Development
Project Number:	2433-6646
Date:	2023-01-18
Designed By:	JD
Checked By:	KR

D-5-4 IMPACT ASSESSMENT - CONCEPT PLAN - 35 Lots

Calculate the Nitrate Concentration at a Boundary (Property *or* Surface Water)

Parameter	Value	Unit	Notes:
Infiltration Volume			
Area of Dilution =	20.4	ha	Total area of site
Background Nitrate Quality in Groundwater =	3.76	mg/L	Average nitrate concentration from January 26, 2006 sampling event (Burnside, 2006)
Annual Infiltration Rate =	200	mm/m2/yr	MECP infiltration rate for sand.
	5,479.45	L/ha/day	
Annual Infiltration Volume =	40,800	m^3/year	
Total Average Background Nitrate =	420,296	mg/day	
Sewage Effluent Volume			
Proposed Number of Lots	35		
Average Daily Volume of Sewage Effluent =	1,000	L/day	
Number of Days of Operation/Use =	365	days/year	
Annual Volume of Sewage Effluent =	12,775	m^3/year	
Totals			
Total Dilutant = wastewater V + infiltration V =	53,575	m^3/year	
Scenario 1 - Conventional System			
Nitrate Concentration in wastewater =	40.0	mg/L	
Total Average Nitrate Loading =	1,400,000	mg/day	
Nitrate Concentration in Percolate =	**12.40**	**mg/L**	
Scenario 2 - Level IV Treatment with 50% Nitrogen Removal			
Nitrate Concentration in wastewater =	20.0	mg/L	
Total Average Nitrate Loading =	700,000	mg/day	
Nitrate Concentration in Percolate =	**7.63**	**mg/L**	
Scenario 3 - Level IV Treatment with 75% Nitrogen Removal			
Nitrate Concentration in wastewater =	10.0	mg/L	
Total Average Nitrate Loading =	350,000	mg/day	
Nitrate Concentration in Percolate =	**5.25**	**mg/L**	

CROZIER CONSULTING ENGINEERS

Project Name:	Arkell Development
Project Number:	2433-6646
Date:	2023-01-18
Designed By:	JD
Checked By:	KR

D-5-4 IMPACT ASSESSMENT - CONCEPT PLAN - 40 Lots

Calculate the Nitrate Concentration at a Boundary (Property *or* Surface Water)

Parameter	Value	Unit	Notes:
Infiltration Volume			
Area of Dilution =	20.4	ha	Total area of site
Background Nitrate Quality in Groundwater =	3.76	mg/L	Average nitrate concentration from January 26, 2006 sampling event (Burnside, 2006)
Annual Infiltration Rate =	200	mm/m2/yr	MECP infiltration rate for sand.
	5,479.45	L/ha/day	
Annual Infiltration Volume =	40,800	m^3/year	
Total Average Background Nitrate =	420,296	mg/day	
Sewage Effluent Volume			
Proposed Number of Lots	40		
Average Daily Volume of Sewage Effluent =	1,000	L/day	
Number of Days of Operation/Use =	365	days/year	
Annual Volume of Sewage Effluent =	14,600	m^3/year	
Totals			
Total Dilutant = wastewater V + infiltration V =	55,400	m^3/year	
Scenario 1 - Conventional System			
Nitrate Concentration in wastewater =	40.0	mg/L	
Total Average Nitrate Loading =	1,600,000	mg/day	
Nitrate Concentration in Percolate =	**13.31**	**mg/L**	
Scenario 2 - Level IV Treatment with 50% Nitrogen Removal			
Nitrate Concentration in wastewater =	20.0	mg/L	
Total Average Nitrate Loading =	800,000	mg/day	
Nitrate Concentration in Percolate =	**8.04**	**mg/L**	
Scenario 3 - Level IV Treatment with 75% Nitrogen Removal			
Nitrate Concentration in wastewater =	10.0	mg/L	
Total Average Nitrate Loading =	400,000	mg/day	
Nitrate Concentration in Percolate =	**5.40**	**mg/L**	

CROZIER CONSULTING ENGINEERS

Project Name:	Arkell Development
Project Number:	2433-6646
Date:	2024-02-26
Designed By:	ZS
Checked By:	KR

D-5-4 IMPACT ASSESSMENT - CONCEPT PLAN - 50 Lots

Calculate the Nitrate Concentration at a Boundary (Property *or* Surface Water)

Parameter	Value	Unit	Notes:
Infiltration Volume			
Area of Dilution =	20.4	ha	Total area of site
Background Nitrate Quality in Groundwater =	3.76	mg/L	Average nitrate concentration from January 26, 2006 sampling event (Burnside, 2006)
Annual Infiltration Rate =	200	mm/m2/yr	MECP infiltration rate for sand.
	5,479.45	L/ha/day	
Annual Infiltration Volume =	40,800	m^3/year	
Total Average Background Nitrate =	420,296	mg/day	
Sewage Effluent Volume			
Proposed Number of Lots	50		
Average Daily Volume of Sewage Effluent =	1,000	L/day	
Number of Days of Operation/Use =	365	days/year	
Annual Volume of Sewage Effluent =	18,250	m^3/year	
Totals			
Total Dilutant = wastewater V + infiltration V =	59,050	m^3/year	
Scenario 1 - Conventional System			
Nitrate Concentration in wastewater =	40.0	mg/L	
Total Average Nitrate Loading =	2,000,000	mg/day	
Nitrate Concentration in Percolate =	**14.96**	**mg/L**	
Scenario 2 - Level IV Treatment with 50% Nitrogen Removal			
Nitrate Concentration in wastewater =	20.0	mg/L	
Total Average Nitrate Loading =	1,000,000	mg/day	
Nitrate Concentration in Percolate =	**8.78**	**mg/L**	
Scenario 3 - Level IV Treatment with 75% Nitrogen Removal			
Nitrate Concentration in wastewater =	10.0	mg/L	
Total Average Nitrate Loading =	500,000	mg/day	
Nitrate Concentration in Percolate =	**5.69**	**mg/L**	

Ministry of Citizenship and Multiculturalism (MCM)

Archaeology Program Unit
Heritage Branch
Citizenship, Inclusion and Heritage Division
5th Floor, 400 University Ave.
Toronto ON M7A 2R9
Tel.: (416) 414-7787
Email: Jessica.Marr@ontario.ca

Ministère des Affaires civiques et du Multiculturalisme (MCM)

Unité des programme d'archéologie
Direction du patrimoine
Division de la citoyenneté, de l'inclusion et du patrimoine
5e étage, 400 ave. University
Toronto ON M7A 2R9
Tél. : (416) 414-7787
Email: Jessica.Marr@ontario.ca

Mar 12, 2024

Kara Adams (P1289)
Lincoln Environmental Consulting Corp
6807 Calvert Strathroy ON N7G 3H5

RE: Review and Entry into the Ontario Public Register of Archaeological Reports: Archaeological Assessment Report Entitled, "STAGE 1-2 ARCHAEOLOGICAL ASSESSMENT OF THE ARKELL LANDS IN PART OF LOTS 7, 8 & 9, CONCESSION 10, TOWNSHIP PUSLINCH, WELLINGTON COUNTY, ONTARIO", Dated Jan 24, 2024, Filed with MCM Toronto Office on Jan 26, 2024, MCM Project Information Form Number P1289-0424-2023, MCM File Number 0019127

Dear Dr. Adams:

This office has reviewed the above-mentioned report, which has been submitted to this ministry as a condition of licensing in accordance with Part VI of the *Ontario Heritage Act*, R.S.O. 1990, c 0.18.[1] This review has been carried out in order to determine whether the licensed professional consultant archaeologist has met the terms and conditions of their licence, that the licensee assessed the property and documented archaeological resources using a process that accords with the 2011 *Standards and Guidelines for Consultant Archaeologists* set by the ministry, and that the archaeological fieldwork and report recommendations are consistent with the conservation, protection and preservation of the cultural heritage of Ontario.

The report documents the assessment of the study area as depicted in Figure 4 of the above titled report and recommends the following:

The Stage 2 archaeological assessment was carried out in accordance with the Ministry of Heritage, Sport, Tourism, and Culture Industries' Standards and Guidelines for Consultant Archaeologists (Government of Ontario 2011).

All work met provincial standards and no archaeological sites were identified during the Stage 2 assessment. If construction plans change to incorporate new areas that were not subject to a Stage 2 field survey, these must be assessed prior to the initiation of construction. In keeping with legislative stipulations, all construction, and demolition-related impacts (including, for example, machine travel, material storage and stockpiling, earth moving) must be restricted to the areas that were archaeologically assessed and cleared by the Ministry of Heritage, Sport, Tourism, and Culture Industries through acceptance of the assessment report into the provincial register.

As no archaeological resources were found on the subject property, no further archaeological assessment of the property is required.

Based on the information contained in the report, the ministry is satisfied that the fieldwork and reporting for the archaeological assessment are consistent with the ministry's 2011 *Standards and Guidelines for Consultant Archaeologists* and the terms and conditions for archaeological licences. This report has been entered into the Ontario Public Register of Archaeological Reports. Please note that the ministry makes no representation or warranty as to the completeness, accuracy or quality of reports in the register.

Should you require any further information regarding this matter, please feel free to contact me.

Sincerely,

Jessica Marr
Archaeology Review Officer

cc. Archaeology Licensing Officer
rob stovel,stovel and associates
tbd tbd,tbd

[1] *In no way will the ministry be liable for any harm, damages, costs, expenses, losses, claims or actions that may result: (a) if the Report(s) or its recommendations are discovered to be inaccurate, incomplete, misleading or fraudulent; or (b) from the issuance of this letter. Further measures may need to be taken in the event that additional artifacts or archaeological sites are identified or the Report(s) is otherwise found to be inaccurate, incomplete, misleading or fraudulent.*

STAGE 1-2 ARCHAEOLOGICAL ASSESSMENT OF THE ARKELL LANDS IN PART OF LOTS 7, 8 & 9, CONCESSION 10, TOWNSHIP OF PUSLINCH, WELLINGTON COUNTY, ONTARIO

SUBMITTED TO

TIMBERWORX CUSTOM HOMES INC.

AND

THE ONTARIO MINISTRY OF CITIZENSHIP AND MULTICULTURALISM

REPORT TYPE: ORIGINAL

ARCHAEOLOGICAL LICENSE NUMBER P1289, KARA ADAMS

PIF P1289-0424-2023

JANUARY 2024

LINCOLN ENVIRONMENTAL CONSULTING

January 2024

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LINCOLN ENVIRONMENTAL CONSULTING

January 2024

Executive Summary

Lincoln Environmental Consulting Corp. (LEC) was retained by Timberworx Custom Homes Inc. to complete a Stage 1-2 archaeological assessment of the Arkell Lands to meet the requirements of the *Planning Act* (Government of Ontario 2014) in advance of a planning permit. The study area measures approximately 16.80 hectares in size and is located in part of Lots 7, 8 & 9, Concession 10, Township of Puslinch, Wellington County, Ontario.

This assessment was triggered by the Provincial Policy Statement that is informed by the *Planning Act* (Government of Ontario 1990a), which states that decisions affecting planning matters must be consistent with the policies outlined in the larger *Ontario Heritage Act* (1990b). According to Section 2.6.2 of the PPS, "*development* and *site alteration* shall not be permitted on lands containing *archaeological resources* or *areas of archaeological potential* unless *significant archaeological resources* have been *conserved*."

In accordance with Section 1.3.1 of the Ministry of Tourism, Culture and Sport's (MHSTCI) 2011 *Standards and Guidelines for Consultant Archaeologists* (Government of Ontario 2011), the Stage 1 archaeological assessment of the Arkell Lands has determined that the study area exhibits high potential for the identification and recovery of archaeological resources and a Stage 2 archaeological assessment is recommended.

The Stage 2 assessment was conducted on May 10th and May 11th 2023, under archaeological consulting license P1289 issued to Kara Adams, MSc, of LEC by the MHSTCI. No archaeological resources were identified during the Stage 2 archaeological assessment of the study area, and as such **no further archaeological assessment of the property is recommended.**

The MHSTCI is asked to review the results presented and accept this report into the Ontario Public Register of Archaeological Reports.

LINCOLN ENVIRONMENTAL CONSULTING

January 2024

Project Personnel

Licensed Archaeologist:	Kara Adams, MSC (P1289)
Project Manager:	Derek Lincoln, MA (P344)
Licensed Field Director:	Carley Adams, MSc (R1319)
Field Technicians:	Owen Gillet, Nick Maharaj, Owen McGrenere, Michael Bagnall, Jayden Duncan, Uluc Yumurutug, Tyler Glanville, Christian Drasovean, Zach Hagarth, Jacob Chrisjohn
GIS Specialist:	Derek Lincoln, MA (P344)
Report Writer:	Carley Adams, MSc (R1319)
Senior Review:	Derek Lincoln, MA (P344)

Acknowledgements

Proponent Contact:	Rob Stovel, Stovel Associates

LINCOLN ENVIRONMENTAL CONSULTING

1.0 PROJECT CONTEXT

1.1 DEVELOPMENT CONTEXT

Lincoln Environmental Consulting Corp. (LEC) was retained by Timberworx Custom Homes Inc. to complete a Stage 1-2 archaeological assessment of the Arkell Lands to meet the requirements of the *Planning Act* (Government of Ontario 2014) in advance of a planning permit. The study area measures approximately 16.80 hectares in size and is located in part of Lots 7, 8 & 9, Concession 10, Township of Puslinch, Wellington County, Ontario.

This assessment was triggered by the PPS that is informed by the *Planning Act* (Government of Ontario 1990a), which states that decisions affecting planning matters must be consistent with the policies outlined in the larger *Ontario Heritage Act* (1990b). According to Section 2.6.2 of the PPS, "*development* and *site alteration* shall not be permitted on lands containing *archaeological resources* or *areas of archaeological potential* unless *significant archaeological resources* have been *conserved*."

Permission to enter the study area and document archaeological resources was provided by Rob Stovel of Stovel and Associates Inc.

1.1.1 Objectives

In compliance with the provincial standards and guidelines set out in the Ministry of Heritage, Sport, Tourism, and Culture Industries' (MHSTCI) 2011 *Standards and Guidelines for Consultant Archaeologists* (Government of Ontario 2011), the objectives of the Stage 1 Archaeological Overview/Background Study are as follows:

- To provide information about the study area's geography, history, previous archaeological fieldwork, and current land conditions;
- To evaluate in detail the study area's archaeological potential which will support recommendations for Stage 2 survey for all or parts of the property; and
- To recommend appropriate strategies for Stage 2 survey.

To meet these objectives LEC archaeologists employed the following research strategies:

- A review of relevant archaeological, historic and environmental literature pertaining to the study area;
- A review of the land use history, including pertinent historic maps; and
- An examination of the Ontario Archaeological Sites Database (ASDB) to determine the presence of known archaeological sites in and around the project area.

The objective of the Stage 2 assessment was to provide an overview of archaeological resources on the property and to determine whether any of the resources might be archaeological sites with cultural heritage value or interest and to provide specific direction for the protection, management and/or recovery of these resources. In compliance with the provincial standards and guidelines set out in the MHSTCI' 2011 *Standards and Guidelines for Consultant Archaeologists* (Government of Ontario 2011), the objectives of the Stage 2 Property Assessment are as follows:

- To document all archaeological resources within the study area;
- To determine whether the study area contains archaeological resources requiring further assessment; and
- To recommend appropriate Stage 3 assessment strategies for archaeological sites identified.

1.2 HISTORICAL CONTEXT

The study area is 16.80 hectares of which approximately 57% consists of active agricultural fields, and 43% consists of manicured lawn and woodlot. The study area is located at the Arkell Lands in part of Lots 7, 8 & 9, Concession 10, Township of Puslinch, Wellington County, Ontario.

1.2.1 Pre and Early Post-Contact Aboriginal Resources

Our knowledge of past First Peoples settlement and land use in Wellington County is incomplete. Nonetheless, using province-wide (MCCR 1997) and region-specific archaeological data, a generalized cultural chronology for native settlement in the area can be proposed. The following paragraphs provide a basic textual summary of the known general cultural trends and a tabular summary appears in Table 1.

The Paleoindian Period

The first human populations to inhabit Ontario came to the region between 12,000 and 10,000 years ago, coincident with the end of the last period of glaciation. Climate and environmental conditions were significantly different than they are today; local environs would not have been welcoming to anything but short-term settlement. Termed Paleoindians by archaeologists, Ontario first peoples would have crossed the landscape in small groups (i.e., bands or family units) searching for food, particularly migratory game species. In the area, caribou may have provided the staple of the Paleoindian diet, supplemented by wild plants, small game, birds and fish. Given the low density of populations on the landscape at this time and their mobile nature, Paleoindian sites are small and ephemeral. They are usually identified by the presence of fluted projectile points and other finely made stone tools.

Archaic

The archaeological record of early native life in Southern Ontario indicates a change in lifeways beginning circa 10,000 years ago at the start of what archaeologists call the Archaic Period. The Archaic populations are better known than their Paleoindian predecessors, with numerous sites found throughout the area. The characteristic projectile points of early Archaic populations appear similar in some respects to early varieties

and are likely a continuation of early trends. Archaic populations continued to rely heavily on game, particularly caribou, but diversified their diet and exploitation patterns with changing environmental conditions. A seasonal pattern of warm season riverine or lakeshore settlements and interior cold weather occupations has been documented in the archaeological record. Since the large cold weather mammal species that formed the basis of the Paleoindian subsistence pattern became extinct or moved northward with the onset of warmer climates, Archaic populations had a more varied diet, exploiting a range of plant, bird, mammal and fish species. Reliance on specific food resources like fish, deer and nuts becomes more pronounced through time and the presence of more hospitable environs and resource abundance led to the expansion of band and family sizes. In the archaeological record, this is evident in the presence of larger sites and aggregation camps, where several families or bands would come together in times of resource abundance. The change to more preferable environmental circumstances led to a rise in population density. As a result, Archaic sites are more abundant than those from the earlier period. Artifacts typical of these occupations include a variety of stemmed and notched projectile points, chipped stone scrapers, ground stone tools (e.g. celts, adzes) and ornaments (e.g. bannerstones, gorgets), bifaces or tool blanks, animal bone and waste flakes, a by-product of the tool making process.

Woodland Period

Significant changes in cultural and environmental patterns are witnessed in the Woodland Period (circa 950 B.C to historic times). The coniferous forests of earlier times were replaced by stands of mixed and deciduous species. Occupations became increasingly more permanent in this period, culminating in major semi-permanent villages by 1,000 years ago. Archaeologically, the most significant changes by Woodland times are the appearance of artifacts manufactured from modeled clay and the construction of house structures. The Woodland Period is often defined by the occurrence of pottery, storage facilities and residential areas similar to those that define the incipient agricultural or Neolithic period in Europe. The earliest pottery was rather crudely made by the coiling method and house structures were simple enclosures.

Iroquoian Period

The primary Late Woodland occupants of the area were the Neutral Nation, an Iroquoian speaking population described by European missionaries. Like other known Iroquoian groups including the Huron (Wendat) and Petun, the Neutral practiced a system of intensive horticulture based on three primary subsistence crops (corn, beans and squash). Neutral villages incorporated a number of longhouses, multi-family dwellings that contained several families related through the female line. The Jesuit Relations describe several Neutral centres in existence in the 17th century, including a number of sites where missions were later established. While precontact Neutral sites may be identified by a predominance of well-made pottery decorated with various simple and geometric motifs, triangular stone projectile points, clay pipes and ground stone implements, sites post-dating European contact are recognized through the appearance of various items of European manufacture. The latter include materials acquired by trade (e.g., glass beads, copper/brass kettles, iron axes, knives and other metal implements) in addition to the personal items of European visitors and Jesuit priests (e.g., finger rings, stoneware, rosaries, glassware). The Neutral were dispersed, and their population decimated by the arrival of epidemic European diseases and inter-tribal warfare.

Table 1: Cultural Chronology for Native Settlement within Wellington County

Period			Time Range (circa)	Diagnostic Features	Complexes
Paleoindian	Early		9000 – 8400 B.C.	fluted projectile points	Gainey, Barnes, Crowfield
	Late		8400 – 8000 B.C.	non-fluted and lanceolate points	Holcombe, Hi-Lo, Lanceolate
Archaic	Early		8000 – 6000 B.C.	serrated, notched, bifurcate base points	Nettling, Bifurcate Base Horizon
	Middle		6000 – 2500 B.C.	stemmed, side & corner notched points	Brewerton, Otter Creek, Stanly/Neville
	Late		2000 – 1800 B.C.	narrow points	Lamoka
			1800 – 1500 B.C.	broad points	Genesee, Adder Orchard, Perkiomen
			1500 – 1100 B.C.	small points	Crawford Knoll
	Terminal		1100 – 850 B.C.	first true cemeteries	Hind
Woodland	Early		800 – 400 B.C.	expanding stemmed points, Vinette pottery	Meadowood
	Middle		400 B.C. – A.D. 600	thick coiled pottery, notched rims; cord marked	Couture
	Late	Western Basin	A.D. 600 – 900	Wayne ware, vertical cord marked ceramics	Riviere au Vase-Algonquin
			A.D. 900 – 1200	first corn; ceramics with multiple band impressions	Young- Algonquin
			A.D. 1200 – 1400	longhouses; bag shaped pots, ribbed paddle	Springwells-Algonquin
			A.D 1400-1600	villages with earthworks; Parker Festoon pots	Wolf- Algonquin
Contact		Aboriginal	A.D. 1600 – 1700	early historic native settlements	Neutral Huron, Odawa, Wenro
		Euro-Canadian	A.D. 1700-1760	fur trade, missionization, early military establishments	French
			A.D. 1760-1900	Military establishments, pioneer settlement	British colonials, UELs

1.2.2 Historic Euro-Canadian Resources

The 1878 *Illustrated Historical Atlas of Wellington County's* map of the Township of Puslinch depicts a settled urban landscape with several landowners, structures, early transportation routes, and early town sites. A portion of the 1878 historic map of the Township of Puslinch is depicted in Figure 3, and this part of the Lot is listed as being owned by J. Bell, with a single structure depicted near the study area.

1.3 ARCHAEOLOGICAL CONTEXT

The study area is 16.80 hectares of which approximately 57% consists of active agricultural fields, and 43% consists of manicured lawn and woodlot. The study area is located at the Arkell Lands in part of Lots 7, 8 & 9, Concession 10, Township of Puslinch, Wellington County, Ontario.

1.3.1 The Natural Environment

The project area is located in the Horseshow Moraines physiographic region as identified by Chapman and Putnam (1984:127-129).

> *From the edge of the escarpment in the Town of Caledon the moraines trend somewhat west of the Niagara Escarpment forming a belt of moderately hilly relief… Associated with the moraines is a system of old spillways with broad gravel terraces and swampy floors… Good cross-sections of this landscape may be seen along Highway 7 from Rockwood to Georgetown.*
>
> (Chapman and Putnam 1984:128)

The soils here are comprised of sandy loam, ideal for agricultural practices and aboriginal settlement.

Potable water is the single most important resource for any extended human occupation or settlement and since water sources in southwestern Ontario have remained relatively stable over time, proximity to drinkable water is regarded as a useful index for the evaluation of archaeological site potential. In fact, distance to water is one of the most commonly used variables for predictive modeling of archaeological site location in Ontario. The closest extant source of potable water is the Eramosa River which passes north-west of the study area.

1.3.2 Previously Known Archaeological Sites and Surveys

In order to compile an inventory of archaeological resources, the registered archaeological site records kept by the MHSTCI were consulted. In Ontario, information concerning archaeological sites stored in the ASDB is maintained by the MHSTCI. This database contains archaeological sites registered according to the Borden system. Under the Borden system, Canada is divided into grid blocks based on latitude and longitude. A Borden Block is approximately 13 kilometers east to west and approximately 18.5 kilometers north to south. Each Borden Block is referenced by a four-letter designator and sites within a block are numbered sequentially as they are found.

Information concerning specific site locations is protected by provincial policy and is not fully subject to the *Freedom of Information and Protection of Privacy Act*. The release of such information in the past has led to looting or various forms of illegally conducted site destruction. Confidentiality extends to all media capable of conveying location, including maps, drawings, or textual descriptions of a site location. The MHSTCI will provide information concerning site location to the party or an agent of the party holding title to a property, or to a licensed archaeologist with relevant cultural resource management interests.

An examination of the ASDB has shown that there are 15 archaeological sites registered within a one-kilometer radius of the study area (Sites Data Search, Government of Ontario, May 5th, 2023); Table 2

summarizes the registered archaeological sites within one-kilometer of the study area. None of the sites fall within the current study area, nor within 50m of it.

Table 2: Registered Archaeological Sites within One Kilometer of the Study Area

Borden #	Site Name	Site Type	Cultural Affiliation
AjHa-56		Findspot	Archaic, Middle
AjHa-6	Starkey	Unknown	Post-Contact
AjHb-102		Other site	Woodland, Early
AjHb-103		Findspot	Woodland, Early
AjHb-104		Findspot	Archaic, Middle
AjHb-112		Scatter	Pre-Contact
AjHb-116		Scatter	Pre-Contact
AjHb-119	Haines	Homestead	Post-Contact, Euro-Canadian
AjHb-124	P191	Scatter	Pre-Contact
AjHb-125	Haines 1	Farmstead	Post-Contact
AjHb-95		Findspot	Archaic, Early
AjHb-96		Findspot	Archaic, Early
AjHb-97		Findspot	Archaic, Early
AjHb-98	Arkell 1	Other/discrete refuse Deposit, cabin	Post-Contact, Euro-Canadian
AjHb-99	Arkell 2	Homestead	Post-Contact

1.3.3 Summary of Past Archaeological Investigations within 50 Metres

There have been no documented archaeological investigations within 50 metres of the study area. However, it should be noted that the Ministry of Citizenship and Multiculturalism currently does not provide a complete inventory of archaeological assessments carried out within 50 metres of a property, so a complete inventory of assessments on lands adjacent to the subject property cannot be provided.

1.3.4 Archaeological Potential

Archaeological potential is established by determining the likelihood that archaeological resources may be present on a subject property. LEC applied archaeological potential criteria commonly used by MHSTCI (Government of Ontario 2011) to determine areas of archaeological potential within the region under study. These variables include proximity to previously identified archaeological sites, distance to various types of water sources, soil texture and drainage, glacial geomorphology, elevated topography and the general topographic variability of the area.

Distance to modern or ancient water sources is generally accepted as the most important determinant of past human settlement patterns and, considered alone, may result in a determination of archaeological potential. However, any combination of two or more other criteria, such as well-drained soils or topographic

variability, may also indicate archaeological potential. Finally, extensive land disturbance can eradicate archaeological potential (Wilson and Horne 1995).

As discussed above, distance to water is an essential factor in archaeological potential modeling. When evaluating distance to water it is important to distinguish between water and shoreline, as well as natural and artificial water sources, as these features affect sites' locations and types to varying degrees. The MHSTCI categorizes water sources in the following manner:

- Primary water sources: lakes, rivers, streams, creeks;
- Secondary water sources: intermittent streams and creeks, springs, marshes and swamps;
- Past water sources: glacial lake shorelines, relic river or stream channels, cobble beaches, shorelines of drained lakes or marshes; and
- Accessible or inaccessible shorelines: high bluffs, swamp or marshy lake edges, sandbars stretching into marsh.

The closest extant source of potable water is the Eramosa River which passes north-west of the study area. The water resources that exist and existed close to the study area indicate archaeological potential.

Soil texture can be an important determinant of past settlement, usually in combination with other factors such as topography. As indicated previously, the soils within the study area are variable, but include pockets of well-drained and sandy soils that would be suitable for pre-contact Aboriginal agriculture.

An examination of the ASDB has shown that there are 15 archaeological sites registered within a one-kilometer radius of the study area, though none of them lie within it, nor within 50 meters of it.

For Euro-Canadian sites, archaeological potential can be extended to areas of early Euro-Canadian settlement, including places of military or pioneer settlements; early transportation routes; and properties listed on the municipal register or designated under the *Ontario Heritage Act* or property that local histories or informants have identified with possible historical events. The *Illustrated Historical Atlas of Wellington County* demonstrates that the study area and its environs were densely occupied by Euro-Canadian settlers by the later 19th century. Much of the established road system and agricultural settlement from that time is still visible today.

When the above listed criteria are applied to the study area, the archaeological potential for pre-contact Aboriginal, post-contact Aboriginal, and Euro-Canadian sites is deemed to be moderate to high. Thus, in accordance with Section 1.3.1 of the MHSTCI' 2011 *Standards and Guidelines for Consultant Archaeologists* (Government of Ontario 2011), the Stage 1 archaeological assessment of the Arkell Lands has determined that the study area exhibits moderate to high potential for the identification and recovery of archaeological resources and a Stage 2 archaeological assessment is recommended.

2.0 FIELD METHODS

The Stage 2 assessment of the Arkell Lands was conducted on May 10th, 2023 under PIF # P1289-0424-2023 issued to Kara Adams, MSc, of LEC by the MHSTCI. The study area is 16.80 hectares of which approximately 57% consists of active agricultural fields, and 43% consists of manicured lawn and woodlot. The study area is located at the Arkell Lands in part of Lots 7, 8 & 9, Concession 10, Township of Puslinch, Wellington County, Ontario.

During the Stage 2 survey, assessment conditions were excellent and at no time were the field, weather, or lighting conditions detrimental to the recovery of archaeological material (Table 4). Photos 1 to 15 confirm that field conditions met the requirements for a Stage 2 archaeological assessment, as per the MHSTCI' 2011 *Standards and Guidelines for Consultant Archaeologists* (Section 7.8.6 Standard 1a; Government of Ontario 2011). Figure 4 provides an illustration of the Stage 2 assessment methods, as well as photograph locations and directions.

Table 3: Field and Weather Conditions

Date	Activity	Weather	Field Conditions
May 10th, 2023	Pedestrian survey and test pit survey	Cool, overcast	Soils dry and friable, screens well; >90% visibility
May 11th 2023	Pedestrian survey and test pit survey	Cool, overcast	Soils dry and friable, screens well; >90% visibility

Approximately 43% of the study area consists of manicured lawn and woodlot. These areas were subject to test pit survey at 5-metre intervals in accordance with Section 2.1.2 of the MHSTCI's 2011 *Standards and Guidelines for Consultant Archaeologists* (Government of Ontario 2011). Each test pit was at least 30 centimeters in diameter and excavated five centimeters into sterile subsoil. Test pitting was conducted within one meter of built structures in accordance with Section 2.1.1 Standard 4 of the MHSTCI's 2011 Standards and Guidelines for Consultant Archaeologists (Government of Ontario 2011). The soils and test pits were then examined for stratigraphy, cultural features, or evidence of fill. All soil was screened through six-millimeter (mm) mesh hardware cloth to facilitate the recovery of small artifacts and then used to backfill the pit. No further archaeological methods were employed since no artifacts were recovered during the test pit survey.

Approximately 57% of the study area consists of active agricultural fields. These areas were subject to pedestrian survey at 5-metre intervals in accordance with Section 2.1.1 of the MHSTCI's *2011 Standards and Guidelines for Consultant Archaeologists* (Government of Ontario 2011). These areas were ploughed and allowed to weather sufficiently. The conditions at the time of assessment were optimal and soil surface visibility was greater than 90%. No further archaeological methods were employed since no artifacts were recovered during the pedestrian survey.

3.0 RECORD OF FINDS

The Stage 2 archaeological assessment was conducted employing the methods described in Section 2.0. An inventory of the documentary record generated by fieldwork is provided in Table 5 below. No archaeological resources were identified during the Stage 2 archaeological assessment of the study area.

Table 4: Inventory of Documented Record

Document Type	Current Location of Document Type	Additional Comments
1 Page1 of field notes	LEC office, London	In original field book and photocopied in project file
1 Hand drawn map	LEC office, London	In original field book and photocopied in project file
1 map provided by Client	LEC office, London	Hard and digital copies in project file
38 Digital photographs	LEC office, London	Stored digitally in project file

4.0 ANALYSIS AND CONCULSION

Approximately 43% of the study area consists of manicured lawn and woodlot. These areas were subject to test pit survey at 5-metre intervals in accordance with Section 2.1.2 of the MHSTCI's 2011 *Standards and Guidelines for Consultant Archaeologists* (Government of Ontario 2011). Each test pit was at least 30 centimeters in diameter and excavated five centimeters into sterile subsoil. Test pitting was conducted within one meter of built structures in accordance with Section 2.1.1 Standard 4 of the MHSTCI's 2011 Standards and Guidelines for Consultant Archaeologists (Government of Ontario 2011). The soils and test pits were then examined for stratigraphy, cultural features, or evidence of fill. All soil was screened through six-millimeter (mm) mesh hardware cloth to facilitate the recovery of small artifacts and then used to backfill the pit. No further archaeological methods were employed since no artifacts were recovered during the test pit survey. Approximately 57% of the study area consists of active agricultural fields. These areas were subject to pedestrian survey at 5-metre intervals in accordance with Section 2.1.1 of the MHSTCI's *2011 Standards and Guidelines for Consultant Archaeologists* (Government of Ontario 2011). These areas were ploughed and allowed to weather sufficiently. The conditions at the time of assessment were optimal and soil surface visibility was greater than 90%. No further archaeological methods were employed since no artifacts were recovered during the pedestrian survey.

The Stage 2 assessment did not result in the identification of any archaeological resources.

5.0 RECOMMENDATIONS

The Stage 2 archaeological assessment was carried out in accordance with the Ministry of Heritage, Sport, Tourism, and Culture Industries' Standards and Guidelines for Consultant Archaeologists (Government of Ontario 2011).

All work met provincial standards and no archaeological sites were identified during the Stage 2 assessment. If construction plans change to incorporate new areas that were not subject to a Stage 2 field survey, these must be assessed prior to the initiation of construction. In keeping with legislative stipulations, all construction, and demolition-related impacts (including, for example, machine travel, material storage and stockpiling, earth moving) must be restricted to the areas that were archaeologically assessed and cleared by the Ministry of Heritage, Sport, Tourism, and Culture Industries through acceptance of the assessment report into the provincial register.

As no archaeological resources were found on the subject property, no further archaeological assessment of the property is required.

6.0 ADVICE ON COMPLIANCE WITH LEGISLATION

This report is submitted to the Minister of Tourism, Culture and Sport as a condition of licensing in accordance with Part VI of the *Ontario Heritage Act*, R.S.O. 1990, c 0.18. The report is reviewed to ensure that it complies with the standards and guidelines that are issued by the Minister, and that the archaeological fieldwork and report recommendations ensure the conservation, protection and preservation of the cultural heritage of Ontario. When all matters relating to archaeological sites within the project area of a development proposal have been addressed to the satisfaction of the Ministry of Tourism, Culture and Sport, a letter will be issued by the ministry stating that there are no further concerns with regard to alterations to archaeological sites by the proposed development.

It is an offence under Sections 48 and 69 of the *Ontario Heritage Act* for any party other than a licensed archaeologist to make any alteration to a known archaeological site or to remove any artifact or other physical evidence of past human use or activity from the site, until such time as a licensed archaeologist has completed fieldwork on the site, submitted a report to the Minister stating that the site has no further cultural heritage value or interest, and the report has been filed in the Ontario Public Register of Archaeological Reports referred to in Section 65.1 of the *Ontario Heritage Act*.

Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48(1) of the *Ontario Heritage Act*. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with Section 48(1) of the *Ontario Heritage Act*.

The *Cemeteries Act*, R.S.O. 1990 c. C.4 and the *Funeral, Burial and Cremation Services Act*, 2002, S.O. 2002, c.33 (when proclaimed in force) require that any person discovering human remains must notify the police or coroner and the Registrar of Cemeteries at the Ministry of Consumer Services.

Archaeological sites recommended for further archaeological fieldwork or protection remain subject to Section 48(1) of the *Ontario Heritage Act* and may not be altered, or have artifacts removed from them, except by a person holding an archaeological license.

7.0 BIBLIOGRAPHY AND RESOURCES

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8.0 IMAGES

8.1 PHOTOGRAPHS



Photo 1 : Assessed by 5m Interval Pedestrian Survey Facing North-east



Photo 2 : Assessed by 5m Interval Pedestrian Survey Facing North-west



Photo 3 : Assessed by 5m Interval Pedestrian Survey Facing South-west



Photo 4 : Assessed by 5m Interval Pedestrian Survey Facing North-west



Photo 5: Assessed by 5m Interval Pedestrian Survey Facing South-west



Photo 6 : Assessed by 5m Interval Pedestrian Survey Facing South-east



Photo 7 : Assessed by 5m Interval Test Pit Survey Facing North-west



Photo 8 : Assessed by 5m Interval Test Pit Survey Facing East



Photo 9 : Assessed by 5m Interval Test Pit Survey Facing North



Photo 10 : Assessed by 5m Interval Test Pit Survey Facing South



Photo 11 : Assessed by 5m Interval Pedestrian Survey Facing North-west



Photo 12 : Assessed by 5m Interval Pedestrian Survey Facing South-west



Photo 13: Typical Test Pit Facing North

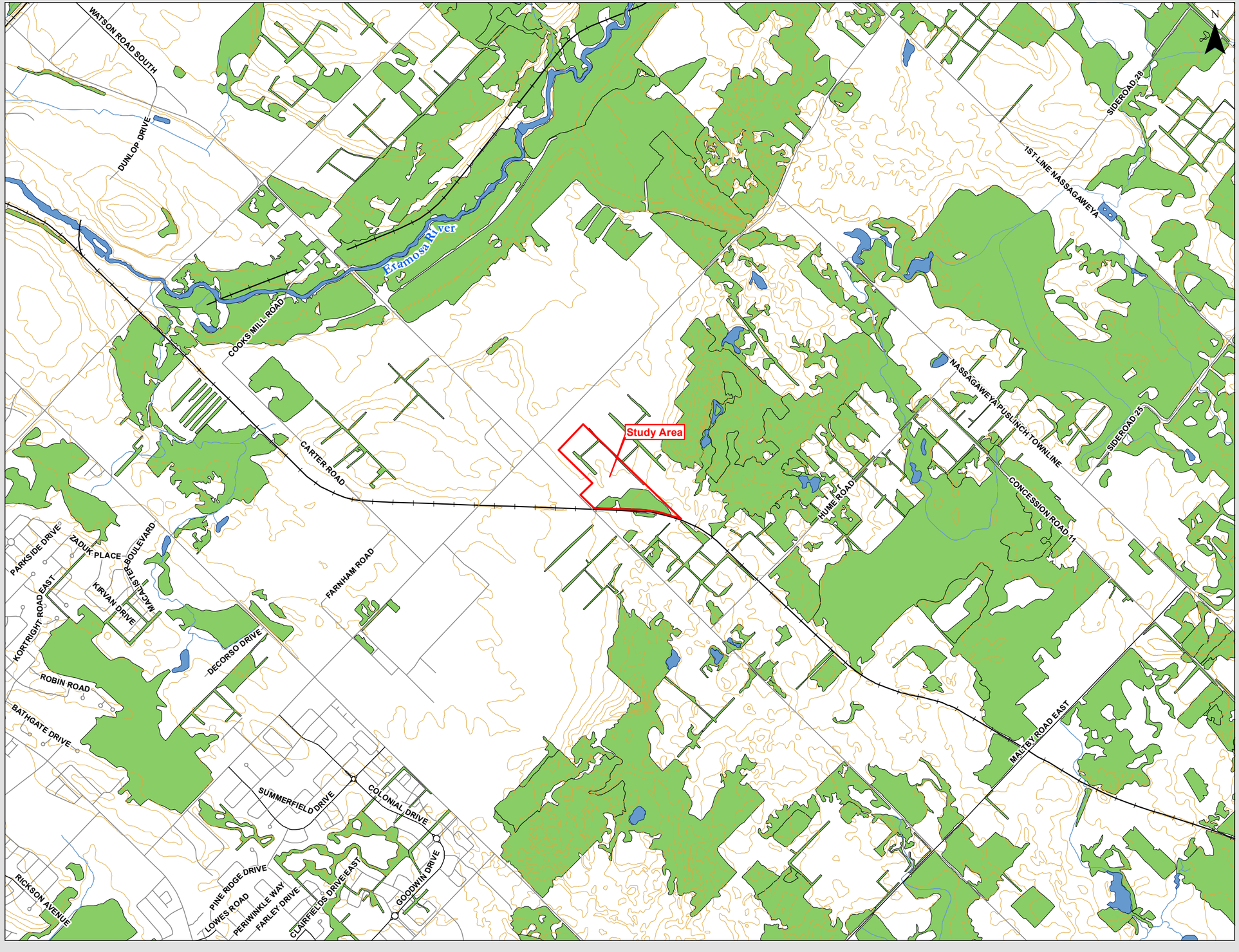


Photo 14: Typical Field Conditions Facing North



Photo 15: Typical Field Conditions Facing North

9.0 MAPS



LINCOLN ENVIRONMENTAL CONSULTING

Stage 1-2 Archaeological Assessment of the Arkell Lands, Arkell, Ontario

Figure 1: Topographic Map of Study Area

This drawing has been prepared for the use of Lincoln Environmental Consulting's client and may not be used or reproduced by a third party, except as agreed upon by the Lincoln Environmental Consulting and the client, as required by law or for use by governmental reviewing agencies. Lincoln Environmental Consulting does not accept responsibility for any party that modifies this drawing without Lincoln Environmental Consulting's expressed consent.

Date: July, 2023

Source: OBM
http://www.geographynetwork.ca/website/obm/viewer.htm

Scale 1:25,000

Datum: NAD 1983 UTM Zone 17N

Legend

- Study Area
- Local Road
- Major Road
- Railroad
- Contour Lines
- Watercourse
- Waterbody
- Wooded Area

Metres
0 500 1,000



LINCOLN ENVIRONMENTAL CONSULTING

Stage 1-2 Archaeological Assessment of the Arkell Lands, Arkell, Ontario

Figure 2: Study Area

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Date: July, 2023

Source: Bing Maps

Scale 1:3,000

Datum: NAD 1983 UTM Zone 17N

Legend

Study Area

Metres

0 50 100



LINCOLN ENVIRONMENTAL CONSULTING

Stage 1-2 Archaeological Assessment of the Arkell Lands, Arkell, Ontario

Figure 3: Portion of the Illustrated Historical Atlas of the County of Wellington, Puslinch Township

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Date: July, 2023

Source: Illustrated Historical Atlas of Waterloo & Wellington Counties Ontario, Toronto: H. Parsell & Co and Walker & Mile, 1881 & 1877.

NOT TO SCALE

Datum: NAD 1983 UTM Zone 17N

Legend

Study Area



LINCOLN ENVIRONMENTAL CONSULTING

Stage 1-2 Archaeological Assessment of the Arkell Lands, Arkell, Ontario

Figure 4: Assessment Strategies and Results

This drawing has been prepared for the use of Lincoln Environmental Consulting's client and may not be used or reproduced by a third party, except as agreed upon by the Lincoln Environmental Consulting and the client, as required by law or for use by governmental reviewing agencies. Lincoln Environmental Consulting does not accept responsibility for any party that modifies this drawing without Lincoln Environmental Consulting's expressed consent.

Date: July, 2023

Source: Bing Maps

Scale 1:3,000

Datum: NAD 1983 UTM Zone 17N

Legend

- Photo Location
- Study Area
- Assessed by Pedestrian Survey at 5m Intervals
- Assessed by Test Pit Survey at 5m Intervals

Metres

0 50 100

PUSLINCH

Comment Summary – Timberworx Custom Homes – 2nd Submission

Consultant	Comments
County of Wellington Planning	Comments pending
GM BluePlan	We completed a brief review of the submitted documents but cannot provide comments at this time as the engineering report and drawings are not stamped by a qualified professional and the SWM drainage figures referenced in the report were not provided.
Stan Denhoed-Township Hydrogeologist	See letter attached, includes comments on Nitrate Assessment
Ecology Comments	Azimuth has received these second submission documents for the Timberworx Homes development proposal (Arkell Road and Watson Road South). Azimuth provided a pre-consultation letter on May 11, 2023 (from an ecology/arborist perspective) that provided recommendations for an EIS. The documents attached in your second submission peer review request pertain to archaeology, a Traffic Impact Study, Functional Servicing and Stormwater Management. Do you know whether or not an EIS is also forthcoming?
Township of Puslinch Fire Department – Brent Smith	The department has the following comments: 1. Please show the location of the firefighting water tanks

PUSLINCH

	2. The fire department's specification of the connections / tanks are attached.
Source Water	See letter attached
GRCA	As the subject property does not contain any watercourses, floodplains, shorelines, wetlands, valley slopes, or other natural hazard features of interest to the GRCA, the property is not subject to Ontario Regulation 150/06 (see attached map). The GRCA will not be providing comments on this submission.
Township Traffic Consultant	See letter attached

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline
Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Hydrogeological Assessment

Geochemistry

Phase I / II ESA

Regional Flow Studies

Contaminant Investigations

OLT Hearings

Water Quality Sampling

Groundwater & Surface Water Monitoring

Groundwater Protection Studies

Groundwater Modelling

Groundwater Mapping

Permits to Take Water

Environmental Compliance Approvals

Designated Substance Surveys

Our File: 2329

April 2, 2024

Township of Puslinch
7404 Wellington Road 34
Puslinch, Ontario N0B 2J0

Attention: Lynne Banks
Development and Legislative Coordinator

Re: Arkell Residential Development
Part Lots 7, 8 and 9, Concession 10, Puslinch, Ontario
Hydrogeological Comments – Preconsultation Submission 2

Dear Lynne,

Harden Environmental Services Ltd. (Harden) is pleased to provide hydrogeological comments for a proposed multi-lot residential development located at Lots 7, 8 and 9, Concession 10 in Puslinch, Ontario (the site).

We have reviewed the following submission materials in preparing these comments:

1. ARL Groundwater Resources Ltd. 2023. Groundwater Supply Assessment, Proposed Residential Development, Arkell, Ontario (Township of Puslinch). Dated March 2023.

2. C.F. Crozier & Associates Inc. 2024a. Functional Servicing and Stormwater Management Report, Arkell Subdivision, Residential Development, Township of Puslinch. CRCA File No. 2433-6646. Dated March 2024.

3. C.F. Crozier & Associates Inc. 2024b. Re: D-5-4 Assessment – Residential Development at Lots 7, 8, 9, Concession 10, Township of Puslinch. Project No. 2433-6646. Dated March 20, 2024.

Based on the reviewed materials, we understand that:

- The site consists of a 20.45-ha parcel located at the southeast corner of the intersection of Arkell Road and Watson Road South, with the Guelph Junction Railway immediately east of the site. Approximately 17.45 ha of the site is considered developable area (Crozier, 2024a).

- The proposed development includes up to 50 residential lots. Municipal servicing is not available in the area. Servicing will be provided by individual private wells and onsite sewage systems.

- Stormwater management (SWM) will be provided by a SWM facility for flood control, a bioswale for infiltration and stormwater conveyance to the SWM facility, and a separate bypass bioswale for offsite drainage.

Our hydrogeological comments are as follows. These comments should be considered in addition to our previous comments (dated May 1, 2023).

Hydrogeological study: A hydrogeological assessment must demonstrate that the proposed development will not negatively impact the hydrological and hydrogeological regime as part of Site Plan Approval. The hydrogeological study must determine groundwater levels, groundwater flow and baseline groundwater quality on the development property. At least one year of onsite shallow groundwater level monitoring should be included, including the spring groundwater high.

The hydrogeological study should address the comments provided within this review.

Note that the previous Hydrogeological Assessment completed for the site by R.J. Burnside & Associates Ltd. (2006) was not provided for review as part of the current submission.

Wellington County Official Plan: The southeast corner of the site (which is not currently proposed for development) is located within the Paris Galt Moraine Policy Area under Schedule B7 of the County of Wellington Official Plan. The majority of the site is outside of the Paris Galt Moraine Policy Area. Section 4.9.7 Policies and Objectives will apply for any development within the Paris Galt Moraine Policy Area. The development must adhere to Sections 4.9.3 (Groundwater), 4.9.4 (Policy Direction) and 4.9.5 (Source Water Protection).

Source protection: The site is within the Grand River Source Protection Area and is mapped within a wellhead protection area (WHPA)-B for quality. The site is also within a draft wellhead protection area (WHPA)-Q for quantity and a significant groundwater recharge area (SGRA). Groundwater recharge policies in the Source Water Protection

Plan apply to this site. The proposed design must infiltrate as much clean runoff as possible to maintain or enhance existing recharge conditions as part of Site Plan Approval.

Water supply: A groundwater supply assessment was completed by ARL Groundwater Resources Ltd. in 2023, which included installation of O. Reg. 903 wells onsite in the aquifer targeted for water supply, a pumping test and water quality analyses. Our previous comments included the following:

"The report does not report on interference between test wells during the pumping tests nor does it address potential interference between future wells and existing wells in the Hamlet. Although there are recommendations for monitoring of future water supply wells, we recommend that one or more water supply wells for lots adjacent to existing homes be constructed early in the development timeline and dedicated to monitor the aquifer between the proposed development and existing homes."

The project hydrogeologist should also comment on whether there could be an overall impact on groundwater and surface water levels due to groundwater removal from the aquifer and infiltration at surface. The assessment should consider long-term impacts at both the local (i.e., hamlet of Arkell) and regional scale.

In alignment with other proposed multi-lot developments in Puslinch, a fulsome analysis of the aquifer water quality by analyzing all parameters in Tables 1 and 2 of Ontario Regulation 169/03 is requested.

Supply well construction: The site is underlain by the Guelph Formation and the Goat Island / Gasport Formation aquifer separated by a regional aquitard. Wells that connect these two aquifers (i.e., multiaquifer wells) are not permitted on any lot as part of the development. The onsite supply wells constructed in 2022 were noted to be cased into the Gasport Formation. Newly constructed supply wells for the site should be either installed in the upper bedrock aquifer or appropriately cased into the Gasport aquifer, in accordance with R.R.O. 1990, Reg. 903: Wells, to minimize potential groundwater movement between the upper and lower bedrock aquifers.

Nitrate impact assessment: The development proposes individual onsite septic systems for each lot. The daily design flow was estimated at 4,575 L/day per lot (Crozier, 2024a). The D-5-4 analysis completed by Crozier (2024b) determined that nitrate-nitrogen loading would exceed the Ontario Drinking Water Quality Standard of 10 mg/L at the property boundary if conventional septic systems were used for each lot, even if only 35 lots were included. Advanced treatment systems with minimum 50% nitrogen removal are required to meet 10 mg/L nitrate-nitrogen at the property boundary, allowing for up to 50 lots with this technology. Waterloo biofilter systems are proposed for each lot.

We generally concur with Crozier's assessment and recommendation for advanced treatment systems; however, the design flows for the proposed homes exceed the standard 1,000 L/day (the recommended standard flow used within D-5-4). The nitrate loading calculations should be revised to reflect the increase in nitrogen inputs to groundwater based on higher daily flows. In addition to the degree of nitrogen reduction, the proponent must also demonstrate the effectiveness and longevity of the proposed tertiary treatment systems. Maintenance agreements or registration on land title may be required to ensure that advanced treatment systems are adequately maintained.

Water balance: A water balance assessment is required to demonstrate that infiltration can be maintained or enhanced as part of the proposed development. Low impact development (LID) measures should be included as part of the design to infiltrate as much clean runoff (i.e., roof runoff) as possible. In-situ infiltration testing is recommended at the locations/depths of proposed infiltration LIDs.

Construction dewatering: Crozier (2024a) indicated that basements are expected to be above the static water table. Proposed foundation and servicing depths (i.e., SWM facilities and onsite sewage systems) must be evaluated for potential construction dewatering requirements. Groundwater table fluctuations and the spring groundwater high should be considered as part of this assessment.

Well decommissioning: Any unused wells must be abandoned by a licensed well contractor in accordance with R.R.O. 1990, Reg. 903: Wells.

Excess soil management: Any import/export of fill/soil from the site must be conducted in accordance with O. Reg. 406/19: On-Site and Excess Soil Management, the Rules for Soil Management and Excess Soil Quality Standards (Soil Rules) and O. Reg. 153/04, as amended.

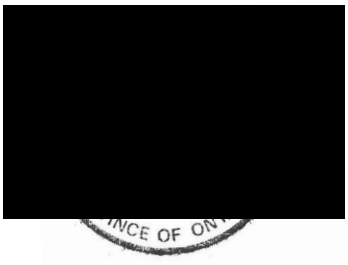
These hydrogeological comments may be amended as additional information is provided by the proponent.

We appreciate the opportunity to provide these comments. Should you have any questions or concerns, please do not hesitate to contact the undersigned.

Harden Environmental Services Ltd.



Angela M. Mason, M.Sc., P.Geo., QP_{ESA}
Senior Hydrogeologist
amason@hardenv.com



Stan Denhoed, P.Eng., M.Sc.
President and Senior Hydrogeologist
sdenhoed@hardenv.com

04/02/2024

Memorandum

To: Lynne Banks – Development and Legislative Coordinator, Township of Puslinch

Cc: Meagan Ferris – Manager of Planning and Environment, Wellington County

From: Kim Funk – Source Protection Coordinator, Wellington Source Water Protection

RE: Arkell Subdivision, Township of Puslinch
Zoning By-law Amendment

Wellington Source Water Protection (WSWP) staff have had the opportunity to review the submitted documents in support of the above noted application. Based on our review, WSWP request that the following plans, reports and/or documentation be included with future submissions or made a condition of Draft Plan of Subdivision Approval, to the satisfaction of the Township's Risk Management Official.

1) The completion of the Drinking Water Threats Screening Form;
2) A Salt Management Plan to manage winter maintenance activities until the roads are assumed by the Township;
3) The submission of a water balance assessment report that evaluates pre and post development hydrogeological conditions and includes Low Impact Development recharge infiltration measures;
4) A liquid fuel handling / storage and spill response procedure for construction if more than 250L of fuel will be on site at any point during construction.

Please confirm that the items below are not proposed to occur on the property. If any are proposed, please provide additional detail or documentation in future submissions.

1) Documentation of any Provincial Approvals (ECA, PTTW, etc.) subject to the proposal;
2) That any unused wells, including unused monitoring wells, are decommissioned as per *Ontario Regulation 903* and that this documentation is submitted;
3) Documentation of any transport pathways proposed for the development.

For more information, please contact sourcewater@centrewellington.ca.

Sincerely,

[redacted] April 2, 2024

Kim Funk, Source Protection Coordinator
519-846-9691 ext 283

kfunk@centrewellington.ca

Attachments: Drinking Water Threats Screening Form
WHPA Maps
Appendix C: Guidance Documents
Appendix D: Water Balance Terms of Reference

WELLINGTON Source Water PROTECTION wellingtonwater.ca

Office Use Only
Roll Number:_____
File Number:_____
Submission Date:_____
WHPA, IPZ, ICA: _____
Vulnerability Score: _____

Drinking Water Source Protection Screening Form

Find out if you live in a vulnerable drinking water area at www.wellingtonwater.ca

For assistance in completing this form, please refer to the "Explanatory Guide" beginning on page 6.

Please note that you may still need to contact the applicable Conservation Authority, as this is not considered correspondence on their behalf.

1. Property Information

Municipal Address of Subject Property: _____

Assessment Roll Number of Subject Property: _____

Property Owner: _____

2. Proposal (Please check all that apply to this application):

	Building
☐	New Structure
☐	Expansion or Conversion of an Existing Structure
☐	New Septic System
☐	Replacement Septic System
☐	Geothermal System (Transport Pathway)
☐	Change of Use

	Planning
☐	Minor Variance
☐	Official Plan Amendment
☐	Consent Application
☐	Zoning By-law Amendment Application
☐	Subdivision/Condominium Application
☐	Site Plan Application

Brief Description of the Proposed Use of Land, Proposed Buildings or Structures. If constructing a geothermal, please provide construction details including depth, vertical or horizontal, closed loop or open loop.

_____

_____

_____

_____

3. Potential Threat Activities Associated with the Application

Please check all applicable activities that may be associated with the development proposal:

3.1 Fuel Handling and Storage greater than 250 litres

	Existing	Proposed	Greater than 2,500L	Underground Storage Tank	Aboveground Storage Tank	Inside Home	Outside Home
Liquid Fuel (i.e. gasoline or diesel)	○	○	○	○	○		
Fuel oil (home heating)	○	○				○	○
Waste oil (heating)	○	○	○	○	○		

3.2 Chemical Handling and Storage

		If Yes, please indicate the type(s) of chemicals if known:		
	Yes	**3.2.1** Dense Non-Aqueous Phase Liquids (DNAPLs), including chlorinated solvents	**3.2.2** Organic Solvents	If Yes, please estimate the total amount
Paints and other coatings (including stains, enamels, lacquers, rust paint)	○	○	○	
Dry cleaning chemicals	○	○	○	
Automotive repair/maintenance and/or industrial manufacturing and processing (e.g. degreasers, automotive fluids, oils, furniture stripping products, chemical solvents, adhesives)	○	○	○	
Solvent based degreasers or liquids for washing metal parts	○	○	○	

3.3 Road Salt Application and/or Outdoor Storage

	Covered	Uncovered	Estimated Volume Stored on Property (m^3)	Estimated Application Area (m^2) including private roads, parking lots, and sidewalks
Road Salt Storage	○	○		
Road salt application (private roads, parking lots, sidewalks, etc.)				

3.4 Snow Storage (see guide)

	Above Grade	Below Grade (buried)	Approximate Storage Area greater than: 0.01 ha (double driveway)	0.5 ha (1 soccer field)	1 ha (2 soccer fields)
Snow Storage	◯	◯	◯	◯	◯

3.5 Waste Storage or Disposal (see guide)

	Yes
3.5.1 Storage and/or application of raw, untreated liquids and solids that are pumped out of septic systems and holding tanks (not including septic tanks)	◯
3.5.2 Storage and/or disposal of oils (does not include restaurant oil or grease); hazardous waste; liquid industrial waste; industrial and commercial waste; or PCB waste	◯

3.6 Storm Water Management/Industrial Sewage

	Yes
Stormwater management facility (treatment, retention, infiltration, recharge or control of stormwater)	☐
Car or truck washing facility	☐
Oil and Water Separator	☐
Sediment control (i.e. Stormceptor)	☐

3.7 Septic Systems

	Existing	Proposed: New	Proposed: Replacement
Septic system for residential or small-scale commercial/industrial/institutional use (Ontario Building Code)	◯	◯	◯
Septic system (Greater than 10,000 litres per day) for commercial/industrial/institutional use (note an Environmental Compliance Approval would be required)	◯	◯	◯

3.8 Water Taking

	Proposed	Existing	If Existing, please provide the following: Drilled	Dug	Well Not In Use*	Approx. Construction Date
3.8.1 Private Well *(*Please note that if there is an existing well that is not in use, Section 3.9 must also be checked)*	◯	◯	☐	☐	☐	
3.8.2 Greater than 50,000 litres per day of water being used (note a Permit to Take Water may be required)	◯	◯				

3.9 Transport Pathway (see guide)

	Yes
Creation of aggregate pits, geothermal systems, non-residential or large residential caissons/building piers, or utilities/excavation within fractured bedrock and underground parking garages	◯
Existing private well not in use	◯

3.10 Recharge Reduction

	Yes
Creation of impervious surfaces (including large roofed areas, pavement, etc.)	◯

3.11 Agricultural

	Application	Storage	Product Name(s)
3.11.1 Fertilizers	◯	◯	
3.11.2 Pesticides	◯	◯	
3.11.3 Agricultural source material (i.e. manure)	◯	◯	
3.11.4 Non-agricultural source material (i.e. biosolids, commercial food wastes, etc.)	◯	◯	

	Yes	Estimated Number of Animals	Type of Animals
3.11.5 Grazing and Pasturing of livestock	◯		
3.11.6 Outdoor Confinement Yard	◯		
3.11.7 Nutrient Management Plan or Strategy, NASM Plan applies to or is registered for the property	◯		
Environmental Farm Plan	◯		

3.12 None of the above are applicable

Check off this box only if none of the above sections have been checked	◯

4. Declaration (Owner or Applicant) or Person Engaged in Activity

Owner

I, _____, declare that the information contained in this application and all attached documentation is true to the best of my knowledge.

_____ _____

Date Signature

Applicant or Authorized Agent

I, _____, declare that the information contained in this application and all attached documentation is true to the best of my knowledge.

_____ _____

Date Signature

Information is collected pursuant to the *Municipal Freedom of Information and Protection of Privacy Act,* R.S.O. 1990, c. M.56 and the *Clean Water Act,* 2006, S.O. 2006, c. 22 for the administration and enforcement of the *Clean Water Act.* Please note that business identity information is not considered personal information pursuant to the *Municipal Freedom of Information and Protection of Privacy Act*.

For any inquiries about the collection of this information, please contact the Risk Management Official, Wellington Source Water Protection, 7444 Wellington Road 21, Elora, ON, N0B 1S0, 519-846-9691 ext. 362.

Explanatory Guide for Completing the Drinking Water Source Protection Screening Form

Your property is located within a municipal well head protection area or intake protection zone and therefore may be subject to the *Clean Water Act,* 2006. The Wellhead Protection Area (WHPA) is the area around a municipal well where land use activities have the potential to affect the quality and quantity of water that flows into the wellhead. For more information, refer to www.wellingtonwater.ca or contact 1-844-383-9800.

To assist staff in determining whether your property and/or application is subject to the Act, the Drinking Water Source Protection Screening Form is completed to inventory the activities that are proposed on your property. The following sections explain the form.

Section 1 – Property Information:
Please fill out the municipal address and property owner for the subject property.

Section 2 – Proposal:
Please check all that apply to the application and provide a brief explanation of the proposed development and/or construction details if construction a geothermal (such as depth, vertical r horizontal, closed loop or open loop).

Section 3 – Potential Threat Activities Associated with Proposed Application:
Within this section please fill out all that apply to your application. If there is a circle provided in the table, please provide a check mark; if there is a blank space in the table please write in the applicable information.

3.1 Liquid Fuel Handling and Storage:
Fill out this section if on the property there is liquid fuel storage or handling greater than 250 litres (1 gal = 3.785 L). This can be located in land uses for residential, agricultural, gas, commercial, industrial or institutional purposes and includes gasoline, diesel or home heating oil. It does not include propane or natural gas.

3.2 Chemical Handling and Storage:
Fill out this section if the application is regarding one of the listed chemical handling or storage activities on the form.

3.2.1 Known DNAPLs:
Fill out this section only if applicant is aware of a Dense Non-Aqueous Phase Liquid (DNAPLS) on the property. DNAPLs are chemicals that are denser than water and therefore have the ability to contaminate the groundwater easily. The specific DNAPLs that pose a potential threat are poly-aromatic hydrocarbons (PAHs), 1, 4-dioxane, trichloroethylene, tetrachloroethylene or perchloroethylene (PCE or PERC) and Vinyl Chloride.

- ***Vinyl Chloride***: Used to make polyvinyl chloride (PVC) pipes, wire coatings, vehicle upholstery and plastic kitchen ware
- ***PAHs***: Used in wood preservatives, pharmaceuticals, dyes and asphalt products.

- ***1,4-dioxane***: Used as a degreasing solvent or solvent stabilizer in various manufacturing processes.
- ***Tetrachloroethylene*** (PCE or PERC): Used in dry cleaning, metal cleaning and as an intermediate in manufacturing processes.
- ***Trichloroethylene*** (TCE): Mainly used for degreasing of metal parts in the automotive and metal industries and also found in some household products such as adhesives, paint removers, paints, rug cleaning fluids, and metal cleaners.

3.2.2 Known Organic Solvents:
Fill out this section if the applicant is aware of Organic Solvents on the property. Organic Solvents are liquid organic compounds with the ability to dissolve solid, gases or liquids and therefore have the ability to contaminate drinking water sources. Organic Solvents that are of potential concern include Carbon Tetrachloride, Chloroform, Dichloromethane and Pentachlorophenol (PCP).

- ***Carbon Tetrachloride***: Once used widely in fire extinguishers, as a cleaning agent, in the manufacture of refrigerants as well as an industrial solvent and metal degreasing agent is a banned substance in Ontario since 1999. The only permitted uses of the chemical are in research laboratories or in the manufacturing process where the product is converted to an alternative product which does not contain a class of ozone-depleting substances.
- ***Chloroform***: commonly used in a laboratory setting, and in the production of pharmaceuticals, dyes and pesticides.
- ***Dichloromethane*** (also known as methylene chloride): used as a solvent in paint strippers and removers. It is used as a process solvent in the manufacture of drugs, pharmaceuticals and film coatings. It is also used as a metal cleaning and finishing solvent in electronics manufacturing, aerosol propellant and as an agent in urethane foam blowing.
- ***Pentachlorophenol*** (PCP): used as an herbicide, insecticide, fungicide, algaecide and disinfectant, and as an ingredient in antifouling paint. Its use has significantly declined due to its high toxicity. Today it is used industrially as a wood preservative and is not manufactured in Canada.

3.3 Road Salt Application, Handling and Storage:
Fill out this section if there will be road salt storage on the property or road salt application on a private road, parking lot, or sidewalk located on the property. Please provide estimates in m^3 for volume and m^2 for area.

3.4 Snow Storage:
Fill out this section if there will be snow storage (above or below grade) on the property and indicate whether the storage will be greater than 0.01 hectare (0.03 acre or 10 metres by 10 metres), greater than 0.5 hectares (1.24 acres or 50 metres by 50 metres), or greater than 1 hectare (2.5 acres or 100 metres by 100 metres). For reference, 0.01 hectare is roughly the size of a double driveway, 0.5 hectares is roughly the size of one soccer field, and 1 hectare is roughly the size of two soccer fields.

3.5.1 Waste Storage or Disposal - Septic Tank Pump outs
Fill out this section only if application is involved in the pumping out or disposal/treatment of raw sewage or septage, porta potties or holding tanks.

3.5.2 Waste Storage or Disposal - Storage and/or Disposal of Hazardous Waste:
Fill out this section if there is hazardous waste or liquid industrial waste stored on the property including waste oil, solvents, and automotive fluids. Please note storage or disposal of oil does not include restaurant oil or grease. Storage of hazardous waste or liquid industrial waste includes wastes requiring registration with the Ontario Hazardous Waste Information Network (HWIN), if applicable. Disposal of waste on site includes landfilling and incineration. Typically, this will only be at commercial or industrial properties.

3.6 Storm Water Management/Industrial Sewage:
Fill out this section if one of the listed storm water management or industrial sewage activities is planned or present. For reference, a storm water management facility may include a retention or detention pond (wet or dry), catch basins, sediment control, recharge systems (such as infiltration galleries), swales and ditches.

3.7 Septic Systems:
Fill out this section if the property will be serviced by a septic system. Please indicate whether the septic system is existing or proposed. If the existing or proposed septic system has a design capacity of less than 10,000 litres, it is regulated under the Ontario Building Code (OBC). A building permit, obtained through the municipality, is required by the OBC for installation of a new septic system and for the repair/replacement of an existing system. If the existing or proposed septic system has a design capacity of greater than 10,000 litres a day, a provincial Environmental Compliance Approval may be required under the Ontario Water Resources Act. Please contact the local Ontario Ministry of the Environment and Climate Change office for more information.

3.8.1 Water Taking - Private well installed:
Fill out this section if there is an existing well present or a new well being installed on the property. This includes private drinking water wells, environmental test wells, geotechnical wells, irrigation wells, etc. Please indicate whether the well is proposed or existing, and fill out the rest of the section (dug or drilled as well as the approximate construction date) for existing wells only.

3.8.2 Water Taking - Greater than 50,000 litres per day
Fill out this section if more than 50,000 litres per day is being withdrawn from a well or a water body (1 gal = 3.785 gal).

3.9 Transport Pathway
Transport pathways are human constructed pathways through soil and bedrock that may increase the vulnerability of groundwater to certain contaminants.

Please check the first circle if your application will be installing a vertical geothermal system, installation of caissons or building piers for a non-residential application or for a large residential application, aggregate project, or installation of utilities or excavation within fractured bedrock. A road occupancy permit application could indicate when fracture bedrock excavation occurs. If geothermal, please provide construction details including depth, vertical or horizontal, closed loop or open loop in the space provided in Part 2 (on the first page of this document). A large residential application includes multi-story, multi-unit residential developments.

Please check the second circle if there is an existing private well that is not in use. Private wells include environmental and / or geotechnical monitoring wells and domestic wells. If you filled out Section 3.8.1 as private well not in use, Section 3.9 should also be completed.

3.10 Recharge Reduction:
Fill out this section if there is going to be an increase in impervious surfaces on the property. For example, asphalt (driveways and parking areas) and covered areas (roofs, decks and structures). If building within current building envelope then it is not an increase. Please note this box only applies within the Town of Erin.

3.11.1 Fertilizers and/or 3.11.2 Pesticides:
Fill out this if there is storage or use of fertilizer or pesticides for agricultural or commercial use. Do not fill out this section if used only for personal use.

3.11.3 Agricultural - Application, handling and storage of agricultural (i.e. manure) and/or 3.11.4 non-agricultural source material (bio solids):
Fill out this section if there is application, handling or storage of Agricultural Source Material (ASM) (manure) or Non-Agricultural Source Material (NASM) on the property. ASM and NASMs include; manure (ASM) and biosolids, commercial food waste, etc. For more information on NASMs and ASMs please look at fact sheet number 4, available on our website, www.wellingtonwater.ca

3.11.5 Agricultural - Grazing and pasturing of livestock:
Fill out this section if there is any grazing, pasturing or housing of one or more livestock on the property excluding household pets. Livestock can include cows, horses, sheep, goats and other animals. If unsure, please contact Wellington Source Water Protection for clarification. Please give an estimation of the number of animals, as well as the type of animal(s).

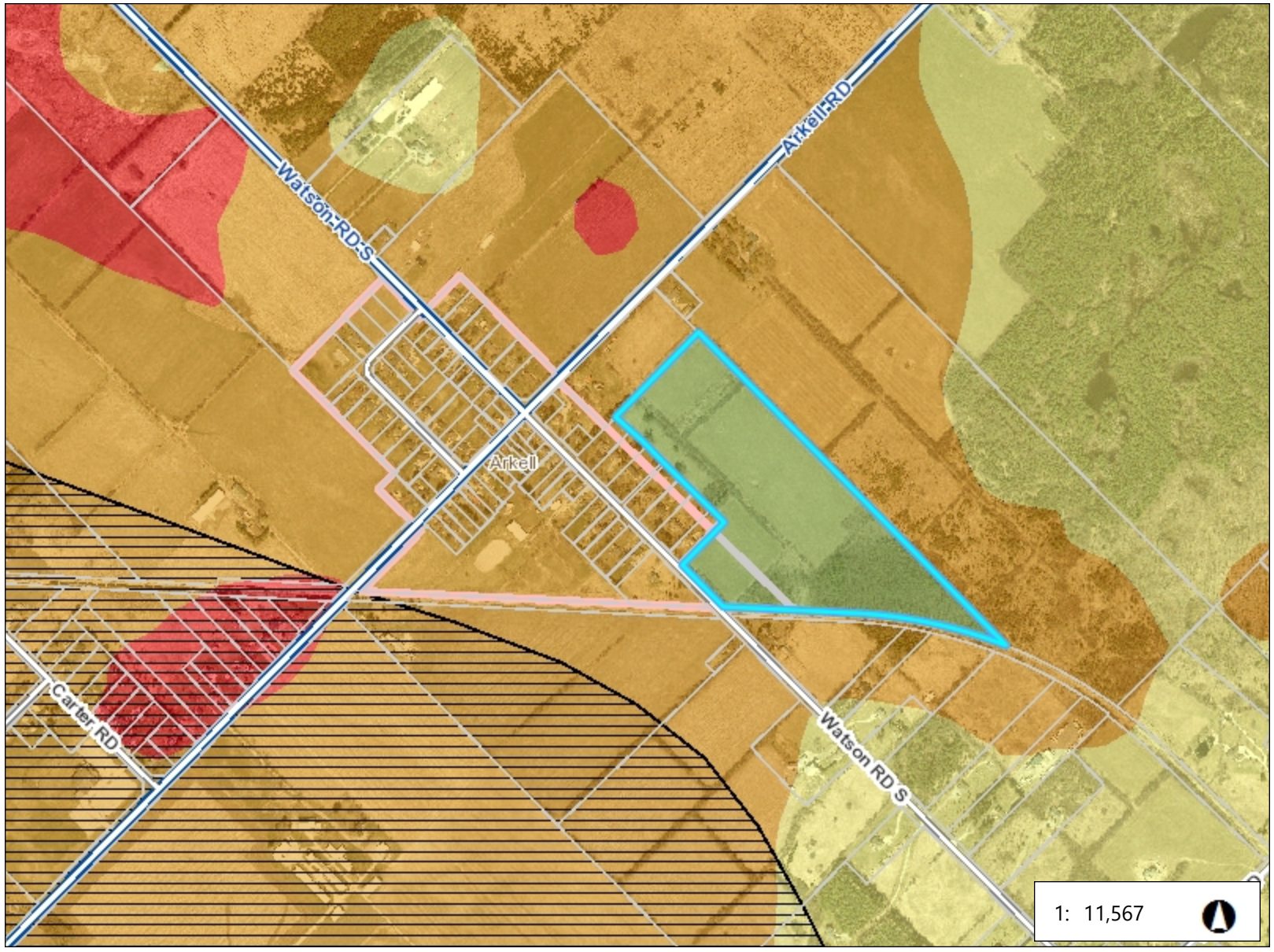
3.11.6 Outdoor Confinement Yard:
Fill out this section if there are any livestock including cows, horses, sheep, goats and other animals housed in an outdoor confinement yard on the property. If unsure, please contact Wellington Source Water Protection for clarification. Please give an estimation of the number of animals, as well as the type of animal(s).

3.11.7 Prescribed Instruments
Fill out this section if there are any provincially prescribed instruments that apply to or are registered for the property. This includes Nutrient Management Strategies, Nutrient Management Plans and Non-Agricultural Source Material Plans.

3.12 None of the above are applicable:
Check that none of the above sections in Part 3 are applicable to the application. This section should only be checked if none of the other sections have been checked.

Section 4 - Declaration:
Either the owner or the applicant must sign and date the form.

2301000008034800000, Arkell





Legend

- Parcels
- Roads
  - Local Road
  - County Road
  - Highway
- Urban Centres and Hamlets
- Well Locations
  - Existing
  - Proposed
- Issue Contributing Area
  - Chloride
  - Nitrate
  - Sodium
  - TCE
- Wellhead Protection Area
  - A
  - B
  - C
  - D
- Vulnerability Score
  - 10
  - 8, D; 8; 8, C
  - 2, 4, 6 (A, B or C)
  - 2,4,6, D; 2,4, D; 2, 4, 6 (D); 4, D; 6,
- HVA
- RoadsLookup

0.6 0 0.29 0.6 Kilometers

WGS_1984_Web_Mercator_Auxiliary_Sphere

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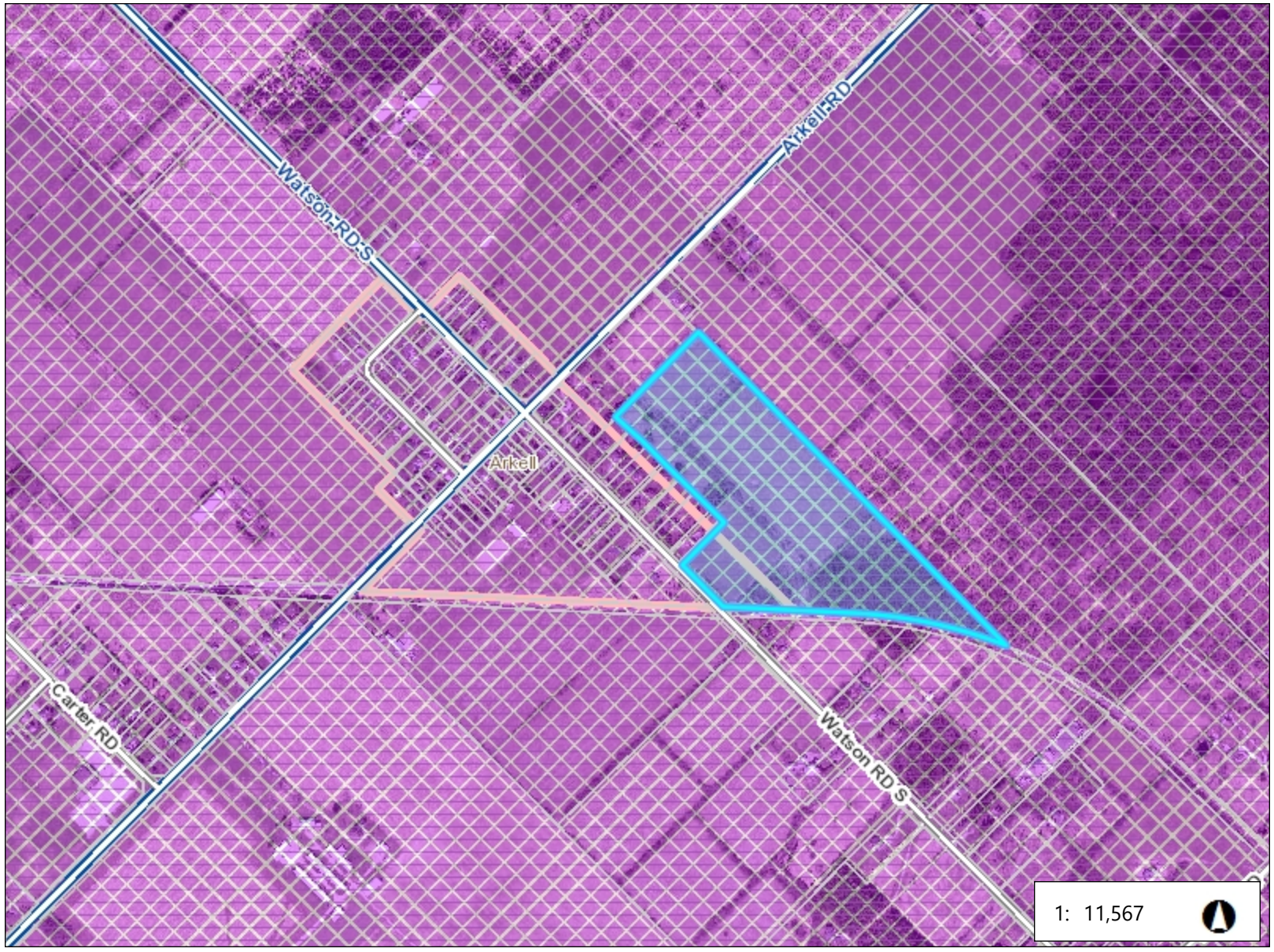
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Notes

Explore Wellington

2301000008034800000, Arkell-Quantity





Legend

- Parcels
- Roads
  - Local Road
  - County Road
  - Highway
- Urban Centres and Hamlets
- Well Locations
  - Existing
  - Proposed
- WHPA Q1_Q2_Boundary
- WHPA Q1_Q2
  - Approved
  - Draft
- SGRA
- RoadsLookup

0.6 0 0.29 0.6 Kilometers

WGS_1984_Web_Mercator_Auxiliary_Sphere

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Notes

Appendix C: Guidance Documents

1. Drinking Water Threats Disclosure Report and Management Plan(s)
2. Winter Maintenance
3. Recharge Infiltration Measures
4. Source Protection Plan Policies

Wellington Source Water Protection
Risk Management Office. 7444 Wellington Road 21. Elora, ON. N0B 1S0
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1. Drinking Water Threats Disclosure Report and Management Plan(s)

1. When more information is required than what is available in the Drinking Water screening form, a Drinking Water Threats Disclosure Report may be a requirement for site plan approval under section 4.9.5.4 of the Wellington County Official Plan.

The relevant section of the County of Wellington Official Plan policy 4.9.5.4 is provided below:

4.9.5.4 Drinking Water Threat Disclosure Reports *The submission of a Drinking Water Threat Disclosure Report will be required as part of a complete application under the Planning Act for development, redevelopment or site alteration of non-residential uses within a Wellhead Protection Area, Intake Protection Zone or Issue Contributing Area. The report shall disclose whether any of the prescribed drinking water threats identified in subsection 4.9.5.2 are expected to occur on the property, as well as the handling and storage of any other chemicals, fuel and wastes, and related volumes, types, storage, handling, disposal, etc. The report shall also disclose the proposed management programs associated with the use of chemicals at the site, including risk management/reduction measures, emergency response plans, spill response/prevention plans, employee awareness training, best management practices and monitoring programs.*

2. The Drinking Water Threat Disclosure Report contains two sections:

    a. identification or disclosure of drinking water threats and

    b. proposed management programs (management plan).

3. The disclosure section must identify whether any of the 22 drinking water threat activities pursuant to the *Clean Water Act* are proposed. For a full list, see below. In addition, the disclosure section must identify any other chemical, fuel or waste activities proposed that are not prescribed by the *Clean Water Act*. In practice, this means the disclosure report must identify **all** chemical, fuel, waste activities proposed as well as sanitary sewage, stormwater, salt or winter maintenance chemical activities, snow storage and fertilizer / landscape maintenance. The following comments provide further detail for the disclosure section of the Drinking Water Threat Disclosure Report:

    a. For each activity identified, whether prescribed by the *Clean Water Act* or not, the disclosure section must clearly identify proposed volumes, types, location on the subject property, how it will be handled, stored, used, generated and / or disposed and whether an Environmental Compliance Approval or other provincial approval is required.

    b. Technical details related to stormwater management can be referenced from the Stormwater Management Brief/Report (if applicable) and does not need to be reproduced in the disclosure section. However, the disclosure section must clearly identify whether an Environmental Compliance Approval is required for the stormwater

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management facility. If unsure, it is recommended the applicant consult with the Ontario Ministry of the Environment, Conservation and Parks to confirm this requirement.

c. If there are proposed sanitary sewage pumping stations on the property, the report should identify if it will be privately owned or assumed by the municipality. If privately owned, the disclosure section must clearly identify whether an Environmental Compliance Approval is required for the sanitary sewage pump and service lateral. It is recommended the applicant consult with the Ontario Ministry of the Environment, Conservation and Parks to confirm this requirement.

d. Regarding the definition of chemical activities this is broad and can include any liquid or solid chemical product including, but not limited to, paints, stains, enamels, other coatings, degreasers, oils, solvents, automotive or machinery fluids, cutting fluids, adhesives, cleaning products, acids, bases, caustics and alcohols. Chemicals in a paste form are considered a liquid and / or solid and shall be included. Aerosols or gaseous chemicals can be excluded, however, a general statement should be provided stating what aerosols or gaseous chemicals will be on the property (ie *In addition to the liquid and solid chemicals identified above, propane and aerosol paints will also be present*). For all liquid or solid chemicals proposed, a Safety Data Sheet or a website link for each chemical must be provided as an appendix.

e. For waste activities, please identify any waste that will be generated and how it will be stored, managed on site and disposed of. This includes, but is not limited to, solid waste such as off cuts, scrap metal, domestic garbage, recycling, compost etc; liquid industrial waste whether it is disposed of through the sewers or through a waste management company; and / or hazardous or subject waste as regulated by Ontario Regulation 347 and registered through the Provincial Hazardous Waste Information Network (HWIN). This includes biomedical and pharmaceutical waste, pesticide containers and tank or container bottoms and hazardous or subject waste subject to small quantity or field exemptions such as battery disposal.

f. For salt, snow, winter maintenance chemicals, fertilizer and landscape maintenance, please identify what activities are proposed and whether they will be conducted by staff, contractors or both. Application and storage locations must be identified on a site plan or sketch along with surface coverings (ie asphalt, gravel etc) and location of catch basins and ditches. For any application, approximate application areas and storage volumes must be calculated. For calculation of road salt / winter maintenance chemical application area, please include all impervious or hard surfaces such as, but not limited to, asphalt, concrete, paving stones etc where salt would be applied. This can include parking lots, walkways, patios etc. Winter maintenance chemicals is meant to be broad and includes any chemical or product used to melt ice, provide traction and / or ice / snow control and includes road salt, sand and pickled sand as well as other road salt alternatives.

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g. Please note that included in the prescribed drinking water threats are consumptive water taking and reduction of groundwater recharge threats. These are related to water quantity. In the disclosure section, the applicant shall clearly identify whether the water usage for the site will be fully municipally serviced or whether any private wells are proposed. If fully municipally serviced no further information is required. If private wells are proposed, details must be provided on the well construction, well screen interval, estimated volume of water pumped from the well and the proposed use of the water. A water well record, if available, shall be provided. Regarding groundwater recharge reduction threats, these proposed activities will be identified through review of the site plan application as those plans identify asphalt and gravel surfaces and proposed building envelopes.

h. Any preferential pathways (transport pathways) existing or created must be reported included in the report. These include, but are not limited to:
    i. old and/or unused wells that have not been properly abandoned;
    ii. new vertical geothermal systems
    iii. underground infrastructure (parking garages, maintenance tunnels etc.)
    iv. removal of large portions of overburden (gravel pits, fill removal)
    v. construction of deep pilings

    If none, the applicant must confirm that no transport pathways are proposed.

4. Regarding the management program section, prescribed drinking water threats identified are typically managed with a legally binding risk management plan pursuant to the *Clean Water Act* or a provincial approval such as an Environmental Compliance Approval (ie for sewage or storm water). If required, the risk management plan must be negotiated and signed prior to the issuance of the final building permits. The requirement for a risk management plan is determined and drafted by the Risk Management Official and if required, will be provided for review after the submission / review of the disclosure section. The disclosure section is critical to determine what activities will be managed by the risk management plan and who the appropriate signing body is (ie the owner or contractor / tenant). Typically, for new developments, the owner signs the risk management plan if the contractor or tenants are unknown.

5. For threats not managed through the risk management plan or provincial approval, these will be managed through a management plan required under County of Wellington Official Plan 4.9.5.4. The management plan must be either completed to the satisfaction of the Risk Management Official prior to signing of the site plan agreement or included as a legally binding condition in the site plan agreement with a completion date. The submission of the disclosure report will provide the information necessary to make this determination and the disclosure report can be provided first for review prior to completion of the management plan, if required. The Risk Management Official will provide guidance on the contents of the management plan.

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Prescribed drinking water threats

The following has been reproduced from Ontario Regulation 287/07 pursuant to the *Clean Water Act*. For an up to date version and for further information, please refer to the regulation at https://www.ontario.ca/laws/regulation/070287#BK3

For information on provincially prescribed thresholds and circumstances please refer to https://www.ontario.ca/page/tables-drinking-water-threats

Excerpt from Ontario Regulation 287/07
1.1 (1) The following activities are prescribed as drinking water threats for the purpose of the definition of "drinking water threat" in subsection 2 (1) of the Act:

1. The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*.

2. The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.

3. The application of agricultural source material to land.

4. The storage of agricultural source material.

5. The management of agricultural source material.

6. The application of non-agricultural source material to land.

7. The handling and storage of non-agricultural source material.

8. The application of commercial fertilizer to land.

9. The handling and storage of commercial fertilizer.

10. The application of pesticide to land.

11. The handling and storage of pesticide.

12. The application of road salt.

13. The handling and storage of road salt.

14. The storage of snow.

15. The handling and storage of fuel.

16. The handling and storage of a dense non-aqueous phase liquid.

17. The handling and storage of an organic solvent.

18. The management of runoff that contains chemicals used in the de-icing of aircraft.

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19. An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body.

20. An activity that reduces the recharge of an aquifer.

21. The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.

22. The establishment and operation of a liquid hydrocarbon pipeline. O. Reg. 385/08, s. 3; O. Reg. 206/18, s. 1.

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2. Winter Maintenance (Management Plan) Measures

The below information is provided as a guidance for developing a winter maintenance plan. The plan should include the following headings and additional detail is expected for each heading.

Administration

Employee & Contractor Training

Inspections & Record Keeping

Spill Prevention & Response

- The response plan must include posting the Spills Action Centre number (1-800-268-6060) in an easy to find and read location for staff to use in the event of a spill.

Maintenance Measures

Chemical Application

Snow Storage

For additional information please visit the following websites:

Transport Canada: http://www.wellingtonwater.ca/en/resources/tac_salt.pdf

Environment Canada: https://www.canada.ca/en/environment-climate-change/services/pollutants/road-salts/code-practice-environmental-management.html#s03

Smart About Salt: https://smartaboutsalt.wildapricot.org/

Minnesota Chloride Resources: https://www.pca.state.mn.us/business-with-us/statewide-chloride-resources

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3. Recharge Infiltration Measures

Design measures to ensure that recharge to the aquifer is maintained, and that the recharge is as contaminant-free as possible. These include, but are not limited to:

- Maintenance of pre-development recharge or maximization of off-site recharge, if predevelopment levels cannot be maintained on-site. If off-site recharge is the preferred option, please contact sourcewater@centrewellington.ca
- To maintain pre-development recharge, maximization of lot-level infiltration, including directing roof runoff to pervious surfaces, such as landscaped areas, gravelled areas with no pedestrian or vehicle traffic and/or infiltration galleries, rather than paved or gravel surfaces with pedestrian or vehicle traffic where ice accumulation, and therefore salt application, may occur. This will involve identifying where downspouts will be located and to where they will drain.
- If roof run-off cannot be directed for infiltration, then it is recommended it is piped directly to the storm sewer and/or stormwater management facility to avoid icing of surfaces. Note the preference is some level of roof run-off infiltration to achieve a pre- to post-development water balance.
- Reduction of impervious surfaces, including use of pervious materials in areas that would not require salt application, such as patios, pathways or amenities.
- Ensuring that any stormwater management facility that would receive parking lot runoff have an impervious liner, to avoid recharge of water containing contaminants, particularly sodium and chloride, back to the aquifer. Please note a stormwater management facility may also need provincial approval.

For additional information please visit the following websites:

https://sustainabletechnologies.ca/home/urban-runoff-green-infrastructure/low-impact-development/

https://cvc.ca/low-impact-development/

4. Source Protection Plan Policies

There are five Source Protection Plan areas within Wellington County. To determine which plan applies to your property please visit: http://www.wellingtonwater.ca/en/wswp-resources/mapping-tool.aspx.

For more information on the relevant Source Protection Plan policy, please visit the following websites:

Grand River: https://www.sourcewater.ca/en/source-protection-areas/resources/Documents/Grand/GRSPA_SPP_not-updated_S7-Wellington_clean.pdf

Maitland Valley: https://www.sourcewaterinfo.on.ca/wp-content/uploads/2019/02/MV_SPP_Amended_February_5_2019_Web_Post_RE.pdf

Saugeen Valley: https://home.waterprotection.ca/source-protection-plan/assessment-reports/saugeen-valley/

CTC: https://ctcswp.ca/protecting-our-water/the-ctc-source-protection-plan/

Halton-Hamilton: https://www.protectingwater.ca/wp-content/uploads/sites/2/2023/02/HHSPP-clean_221104.docx.pdf

Water Balances for Planning Applications

County of Wellington Source Protection Policy – Water Balance

The Grand River Source Protection Plan (approved version: February 9, 2022) includes Policies Addressing Prescribed Drinking Water Threats to municipal water supply sources (County of Wellington, Section 7.4). Under the heading; 20. An Activity that Reduces the Recharge of an Aquifer, Policy Number WC-MC-23.5, as it applies to Future Land Use Planning relative to a Municipal Wellhead Protection Area – Quantity (WHPA-Q), is as follows:

> *To ensure that any Recharge Reducing Activity never becomes a significant drinking water threat, where this activity would be a significant drinking water threat as prescribed by the CWA, the Planning Approval Authority shall require that all site plan, subdivision and vacant land condominium applications to facilitate Major Development* for new residential, commercial, industrial and institutional uses provide a water balance assessment for the proposed development which addresses each of the following requirements:*
>
> > *a. maintain pre-development recharge to the greatest extent feasible through best management practices such as LID, minimizing impervious surfaces, and lot level infiltration;*
> > *b. where pre-development recharge cannot be maintained on site, implement and maximize off-site recharge enhancement (within the same WHPA-Q) to compensate for any predicted loss of recharge from the development; and*
> > *c. within a WHPA-Q in a Chloride, Sodium, or Nitrate Issue Contributing Area (ICA), the water balance assessment must consider water quality when recommending best management practices and address how recharge will be maintained and water quality will be protected including consideration of how water quality will be protected from application and storage of winter maintenance materials including Salt.*
>
> *The Planning Approval Authority shall use its discretion to implement the requirements of this policy to the extent feasible and practicable given the nature of the proposed development, specific circumstances of a site and off-site recharge opportunities.*

** Major Development – means development consisting of:*

a. the creation of four or more lots;

b. the construction of a building or buildings with a ground floor area of 500 m² or more; or

c. the establishment of a Major Recreational Use.

Water Balance Guidelines

A guideline for preparation of a water balance for a proposed land development site is recommended: Hydrogeological Assessment Submissions Conservation Authority Guidelines for Development Applications, June 2013. Sub-section 3.2.4 Water Balance Analysis in this document provides specific guidance for estimating the monthly pre- and post-development

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recharge and runoff. Within this section, the following are required, at a minimum, when conducting a water balance analysis:

1. Obtain precipitation values from a reliable source such as Environment Canada Meteorological Services for the area (utilize closest station with adequate data, including monthly normal precipitation).
2. Estimate of local values for major water balance components (evapotranspiration, surplus, runoff, and infiltration) for pre-development, post-development, and post-development with mitigation conditions (e.g. proponents are to describe what mitigation measures (if any) are attainable/feasible to offset fluctuations of both water balance and stormwater runoff from the development property(s).
3. Calculations of impervious areas that reflect actual conditions based on the proposed site plan, or a reasonable range of impervious areas used in those cases where only a conceptual development plan is provided.
4. Runoff coefficients consistent with generally accepted numbers (e.g. MECP guidelines*).
5. The water balance is required to account for changes to grading/topography and land cover.
6. Grain size analysis for both the fill material and on-site soils to confirm fill material is similar to existing soil conditions (may be recommended).
7. Appropriate catchments should be used within the analysis (i.e. delineate catchments based on drainage, grades, vegetation, soils and explain how infiltration and runoff will change within these zones for both pre- and post-development).
8. Figure of catchments used within the pre- and post-development water balance.
9. All calculations should be provided in a table format to demonstrate inputs are equal to outputs.
10. As per policy WC-MC-23.5, sub section c., the report shall specifically account for how water quality will be protected, with respect to the appropriate Issue Contributing Area. If a significant Drinking Water Threat(s) is required to be managed with a legally binding risk management plan (RMP) pursuant to the *Clean Water Act* and Grand River Source Protection Plan, the Risk Management Office will forward this documentation for review. If a Salt Management Plan is requested, the review of Wellington County specific guidance is recommended.

    * Low Impact Development Stormwater Management Guidance Manual, Draft For Consultation, Ministry of the Environment, Conservation and Parks, January 2022.

An example Water Budget Analysis is provided in Appendix A of the Hydrogeological Assessment Submissions Conservation Authority Guidelines for Development Applications.

Both the Credit Valley Conservation Authority and Toronto and Region Conservation Authority's Low Impact Development Stormwater Management Planning and Design Guide, 2010, and the MECP's Low Impact Development Stormwater Management Guidance Manual, can be used as tools to assist in developing more sustainable stormwater management practices. Please refer to these document draft, or as amended.

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April 25, 2024

Lynne Banks
Development and Legislative Coordinator
Township of Puslinch
7404 Wellington Road 34
Puslinch, ON · N0B 2J0

Re: Section of Lots 7, 8 and 9, Concession 10
Traffic Impact Study, March 2024, Crozier
Peer Review Comments

Dear Lynne,

I've reviewed the Traffic Impact Study prepared by Crozier for the Zoning By-law amendment application for the lands identified above near the intersection of Watson Road South and Arkell Road and dated March 2024.

My comments are as follows:

- I am in agreement with the existing traffic and the background traffic along with the analyses completed for those scenarios. I am also in agreement with the trip generation estimates for the site.
- The translation between the TTS analysis and the site traffic assignment is not clear. The majority of the site traffic has been assigned to and from the southeast on Watson Road South when the TTS analysis suggests most traffic is destined to and from the northwest, the southwest and the west. However, it is my opinion that changing the assignment of traffic would not materially change the capacity analyses and would not change the recommendations in the report. The two study area intersections are forecast to operate at good levels of service and the traffic volumes generated by the proposal are low.
- A new public road connection is proposed to Watson Road South, which is a Township road. The consultant has provided a sight distance assessment indicating that the available sight distance exceeds the TAC requirements. I would like to have the consultant confirm how the available sight distances were determined – were they measured in the field or calculated based on a review of base mapping?
- The proposed new road connection is located near the level railway crossing of Watson Road South. We will need to receive confirmation from Guelph Junction Railway that

they are in agreement with the new road connection. The capacity analysis indicates that there is no queuing expected from the new intersection toward the railway.

- The County and their consultant may have additional comments based on their review of the emergency access and the Watson/Arkell intersection.

Let me know if there is anything further you would like to discuss with respect to this application.

Sincerely,

[redacted]

Julia Salvini, MEng, PEng
President

Cc: Mike Fowler, Township of Puslinch
Pasquale Costanzo, Wellington County