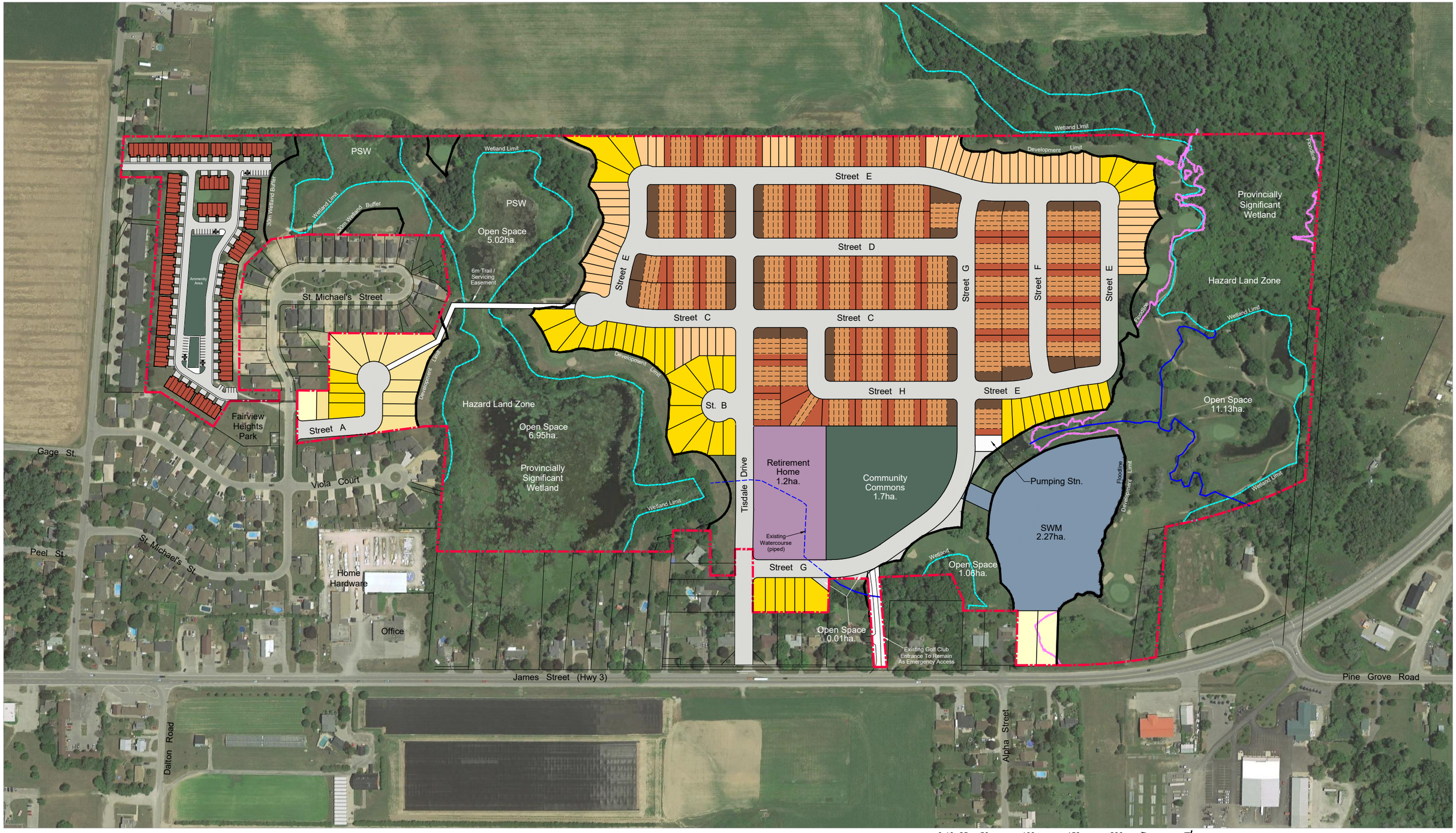


Delhi Development Inc.

DEVELOPMENT CONCEPT

Delhi Golf & Country Club

Site Area: 55.32ha. (136.7ac.)
Developable Area: 29.73ha. (73.4ac)
No. of Lots / Units: 874

- 18' Townhouses (129)
- 18' Street Townhouses (313)
- 20' Street Townhouses (130)
- 22' Street Townhouses (32)
- 30' Lots (57)
- 36' Lots (50)
- 44' Lots (10)
- 60' Lots (3)
- Retirement Home (150)

0 10 25 50 100 150 200
Metres

NOTE: This concept should be considered as a preliminary demonstration model that illustrates an 'order of magnitude' development scenario for the site and is subject to municipal planning approvals.

Scale 1:4,000 | February 23, 2023 | Project No.: 21208 | Drawn By: SL

GSP group

PLAN OF SURVEY OF BLOCK 30 PLAN 37M–XXXX TOWNSHIP OF DELHI NORFOLK COUNTY

SCALE 1:500

10m 5m 0m 10m 20m 30m 40metres

R–PE SURVEYING LTD., O.L.S.

METRIC
DISTANCES AND COORDINATES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048

NOTES

□	DENOTES MONUMENT SET
■	DENOTES MONUMENT FOUND
SSIB	DENOTES SHORT STANDARD IRON BAR
SIB	DENOTES STANDARD IRON BAR
IB	DENOTES IRON BAR
P.I.N.	DENOTES PROPERTY IDENTIFIER NUMBER
PL1	DENOTES PLAN 37M–
ORP	DENOTES OBSEREVED REFERENCE POINT

SURVEYOR'S CERTIFICATE

I CERTIFY THAT:

1. THIS SURVEY AND PLAN ARE CORRECT AND IN ACCORDANCE WITH THE SURVEYS ACT, THE SURVEYORS ACT AND THE LAND TITLES ACT AND THE REGULATIONS MADE UNDER THEM.
2. THE SURVEY WAS COMPLETED ON THE _____ DAY OF _____ 2023.

DATE _____ 2023

_____
C. P. EDWARD
ONTARIO LAND SURVEYOR

INTEGRATION NOTE

BEARINGS ARE GRID, UTM, NAD83 (CSRS)(CBN-v6: 2010.0), DERIVED FROM ORP Ⓐ AND ORP Ⓑ. OBSERVED REFERENCE POINTS ARE DERIVED FROM REAL TIME NETWORK STATION No. PRS909292336693 (NORTHING 4743051.29, EASTING 553065.34).

COORDINATES ARE UTM, NAD83 (CSRS)(CBN-v6: 2010.0), TO URBAN ACCURACY PER SEC. 14 (2) OF O.REG. 216/10, AND CANNOT, IN THEMSELVES, BE USED TO RE–ESTABLISH CORNERS OR BOUNDARIES ON THIS PLAN.

POINT ID	NORTHING	EASTING
ORP Ⓐ	4743364.30	542103.80
ORP Ⓑ	4743415.16	542339.39

DISTANCES ARE GROUND AND CAN BE CONVERTED TO GRID BY MULTIPLYING BY THE COMBINED SCALE FACTOR OF 0.999591.

I REQUIRE THIS PLAN TO BE DEPOSITED UNDER THE LAND TITLES ACT.

DATE _____, 2023

_____
C. P. EDWARD, O.L.S.

PLAN 37R–

RECEIVED AND DEPOSITED

DATE _____, 2023

_____
REPRESENTATIVE FOR LAND REGISTRAR FOR THE LAND TITLES DIVISION OF NORFOLK (No.37)

SCHEDULE			
PART	LOT	CONCESSION	P.I.N.
1 TO 130	PART OF 24	13	PART OF P.I.N. 50167–0207

(KNOWN AS) WILSON AVENUE
(ROAD ALLOWANCE BETWEEN CONCESSION 12 AND 13)

N77°49'54"E 45.72

N16°34'10"W 45.12

N77°49'10"E 241.19

N16°20'25"W 117.20

N73°25'05"W 34.14

N73°49'45"E 100.00

N82°29'30"E 40.15

N07°01'30"W 36.16

N73°21'40"E 11.96

M.20,12.91N

M.51,10.81N

45.00

55.90

CONDO BLOCK
NORFOLK CONDOMINIUM PLAN No. 50814
UNIT 1 UNIT 2 UNIT 3 UNIT 4 UNIT 5 UNIT 6 UNIT 7 UNIT 8 UNIT 9 UNIT 10 UNIT 11 UNIT 12 UNIT 13

BLOCK MACAN PLAN No. 14

PART 7, PLAN 37R–6365 SUBJECT TO AN EASEMENT FOR ENTRY AS IN NR46

PART 130

PART 1 PART 2 PART 3 PART 4 PART 5 PART 6 PART 7 PART 8 PART 9 PART 10 PART 11 PART 12 PART 13 PART 14 PART 15 PART 16 PART 17 PART 18 PART 19 PART 20 PART 21 PART 22 PART 23 PART 24 PART 25 PART 26 PART 27 PART 28 PART 29 PART 30 PART 31 PART 32 PART 33 PART 34 PART 35 PART 36 PART 37 PART 38 PART 39 PART 40 PART 41 PART 42 PART 43 PART 44 PART 45 PART 46 PART 47 PART 48 PART 49 PART 50 PART 51 PART 52 PART 53 PART 54 PART 55 PART 56 PART 57 PART 58 PART 59 PART 60 PART 61 PART 62 PART 63 PART 64 PART 65 PART 66 PART 67 PART 68 PART 69 PART 70 PART 71 PART 72 PART 73 PART 74 PART 75 PART 76 PART 77 PART 78 PART 79 PART 80 PART 81 PART 82 PART 83 PART 84 PART 85 PART 86 PART 87 PART 88 PART 89 PART 90 PART 91 PART 92 PART 93 PART 94 PART 95 PART 96 PART 97 PART 98 PART 99 PART 100 PART 101 PART 102 PART 103 PART 104 PART 105 PART 106 PART 107 PART 108 PART 109 PART 110 PART 111 PART 112 PART 113 PART 114 PART 115 PART 116 PART 117 PART 118 PART 119 PART 120 PART 121 PART 122 XXXX PART 123 PART 124 PART 125 PART 126 PART 127 PART 128 PART 129

PART 130

PART 130

PART 130

P.I.N. 50167

LOT 57
LOT 56
LOT 55 P.I.N. 50167–0116
LOT 54 P.I.N. 50167–0353
LOT 53 P.I.N. 50167–0117
LOT 52 P.I.N. 50167–0118
LOT 51 P.I.N. 50167–0119
LOT 50
LOT 49
LOT 48
LOT 47
LOT 46
LOT 59 P.I.N. 50167–0124
LOT 60

PART 1, PLAN 37R–2871 P.I.N. 50167–0311

PART 1, PLAN 37R–8997 P.I.N. 50167–0358

LOT 23 CONCESSION 13

BLOCK 38

ST. MICHAEL'S STREET
(BY REGISTERED PLAN 1199)
P.I.N. 50167–0174

R-PE SURVEYING LTD.
ONTARIO LAND SURVEYORS
643 Chrislea Road, Suite 7
Woodbridge, Ontario L4L 8A3
Tel.(416)635–5000 Fax (416)635–5001
Tel.(905)264–0881 Fax (905)264–2099
Website: www.r–pe.ca

DRAWN: A.Q. CHECKED:
JOB No. 22–377 CAD FILE No. 22377R01C–POTL

PLAN OF SURVEY OF BLOCK 30 PLAN 37M–XXXX TOWNSHIP OF DELHI NORFOLK COUNTY

SCALE 1:500

10m 5m 0m 10m 20m 30m 40metres

R–PE SURVEYING LTD., O.L.S.

METRIC
DISTANCES AND COORDINATES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048

NOTES

□	DENOTES MONUMENT SET
■	DENOTES MONUMENT FOUND
SSIB	DENOTES SHORT STANDARD IRON BAR
SIB	DENOTES STANDARD IRON BAR
IB	DENOTES IRON BAR
P.I.N.	DENOTES PROPERTY IDENTIFIER NUMBER
PL1	DENOTES PLAN 37M–
ORP	DENOTES OBSEREVED REFERENCE POINT

SURVEYOR'S CERTIFICATE

I CERTIFY THAT:

1. THIS SURVEY AND PLAN ARE CORRECT AND IN ACCORDANCE WITH THE SURVEYS ACT, THE SURVEYORS ACT AND THE LAND TITLES ACT AND THE REGULATIONS MADE UNDER THEM.
2. THE SURVEY WAS COMPLETED ON THE _____ DAY OF _____ 2023.

DATE _____ 2023

_____
C. P. EDWARD
ONTARIO LAND SURVEYOR

INTEGRATION NOTE

BEARINGS ARE GRID, UTM, NAD83 (CSRS)(CBN-v6: 2010.0), DERIVED FROM ORP Ⓐ AND ORP Ⓑ. OBSERVED REFERENCE POINTS ARE DERIVED FROM REAL TIME NETWORK STATION No. PRS909292336693 (NORTHING 4743051.29, EASTING 553065.34).

COORDINATES ARE UTM, NAD83 (CSRS)(CBN-v6: 2010.0), TO URBAN ACCURACY PER SEC. 14 (2) OF O.REG. 216/10, AND CANNOT, IN THEMSELVES, BE USED TO RE–ESTABLISH CORNERS OR BOUNDARIES ON THIS PLAN.

POINT ID	NORTHING	EASTING
ORP Ⓐ	4743364.30	542103.80
ORP Ⓑ	4743415.16	542339.39

DISTANCES ARE GROUND AND CAN BE CONVERTED TO GRID BY MULTIPLYING BY THE COMBINED SCALE FACTOR OF 0.999591.

I REQUIRE THIS PLAN TO BE DEPOSITED UNDER THE LAND TITLES ACT.

DATE _____, 2023

_____
C. P. EDWARD, O.L.S.

PLAN 37R–

RECEIVED AND DEPOSITED

DATE _____, 2023

_____
REPRESENTATIVE FOR LAND REGISTRAR FOR THE LAND TITLES DIVISION OF NORFOLK (No.37)

SCHEDULE			
PART	LOT	CONCESSION	P.I.N.
1 TO 130	PART OF 24	13	PART OF P.I.N. 50167–0207

(KNOWN AS) WILSON AVENUE
(ROAD ALLOWANCE BETWEEN CONCESSION 12 AND 13)

N77°49'54"E 45.72

N16°34'10"W 45.12

N77°49'10"E 241.19

N16°20'25"W 117.20

N73°25'05"W 34.14

N73°49'45"E 100.00

N82°29'30"E 40.15

N07°01'30"W 36.16

N73°21'40"E 11.96

M.20,12.91N

M.51,10.81N

45.00

55.90

CONDO BLOCK
NORFOLK CONDOMINIUM PLAN No. 50814
UNIT 1 UNIT 2 UNIT 3 UNIT 4 UNIT 5 UNIT 6 UNIT 7 UNIT 8 UNIT 9 UNIT 10 UNIT 11 UNIT 12 UNIT 13

BLOCK MACAN PLAN No. 14

PART 7, PLAN 37R–6365 SUBJECT TO AN EASEMENT FOR ENTRY AS IN NR46

PART 130

PART 1 PART 2 PART 3 PART 4 PART 5 PART 6 PART 7 PART 8 PART 9 PART 10 PART 11 PART 12 PART 13 PART 14 PART 15 PART 16 PART 17 PART 18 PART 19 PART 20 PART 21 PART 22 PART 23 PART 24 PART 25 PART 26 PART 27 PART 28 PART 29 PART 30 PART 31 PART 32 PART 33 PART 34 PART 35 PART 36 PART 37 PART 38 PART 39 PART 40 PART 41 PART 42 PART 43 PART 44 PART 45 PART 46 PART 47 PART 48 PART 49 PART 50 PART 51 PART 52 PART 53 PART 54 PART 55 PART 56 PART 57 PART 58 PART 59 PART 60 PART 61 PART 62 PART 63 PART 64 PART 65 PART 66 PART 67 PART 68 PART 69 PART 70 PART 71 PART 72 PART 73 PART 74 PART 75 PART 76 PART 77 PART 78 PART 79 PART 80 PART 81 PART 82 PART 83 PART 84 PART 85 PART 86 PART 87 PART 88 PART 89 PART 90 PART 91 PART 92 PART 93 PART 94 PART 95 PART 96 PART 97 PART 98 PART 99 PART 100 PART 101 PART 102 PART 103 PART 104 PART 105 PART 106 PART 107 PART 108 PART 109 PART 110 PART 111 PART 112 PART 113 PART 114 PART 115 PART 116 PART 117 PART 118 PART 119 PART 120 PART 121 PART 122 XXXX PART 123 PART 124 PART 125 PART 126 PART 127 PART 128 PART 129

PART 130

PART 130

PART 130

P.I.N. 50167

LOT 57
LOT 56
LOT 55 P.I.N. 50167–0116
LOT 54 P.I.N. 50167–0353
LOT 53 P.I.N. 50167–0117
LOT 52 P.I.N. 50167–0118
LOT 51 P.I.N. 50167–0119
LOT 50
LOT 49
LOT 48
LOT 47
LOT 46
LOT 59 P.I.N. 50167–0124
LOT 60

PART 1, PLAN 37R–2871 P.I.N. 50167–0311

PART 1, PLAN 37R–8997 P.I.N. 50167–0358

LOT 23 CONCESSION 13

BLOCK 38

ST. MICHAEL'S STREET
(BY REGISTERED PLAN 1199)
P.I.N. 50167–0174

R-PE SURVEYING LTD.
ONTARIO LAND SURVEYORS
643 Chrislea Road, Suite 7
Woodbridge, Ontario L4L 8A3
Tel.(416)635–5000 Fax (416)635–5001
Tel.(905)264–0881 Fax (905)264–2099
Website: www.r–pe.ca

DRAWN: A.Q. CHECKED:
JOB No. 22–377 CAD FILE No. 22377R01C–POTL

DRAFT PLAN OF COMMON ELEMENTS CONDOMINIUM BLOCK 30 PLAN 37M–XXXX TOWNSHIP OF DELHI NORFOLK COUNTY

SCALE 1:500

10m 5m 0m 10m 20m 30m 40metres

R–PE SURVEYING LTD., O.L.S.

METRIC
DISTANCES AND COORDINATES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048

NOTES

V DENOTES VISITOR PARKING
H/C DENOTES HANDICAP SPACE

LAND USE

PROPOSED SITE AREA (COMMON ELEMENTS AREA) = 1.229 Ha.
PARCELS OF TIED LAND (POTL): 129 POTLs
LAND USE INFORMATION OBTAINED FROM SITE PLAN BY GSP GROUP DATED FEBRUARY 23, 2023

SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED AND THEIR RELATIONSHIP TO THE ADJOINING LANDS ARE ACCURATELY AND CORRECTLY SHOWN.

DATE MARCH 22nd ,2023

C. P. EDWARD
ONTARIO LAND SURVEYOR

ADDITIONAL INFORMATION AS REQUIRED BY SECTION 51(17) OF THE PLANNING ACT

(b) SEE PLAN
(c) SEE KEY PLAN
(d) RESIDENTIAL
(e) SEE PLAN
(f) SEE PLAN
(g) SEE PLAN AND KEY PLAN
(h) PIPED WATER
(i) SEE ENGINEERING REPORT
(j) SEE SITE AND GRADING PLANS
(k) FULLY SERVICED
(l) SEE PLAN

OWNER'S CERTIFICATE

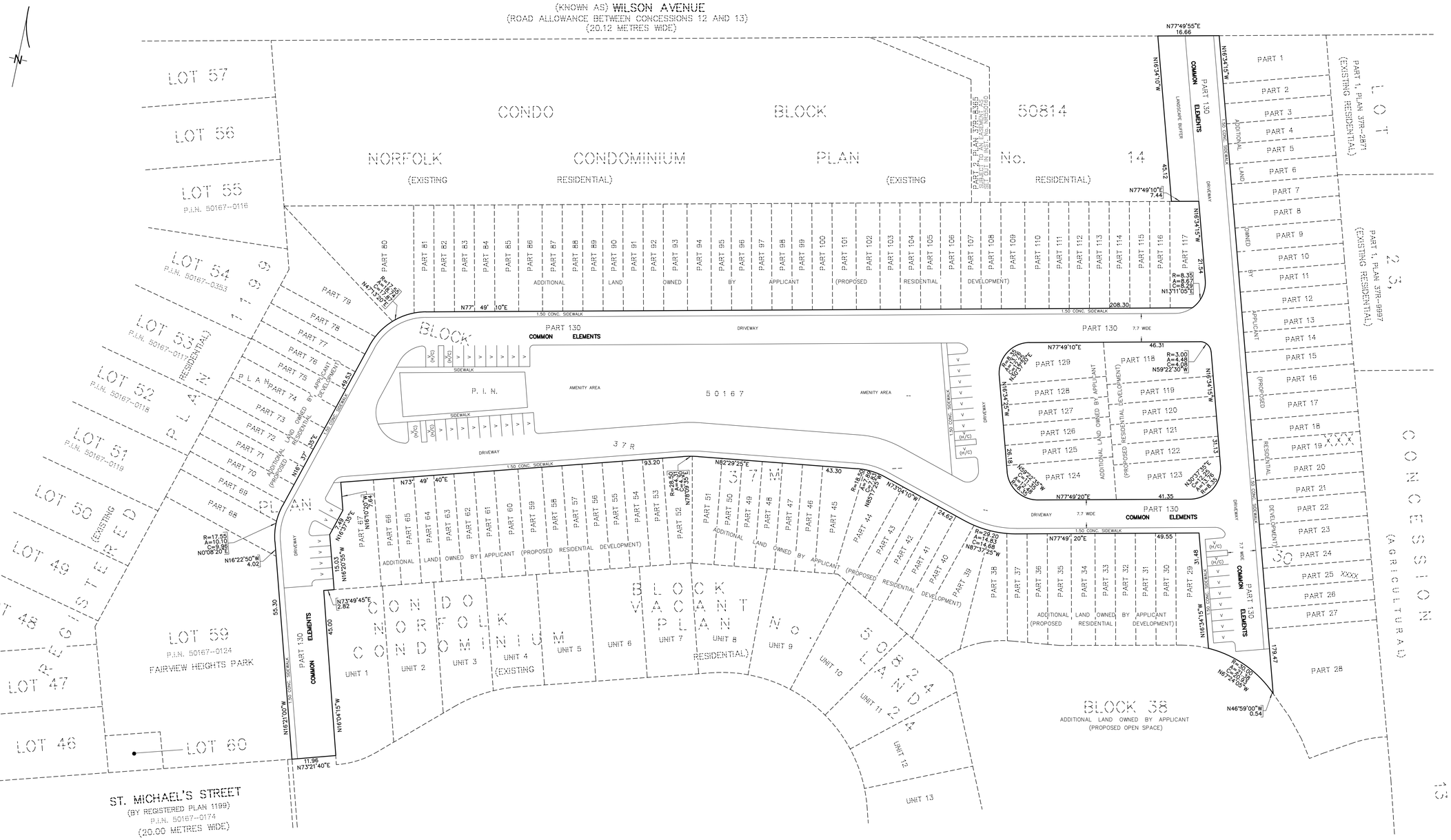
I HEREBY AUTHORIZE R–PE SURVEYING LTD., O.L.S. TO PREPARE AND SUBMIT THIS DRAFT PLAN OF COMMON ELEMENTS CONDOMINIUM TO THE TOWNSHIP OF DELHI FOR APPROVAL.

DATE MARCH 24th , 2023

DELHI LAND HOLDINGS LIMITED

MARIO GIAMPIETRI
AUTHORIZED SIGNING OFFICER
I HAVE THE AUTHORITY TO BIND THE CORPORATION

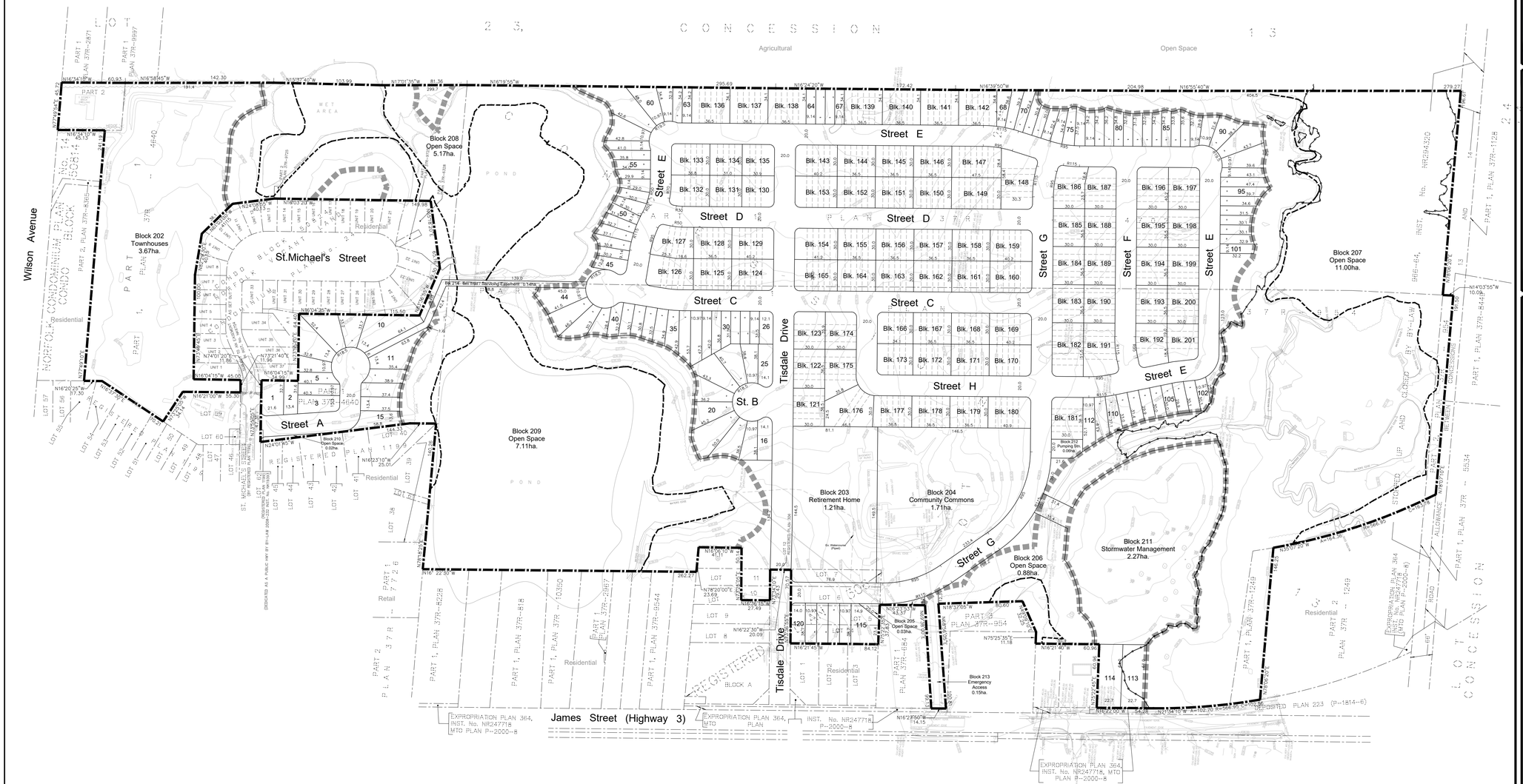
SHAWN EVANS
AUTHORIZED SIGNING OFFICER
I HAVE THE AUTHORITY TO BIND THE CORPORATION

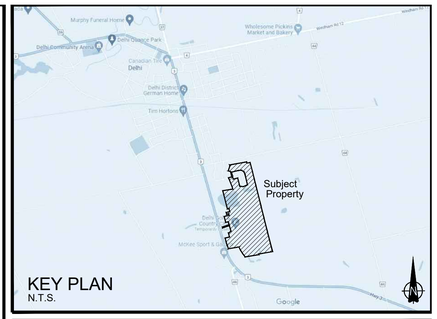


R-PE SURVEYING LTD.
ONTARIO LAND SURVEYORS
643 Chrislea Road, Suite 7
Woodbridge, Ontario L4L 8A3
Tel.(416)635–5000 Fax (416)635–5001
Tel.(905)264–0881 Fax (905)264–2099
Website: www.r–pe.ca

DRAWN: A.Q. CHECKED: C.P.E.
JOB No. 22–377 CAD FILE No. 22377–CEC–01–c

Mar 22, 2023 – 08:03:02





DRAFT PLAN OF SUBDIVISION

Lots 4,5,6,7 and 12, Part of Lots 10 and 11,
Registered Plan 306,
Part of Lot 24, Concession 13,
Part of the Road Allowance Between
Concessions 12 and 13,
(STOPPED UP AND CLOSED BY BY-LAW 966-64, INST. No.NR294320)
(GEOGRAPHIC TOWNSHIP OF WINDHAM)
Township of Delhi
County of Norfolk

LAND USE SCHEDULE

DESCRIPTION	LOTS/BLKS.	UNITS	AREA (ha.)
Residential	1-120	120	5.45
Street Townhouses	121-201	475	9.34
Townhouses	202	129	3.67
Retirement Home	203	150	1.21
Community Commons	204		1.71
Open Space	205-210		24.21
Stormwater Management	211		2.27
Pumping Station	212		0.06
Emergency Access	213		0.15
Trail / Servicing Easement	214		0.14
Roads			7.11
TOTAL		874	55.32

LEGEND

- Outermost Constraint Line
- Wetland Boundary
- Floodline

ADDITIONAL INFORMATION

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

INFORMATION REQUIRED BY CLAUSES a,b,c,d,e,f,g,j and l ARE AS SHOWN ON THE DRAFT PLAN.
h) Municipal water supply
i) Silt, sand, sand and gravel, clayey silt, sandy silt, silty sand and silty clay
k) All sanitary and storm sewers as required

OWNER'S CERTIFICATE

I AUTHORIZE THE GSP GROUP INC. TO PREPARE AND SUBMIT THIS DRAFT PLAN OF SUBDIVISION TO NORFOLK COUNTY.

MARIO GIAMPIETRI, ASO
Delhi Land Holdings Limited
January 20, 2023
DATE

SHAWN EVANS, ASO
Delhi Land Holdings Limited
JAN. 20, 2023
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.

C.P. EDWARD, O.L.S.
R-PE Surveying Ltd.
January 23, 2023
DATE

GSP group
PLANNING I URBAN DESIGN I LANDSCAPE ARCHITECTURE
gspgroup.ca

REVISIONS
March 9, 2023

Date: January 30, 2023	Drawn By: S.L.	Dwg. File Name:dp21208c.dwg
Scale: 1:2,000 metric	Project No.: 21208	

DELHI GOLF AND COUNTRY CLUB, NORFOLK COUNTY

Proposed Residential Subdivision
Transportation Impact Study

Prepared For: Delhi Development Inc.

March 2023

BA Group

© BA Consulting Group Ltd.
45 St. Clair Avenue West, Suite 300
Toronto, ON M4V 1K9
www.bagroup.com

TABLE OF CONTENTS

1.0 INTRODUCTION 1
- 1.1 Overview 1
- 1.2 The Site 1
- 1.3 The Proposed Development 1

2.0 PLANNING POLICIES 5
- 2.1 Norfolk County Official plan 5
- 2.2 Norfolk County Integrated Sustainable Master Plan 5

3.0 AREA TRANSPORTATION CONTEXT 6
- 3.1 Road network 6
- 3.2 Transit Network 7
- 3.3 Active Transportation Network 8

5.0 TRAFFIC VOLUME PROJECTIONS 13
- 5.1 Scope 13
- 5.2 Existing Traffic Volumes 13
- 5.3 Future Background Traffic Volumes 14
- 5.4 Site Traffic Forecasts 15

6.0 OPERATION ANALYSIS 33
- 6.1 Analysis Methodology 33
- 6.2 Analysis Assumptions and Parameters 33
- 6.3 Intersection Operations Analysis 33
- 6.4 Driveway Results Operations Analysis 35

7.0 TRANSPORTATION DEMAND MANAGEMENT 36
- 7.1 Mobility Choice Travel Plan 36
- 7.2 Organizational Framework 36

8.0 DESIGN CONSIDERATIONS 39
- 8.1 Emergency Vehicle Access 39
- 8.2 James Street (Highway 3) / Tisdale Drive Intersection 39
- 8.3 James Street (Highway 3) / Wilson Avenue Intersection 40
- 8.4 Concept Road Plan 40
- 8.5 On-Street Parking 40

9.0 SUMMARY AND CONCLUSIONS 41

LIST OF TABLES

Table 1 Car Parking Requirements – Norfolk County Zoning By-law 1-Z-2014 12
Table 2 Existing Traffic Data Sources 14
Table 3 Area Background Development 14
Table 4 Adopted Vehicle Trip Generation Rates 15
Table 5 Site Vehicle Trip Generation 16
Table 6 Site Traffic Distribution 16
Table 7 Potential Mobility Choice Travel Plan Strategies 37

LIST OF FIGURES

Figure 1: Site Location 3
Figure 2: Concept Plan 4
Figure 3: Area Road Network 9
Figure 4: Area Transit Network 10
Figure 5: Area Active Transportation Network 11
Figure 6: Existing Lane Configurations (2023) 18
Figure 7: Future Lane Configurations 19
Figure 8: Existing Traffic Volumes (2023) 20
Figure 9: Background Development Traffic Volumes 21
Figure 10: Corridor Growth Traffic Volumes (2028) 22
Figure 11: Corridor Growth Traffic Volumes (2033) 23
Figure 12: Corridor Growth Traffic Volumes (2038) 24
Figure 13: Future Background Traffic Volumes (2028) 25
Figure 14: Future Background Traffic Volumes (2033) 26
Figure 15: Future Background Traffic Volumes (2038) 27
Figure 16: Existing Site Traffic Volumes Removal 28
Figure 17: Site Traffic Volumes 29
Figure 18: Future Total Traffic Volumes (2028) 30
Figure 19: Future Total Traffic Volumes (2033) 31
Figure 20: Future Total Traffic Volumes (2038) 32

TABLE OF APPENDICES

APPENDIX A: Concept Plan (not to scale)
APPENDIX B: Concept Road Plan and Highway 3 Functional Plan
APPENDIX C: Traffic Counts
APPENDIX D: Growth Analysis
APPENDIX E: Synchro Summary Tables and Outputs
APPENDIX F: Signal Timing Plans
APPENDIX G: Signal Warrant and Turn Lane Warrants

APPENDIX H: On-Street Parking Plan

1.0 INTRODUCTION

1.1 Overview

BA Group is retained by Delhi Development Inc. c/o Geranium to provide transportation consulting services in relation to the proposed residential subdivision located on the Delhi Golf and Country Club Lands in Norfolk County. Official Plan Amendment (OPA) (for a boundary expansion and redesignation of lands), Zoning By-law Amendment (ZBA) and Draft Plan of Subdivision and Condominium applications are being made to the County for the proposed redevelopment.

This report is being submitted in support of the proposed development and provides an assessment of the transportation impacts of the development proposal.

1.2 The Site

The Site is located southeast of the James Street (Highway 3) / Wilson Avenue intersection and is generally bound by Wilson Avenue and residential dwellings to the north, rural land to the south and east, and James Street (Highway 3) and residential dwellings to the west.

The site is currently occupied by the Delhi Golf and Country Club, which includes an 18-hole golf course, provincially significant wetlands, and a clubhouse. Access to an at-grade parking lot servicing the Delhi Golf and Country Club is available via a driveway to James Street (Highway 3). Part of the Site also includes a dwelling at the northeast corner of the Site, with access to a driveway and garage via Wilson Avenue.

The Site location is shown in **Figure 1**.

1.3 The Proposed Development

The proposed development contemplates the construction of a residential subdivision comprising the following:

- 724 residential units, including:
  - 120 detached dwellings;
  - 129 condominium townhouses; and
  - 475 street townhouses.
- A retirement home comprising 150 units.

The redevelopment concept is divided into three sections, separated by the provincially significant wetlands which are proposed to be retained, including:

- A total of 105 detached dwellings, 475 street townhouses and 150 retirement units located at the south end of the Site (herein referred to as “Area A”). The dwellings and townhouses will be serviced by an internal road network, with primary access available by an extension of the existing Tisdale Drive into the Site. The James Street (Highway 3) / Tisdale Drive intersection is proposed to be signalized to accommodate the proposed redevelopment. As part of the signalization it is proposed to construct a southbound left turn lane and a northbound right turn lane on James Street (Highway 3) to facilitate left and right turns into Area A, and to widen the existing Tisdale Drive pavement to 9.5 metres in accordance with Section 6.2.2 of the Norfolk County Design Criteria, dated August 2017 (herein referred to as the “NCDC”) for a minor collector road. A secondary, emergency access is proposed to James Street (Highway 3) via the existing golf club entrance;
- A total of 15 detached dwellings, located centrally within the Site and serviced by a cul-de-sac which is proposed to connect to the existing St. Michael’s Street (herein referred to as “Area B”); and
- A townhouse block at the northeast corner of the Site, comprising the proposed 129 condominium townhouses (herein referred to as “Area C”). The townhouses will be serviced by a private internal road network, with access available via a connection to Wilson Avenue.

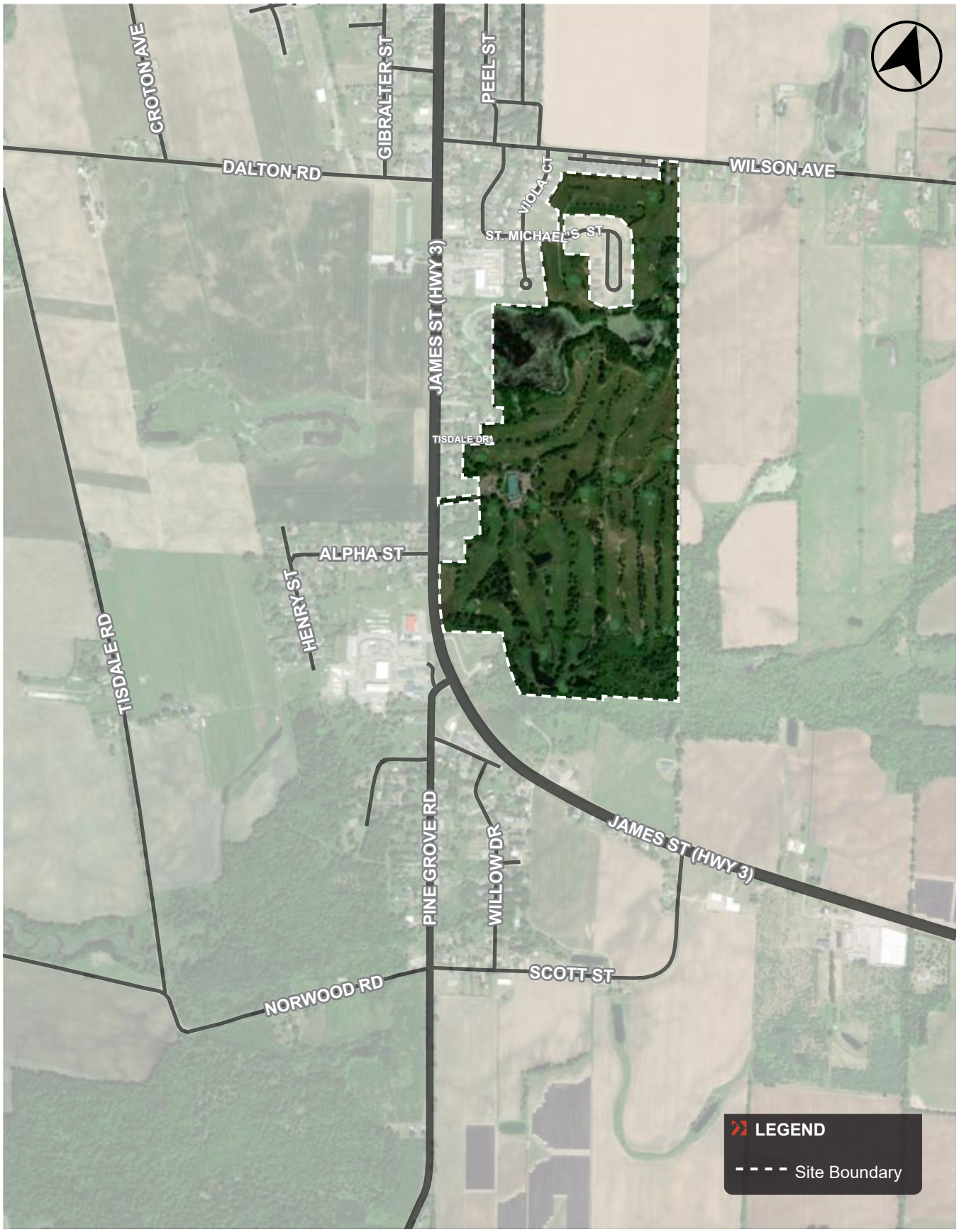
Area A and Area B are proposed to generally comprise public local roads with a 20 metre wide right of way and an 8 metre wide road pavement, in accordance with Section 6.2.2 of the NCDC. Tisdale Drive and Street G are proposed with a 9.5 metre wide pavement within a 20 metre right of way, in accordance with Section 6.2.2 of the NCDC for a minor collector road. A sidewalk will be provided along one side of roads within Area A and Area B, as required by Section 6.6.2 of the NCDC.

Area C is proposed to be serviced by a private condominium road network. Roads within Area C are proposed with a road pavement width of 7.7 metres and a 1.5 metre wide sidewalk on one side. A total of 44 car parking spaces are proposed within Area C for visitors.

Internal intersections across the redevelopment are expected to operate under two-way or all-way 'Stop' control. Vehicle access to individual lots is generally proposed via the abovementioned internal road networks, while two lots front Highway 3.

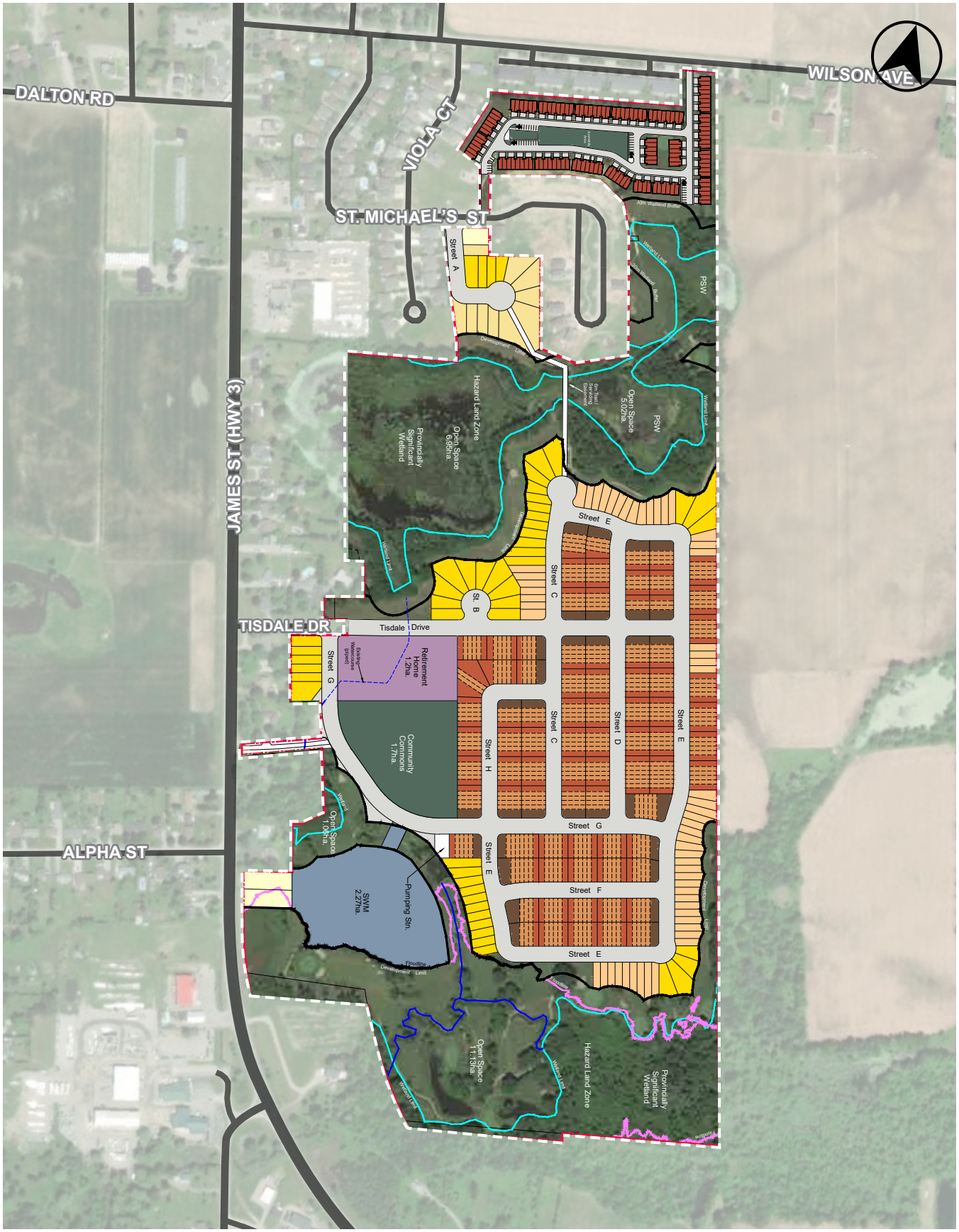
In addition to the abovementioned land uses and internal road networks, the redevelopment will comprise of features such as a community commons, storm water facilities, open space, and wetlands.

The concept plan is shown in **Figure 2** and a reduced copy (not to scale) is attached in **Appendix A**. A preliminary concept road plan, Highway 3 functional plan, and vehicle manoeuvring diagrams for the townhouse block are attached in **Appendix B**.



P:\6860\41\Graphics\AdobeIDs\6860-41 - Figures for Report - Dec.indd

FIGURE 1 SITE LOCATION



P:\6860\41\Graphics\AdobeIDs\6860-41 - Figures for Report - Dec.indd

FIGURE 2 CONCEPT PLAN

2.0 PLANNING POLICIES

2.1 Norfolk County Official plan

The Norfolk County Official Plan (herein referred to as the Norfolk OP) was adopted by Council on May 9, 2006 and seeks to direct future growth, development and change in the County. The Norfolk OP includes details of transportation infrastructure, notably road hierarchy and active transportation.

2.2 Norfolk County Integrated Sustainable Master Plan

The Norfolk County Integrated Sustainable Master Plan (ISMP) was adopted by Council on November 8, 2016.

The ISMP assessed storm water, wastewater, drinking water and transportation to identify the needs to the year 2041 in these service areas.

The ISMP identified the following infrastructure recommendations which are relevant to the Site:

- James Street (Highway 3) to be considered for a “Complete Street” redesign between Wilson Avenue and Church Street, which would allow for safe access by all potential users, including pedestrians, cyclists, motorists, and transit users. The ISMP notes that design principles that could be considered for implementation include wider sidewalks, lane narrowing, bump-outs, pedestrian crossings, bicycle parking, streetscaping and amenities. Detailed design would ultimately confirm the proposed “Complete Street” improvements for pedestrians, cyclists, motorists, and transit users. The complete street redesign as identified in the ISMP applies north of the Site and does not apply along the Site frontage.
- A signed bicycle route with sharrows on Wilson Avenue between James Street (Highway 3) and Viola Court, and a signed bicycle route on Wilson Avenue east of Viola Court; and
- Construction of a sidewalk on Wilson Avenue between James Street (Highway 3) and Viola Court.

The ISMP also includes a County-wide recommendation that sidewalks should be required to be provided on both sides of major and minor roads.

3.0 AREA TRANSPORTATION CONTEXT

3.1 Road network

3.1.1 Overview

The following sections provide an overview of the area road network, as shown graphically in **Figure 3**.

3.1.2 James Street (Highway 3)

James Street (Highway 3) forms part of Highway 3 which extends generally in an east-west direction from Highway 124 in Fort Erie to the international United States/Canada border crossing in Windsor. In the vicinity of the Site, James Street (Highway 3) is aligned in a north-south direction.

Highway 3 is a provincial highway operated by the MTO, though some sections through communities are defined as "Connecting Links" and are operated by the respective municipality. In this case, a section of Highway 3 through Delhi, between Wilson Avenue in the south (James Street) and Church Street West in the north (King Street), is operated by Norfolk County. The section of James Street along the Site frontage is operated and managed by the MTO.

In the vicinity of the Site, James Street (Highway 3) operates with a single traffic lane in each direction, with localized widening provided at some intersections for turn lanes. North of Wilson Avenue, James Street (Highway 3) widens to two traffic lanes in each direction along the Connecting Link through Delhi.

At the south end of the Site, James Street (Highway 3) has a posted speed limit of 70 kilometres per hour. Between Dalton Road and Tisdale Drive, the posted speed limit reduces to 60 kilometres per hour and north of Wilson Avenue, the posted speed limit reduces further to 50 kilometres per hour along the Connecting Link through Delhi.

An asphalt sidewalk is provided along the east side of James Street (Highway 3), extending from approximately 200 metres south of Dalton Road to/from north through the Delhi community. An asphalt sidewalk is also provided along the east side of James Street (Highway 3) between Tisdale Drive and Alpha Street.

3.1.3 Wilson Avenue

Wilson Avenue is a local road which extends generally in an east-west direction from Fertilizer Road to James Street (Highway 3). East of Fertilizer Road, Wilson Avenue continues as Windham Road 13.

In the vicinity of the Site, Wilson Avenue operates with a single traffic lane in each direction and has a posted speed limit of 50 kilometres per hour. There are no sidewalks along Wilson Avenue in the vicinity of the Site.

The James Street (Highway 3) / Wilson Avenue intersection is Stop-controlled, with priority given to James Street (Highway 3).

3.1.4 Tisdale Drive

Tisdale Drive is a local road which extends from James Street (Highway 3) to its terminus approximately 100 metres to the east.

Tisdale Drive currently services four dwellings and provides for two directions of travel within a pavement width of approximately 4.5 metres. Tisdale Drive operates with the default speed limit of 50 kilometres per hour and does not have sidewalks.

The James Street (Highway 3) / Tisdale Drive intersection is Stop-controlled, with priority given to James Street (Highway 3).

3.1.5 St. Michael's Street

St. Michael's Street is a local road which extends south from Wilson Avenue for approximately 200 metres, then extends east for approximately 300 metres and terminates in a loop which extends approximately 150 metres to the south.

St. Michael's Street provides for two directions of travel within a pavement width of approximately 8 metres and operates with the default speed limit of 50 kilometres per hour. There are no sidewalks along St. Michael's Street.

The Wilson Avenue / St. Michael's Street intersection is Stop-controlled, with priority given to Wilson Avenue.

3.1.6 Viola Court

Viola Court is a local road which extends south from Wilson Avenue for approximately 200 metres and connects with St. Michael's Street.

Viola Street provides for two directions of travel within a pavement width of approximately 8 metres and operates with the default speed limit of 50 kilometres per hour. There are no sidewalks along Viola Court.

The Wilson Avenue / Viola Court intersection is Stop-controlled, with priority given to Wilson Avenue. The Viola Court / St. Michael's Street intersection is Stop-controlled with priority given to Viola Court.

3.2 Transit Network

Norfolk County operates transit services under their "Out of Town" schedule, which start and end at Simcoe Library and travel through other nearby communities, including Delhi. Services on the "Out of Town" schedule which operate through Delhi include:

- The Monday service, which operates through Brantford, Delhi, Windham Centre and Waterford;
- The Wednesday service which operates through Brantford, Delhi, Courtland, Tillsonburg, Langton, Greens Corner and Bill's Corner; and
- The Thursday service which operates through Brantford, Delhi, Bill's Corner and Port Dover.

From the connection to Brantford, local Brantford Transit services are available, along with further regional connections via GO Transit and VIA Rail. There are five stops in Delhi, with the nearest located at the Delrose Retirement Residence on Gibraltar Street, approximately 500 metres to the northwest of the Site. A total of five services are operated across the day.

The area transit network is shown in **Figure 4**.

3.3 Active Transportation Network

An asphalt sidewalk is provided along the east side of James Street (Highway 3) in the vicinity of the site, starting approximately 200 metres south of Dalton Road , and extending north through Delhi. An asphalt sidewalk is also provided along the east side of James Street (Highway 3) between Tisdale Drive and Alpha Street. Beyond this, pedestrian infrastructure in the vicinity of the Site is generally limited.

There is no formal cycling infrastructure in the vicinity of the Site. Wilson Avenue and James Street (Highway 3) between Wilson Avenue and William Street are identified in the Norfolk OP as an on-road cycling route and include “Share the Road” signage on Wilson Avenue.

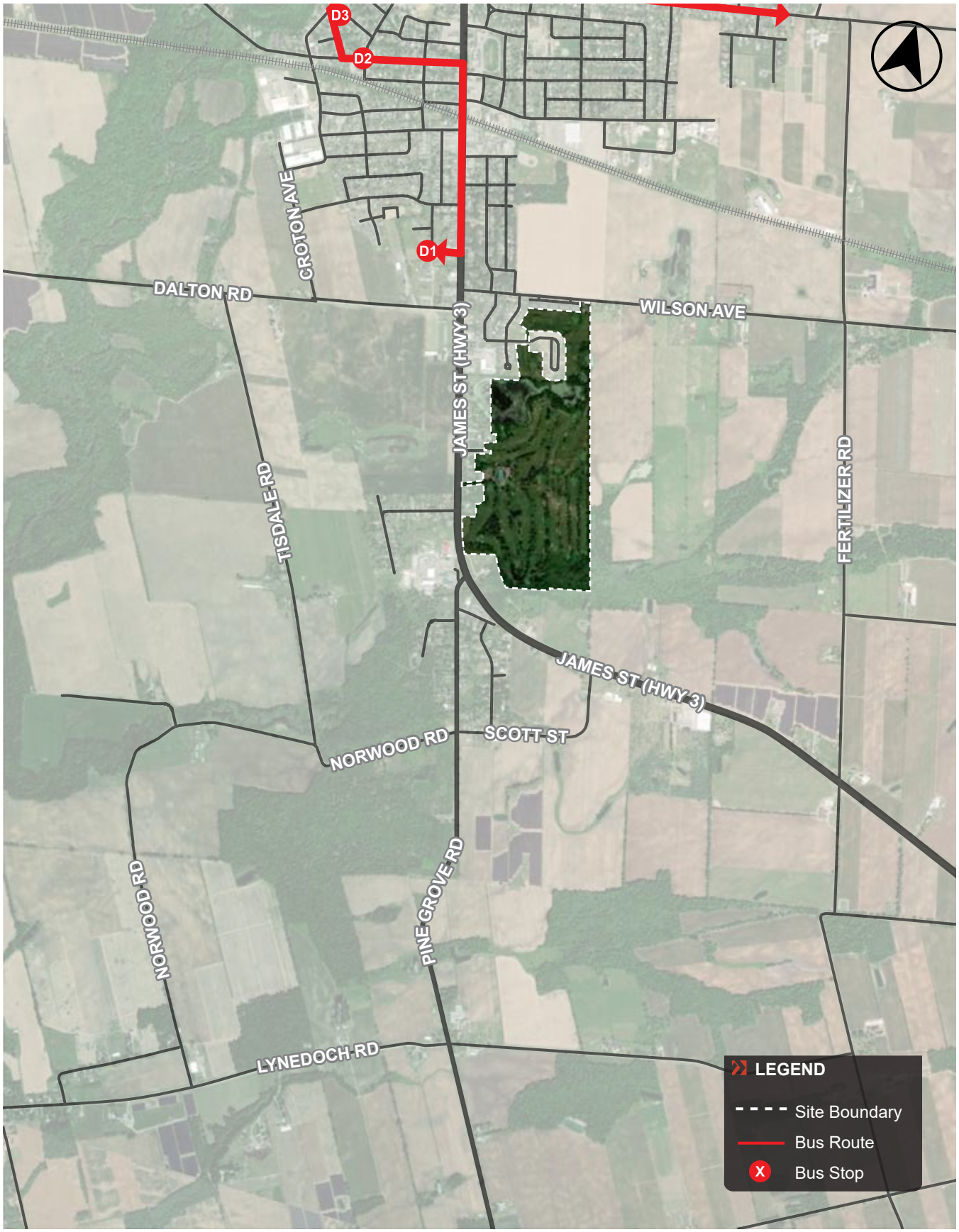
As noted in **Section 2.2**, some additional infrastructure is being considered in the vicinity of the Site as part of the ISMP, including:

- James Street (Highway 3) to be considered for a “Complete Street” redesign between Wilson Avenue and Church Street, which would allow for safe access by all potential users, including pedestrians, cyclists, motorists, and transit users. The ISMP notes that design principles that could be considered for implementation include wider sidewalks, lane narrowing, bump-outs, pedestrian crossings, bicycle parking, streetscaping and amenities. Detailed design would ultimately confirm the proposed “Complete Street” improvements for pedestrians, cyclists, motorists, and transit users. The complete street redesign as identified in the ISMP applies north of the Site and does not apply along the Site frontage.
- A signed bicycle route with sharrows on Wilson Avenue between James Street (Highway 3) and Viola Court, and a signed bicycle route on Wilson Avenue east of Viola Court; and
- Construction of a sidewalk on Wilson Avenue between James Street (Highway 3) and Viola Court.

The area active transportation network is shown in **Figure 5**.

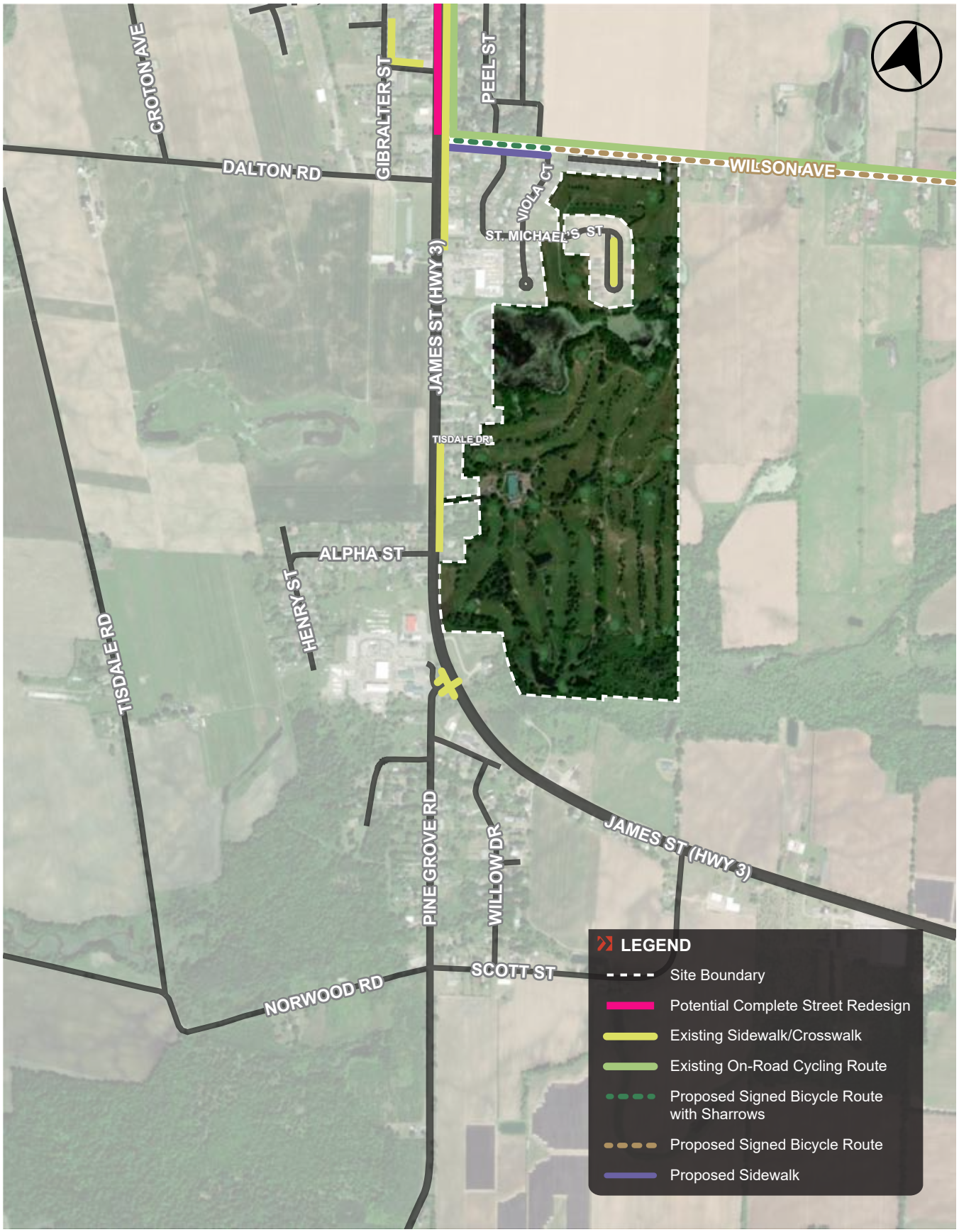
P:\6860\41\Graphics\AdobeIDs\6860-41 - Figures for Report - Dec.indd

FIGURE 3 AREA ROAD NETWORK



P:\6860\41\Graphics\AdobeIDs\6860-41 - Figures for Report - Dec.indd

FIGURE 4 AREA TRANSIT NETWORK



P:\6860\41\Graphics\AdobeIDs\6860-41 - Figures for Report - Dec.indd

FIGURE 5 AREA ACTIVE TRANSPORTATION NETWORK

4.0 VEHICLE PARKING CONSIDERATIONS

The car parking requirements for the proposal are outlined in the Norfolk County Zoning By-Law 1-Z-2014. The requirements are applied to the proposal in **Table 1**.

Table 1 Car Parking Requirements – Norfolk County Zoning By-law 1-Z-2014

Use	Number	Rate	Requirement[1]
Resident	724 dwellings	2 spaces per dwelling	1,448 spaces
Visitors (condominium townhouses only)	129 dwellings	1 space per 3 dwellings	43 spaces
Retirement Home	150 units	3 spaces per bed	450 spaces
Total			**2,099 spaces**

Notes:
1. Rounded up to the nearest whole number, in accordance with Clause 3.24.1 of the Whitchurch-Stouffville Comprehensive Zoning By-law 2010-001-ZO

The proposed plans don't currently show detail with regards to the individual dwellings; however the intention is for resident parking to be accommodated within individual garages and driveways.

Detail is also not provided for the retirement home at this stage, however the by-law rate of 3 spaces per bed is notably high. It is noted that this rate was incorporated into Zoning By-law 1-Z-2014 through By-law 7-Z-2018, which was approved at a Council Meeting on January 30, 2018. Based on the Agenda for this meeting, it is noted that a rate of "1 space for every 3 beds" was recommended, however the rate of "3 spaces per bed" was ultimately incorporated into Zoning By-law 1-Z-2014. The recommended rate of "1 space for every 3 beds" would be generally consistent with car parking rates for a retirement home within a number of other nearby municipalities, including the following:

- Municipality of Lambton Shores Comprehensive Zoning By-law 1 of 2003: 1 space per 3 beds
- Municipality of Middlesex Centre Comprehensive Zoning By-law 2005-005: 1 space per 2.5 beds
- Municipality of West Perth Comprehensive Zoning By-law 100-1998: 1 space per 3 beds
- City of London Zoning By-law Z-1: 1 space per 3 beds

On the basis of the foregoing, it is considered appropriate to adopt the recommended rate of "1 space for every 3 beds" for the retirement home.

For the condominium townhouse visitor parking, a total of 44 spaces is shown within Area C, satisfying the Zoning By-law requirement.

Overall, the following minimum car parking rates are proposed:

- 2 spaces per dwelling for residents of the proposed detached and street townhouse dwellings;
- 1 space per 3 dwellings for visitors of the proposed condominium townhouses; and
- 1 space per 3 beds for the retirement home

5.0 TRAFFIC VOLUME PROJECTIONS

5.1 Scope

For the purpose of analysis, a 5-year build-out timeframe (i.e., 2028) has been assumed. In accordance with MTO TIS Guidelines, analysis has also been undertaken for opening date plus 5 years (i.e., 2033) and opening date plus 10 years (i.e., 2038).

Accordingly, analysis has been completed for the following scenarios during the AM and PM peak hour:

- Existing Conditions (2023)
- Future Background Conditions (2028)
- Future Background Conditions (2033)
- Future Background Conditions (2038)
- Future Total Conditions (2028)
- Future Total Conditions (2033)
- Future Total Conditions (2038)

Intersections included within the analysis study area are listed below:

- Wilson Avenue / Viola Court
- Wilson Avenue / St. Michael's Street
- Viola Court / St. Michael's Street
- James Street (Highway 3) / Wilson Avenue
- James Street (Highway 3) / Tisdale Drive
- James Street (Highway 3) / Alpha Street
- James Street (Highway 3) / Pine Grove Road
- St. Michael's Street / Site Driveway
- Wilson Avenue / Site Driveway

Existing lane configurations are shown in **Figure 6** and future lane configurations are shown in **Figure 7**.

5.2 Existing Traffic Volumes

Existing peak hour traffic volumes have been established based on traffic counts undertaken by Spectrum Traffic Data on behalf of BA Group. The intersections which were counted are summarized in **Table 2**. The existing baseline area traffic volumes for the AM and PM peak hours are provided in **Figure 8**, and the raw data is attached in **Appendix C**.

Table 2 Existing Traffic Data Sources

Intersection	Count Date	Count Times	Source
James St / Alpha St	Wednesday, May 25, 2022	7:00am-7:00pm	Spectrum Traffic Data
Wilson Ave / Viola Ct		7:00am-9:00am 4:00pm-6:00pm	
Wilson Ave / St. Michael's St			
Viola Ct / St. Michael's St			
James St (Hwy 3) / Wilson Ave			
James St / Tisdale Dr			
James St / Delhi Golf & Country Club Access			
James St / Pine Grove Rd			

5.3 Future Background Traffic Volumes

5.3.1 Background Development Growth

Background development traffic allowances included within the analysis were based on information available within the Norfolk County pending development applications map, as summarized in **Table 3**. In the absence of an available transportation study, trip generation and distribution assumptions consistent with those adopted for the site were manually applied to the proposed redevelopment.

Background development traffic volumes are shown in **Figure 9**.

Table 3 Area Background Development

Site	Development Statistics	Study
Banstead Street ZBA (pending application)	30 residential units	Manually Derived

5.3.2 Corridor Growth

A growth analysis has been undertaken of James Street (Highway 3) based on data at Pine Grove Road provided by the MTO or sourced by BA Group, dating back to 2009. The growth analysis indicates generally consistent volumes on James Street (Highway 3), with growth rates generally calculated in the range of 0-1.5% depending on the direction and peak hour. The growth analysis is attached in **Appendix D**.

Notwithstanding the above, for the purpose of this assessment, a growth rate of 2% per annum has conservatively been adopted along James Street (Highway 3).

Corridor growth traffic volumes for the 2028, 2033 and 2038 horizons are shown in **Figure 10**, **Figure 11** and **Figure 12** respectively.

5.3.3 Future Background Traffic Volumes

The future background traffic volumes are determined by adding existing traffic volumes, background development traffic volumes and corridor growth traffic volumes.

Future background traffic volumes for the 2028, 2033 and 2038 horizons are shown in **Figure 13**, **Figure 14** and **Figure 15** respectively.

5.4 Site Traffic Forecasts

5.4.1 Existing Site Traffic Volumes

Existing traffic volumes associated with the site are shown on **Figure 16**, and are assumed to be removed from the network with the redevelopment of the site.

5.4.2 Vehicle Trip Generation Rates

Vehicle trip generation rates were adopted based on the ITE Trip Generation Manual 11th Edition, as outlined in **Table 4**.

Table 4 Adopted Vehicle Trip Generation Rates

Land Use	Trip Rate Source	Vehicle Trip Generation Rate					
		AM Peak Hour			PM Peak Hour		
		In	Out	2-Way	In	Out	2-Way
Detached Dwelling	ITE 11th Edition LUC 210 (Single-Family Detached Housing) General Urban/Suburban *(vehicle trips per unit)*	0.18	0.52	0.70	0.59	0.35	0.94
Townhouse	ITE 11th Edition LUC 220 (Single-Family Attached Housing) General Urban/Suburban *(vehicle trips per unit)*	0.15	0.33	0.48	0.32	0.25	0.57
Retirement Home	ITE 11th Edition LUC 252 (Senior Adult Housing – Multifamily) General Urban/Suburban *(vehicle trips per unit)*	0.07	0.13	0.20	0.14	0.11	0.25

5.4.3 Site Vehicle Trip Generation

Based on the above adopted rates, the traffic volumes projected to be generated by the redevelopment are summarized in **Table 5**.

Overall, it is projected that the proposed redevelopment will generate in the order of 405 and 490 two-way vehicle trips during the AM and PM peak hours respectively.

Table 5 Site Vehicle Trip Generation

Site Section	Number & Type of Unit	AM Peak Hour			PM Peak Hour		
		In	Out	2-Way	In	Out	2-Way
Area A	105 detached dwellings	*0.18*	*0.52*	*0.70*	*0.59*	*0.35*	*0.94*
		20	**55**	**75**	**60**	**35**	**95**
	475 street townhouses	*0.15*	*0.33*	*0.48*	*0.32*	*0.25*	*0.57*
		70	**155**	**225**	**150**	**120**	**270**
	150 retirement units	*0.07*	*0.13*	*0.20*	*0.14*	*0.11*	*0.25*
		10	**20**	**30**	**20**	**20**	**40**
	Subtotal	**100**	**230**	**330**	**230**	**175**	**405**
Area B	15 detached dwellings	*0.18*	*0.52*	*0.70*	*0.59*	*0.35*	*0.94*
		5	**5**	**10**	**10**	**5**	**15**
	Subtotal	**5**	**5**	**10**	**10**	**5**	**15**
Area C	129 townhouses	*0.15*	*0.33*	*0.48*	*0.32*	*0.25*	*0.57*
		20	**45**	**65**	**40**	**30**	**70**
	Subtotal	**20**	**45**	**65**	**40**	**30**	**70**
Total		**125**	**280**	**405**	**280**	**210**	**490**

5.4.4 Vehicle Trip Distribution

Site traffic was assigned onto the area road network based on prevailing traffic patterns identified through the existing traffic counts. The adopted distribution is summarized in **Table 6**.

Table 6 Site Traffic Distribution

Direction	Inbound/Outbound
East on Wilson Avenue	25%
North on James Street	35%
South on James Street	25%
South on Pine Grove Road	15%
Total	**100%**

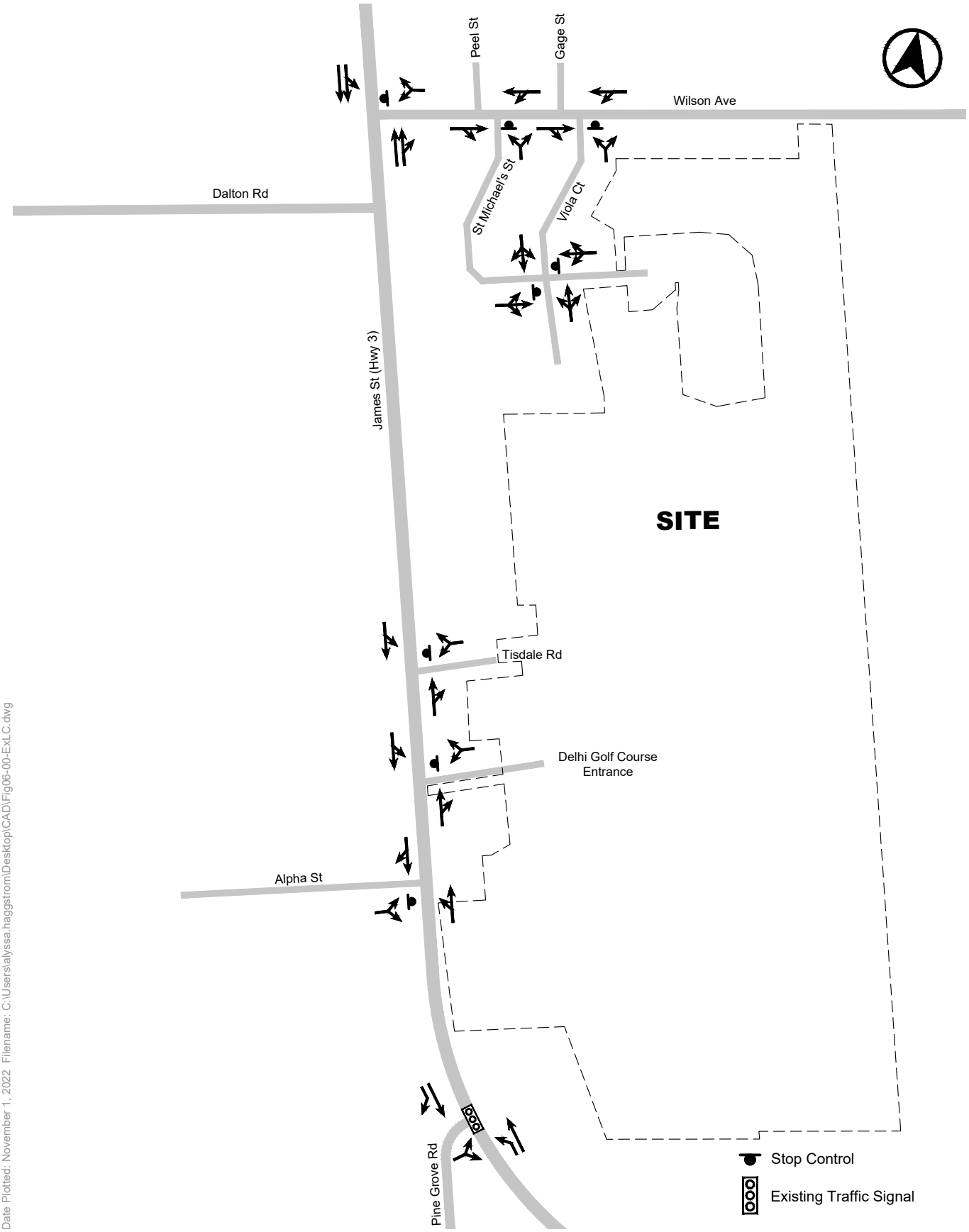
5.4.5 Site Traffic Volumes

The site traffic volumes are shown in **Figure 17**.

5.4.6 Future Total Traffic Volumes

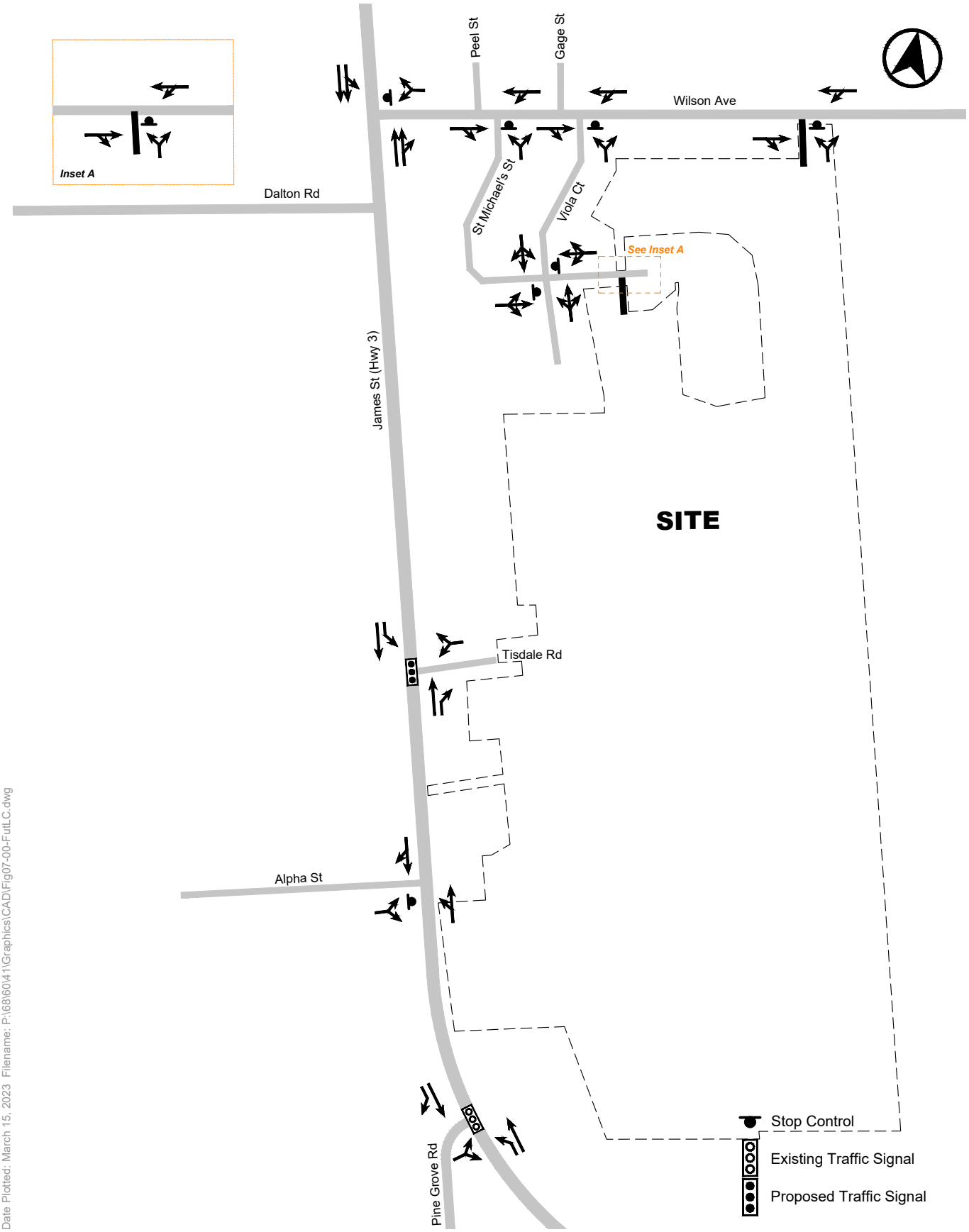
Future total traffic volumes are determined by adding the future background traffic volumes and the site traffic volumes.

The future total traffic volumes are shown in **Figure 18**, **Figure 19** and **Figure 20** for the 2028, 2033 and 2038 horizons respectively.



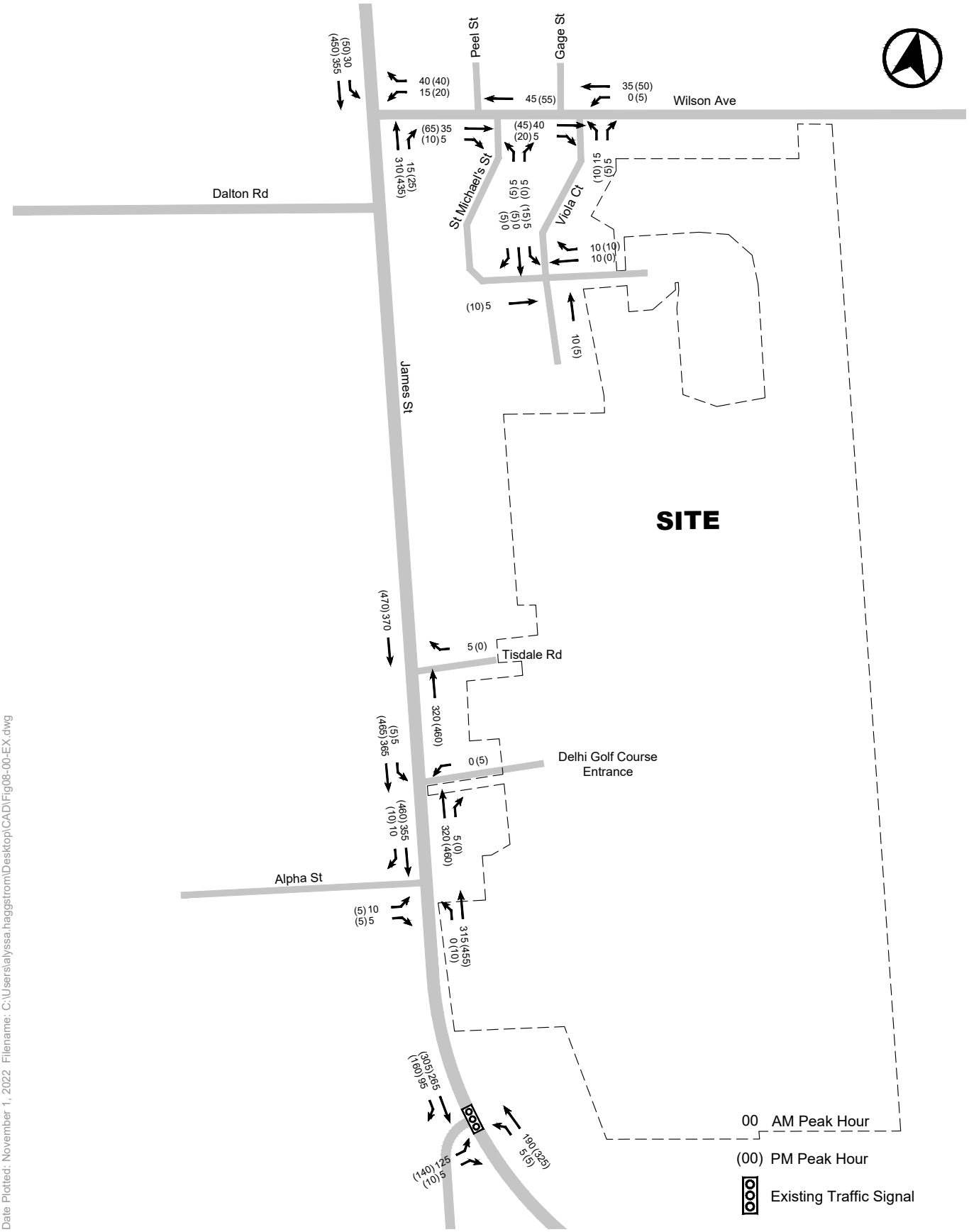
Date Plotted: November 1, 2022 Filename: C:\Users\alyssa.haggstrom\Desktop\CAD\Fig06-00-ExLC.dwg

FIGURE 6 EXISTING LANE CONFIGURATIONS (2023)



Date Plotted: March 15, 2023 Filename: P:\68\6041\Graphics\CAD\Fig07-00-FutLC.dwg

FIGURE 7 FUTURE LANE CONFIGURATIONS



Date Plotted: November 1, 2022 Filename: C:\Users\alyssa.haggstrom\Desktop\CAD\Fig08-00-EX.dwg

FIGURE 8 EXISTING TRAFFIC VOLUMES (2023)

Date Plotted: November 1, 2022 Filename: C:\Users\alyssa.haggstrom\Desktop\CAD\Fig09-00-BG.dwg

FIGURE 9 BACKGROUND TRAFFIC VOLUMES

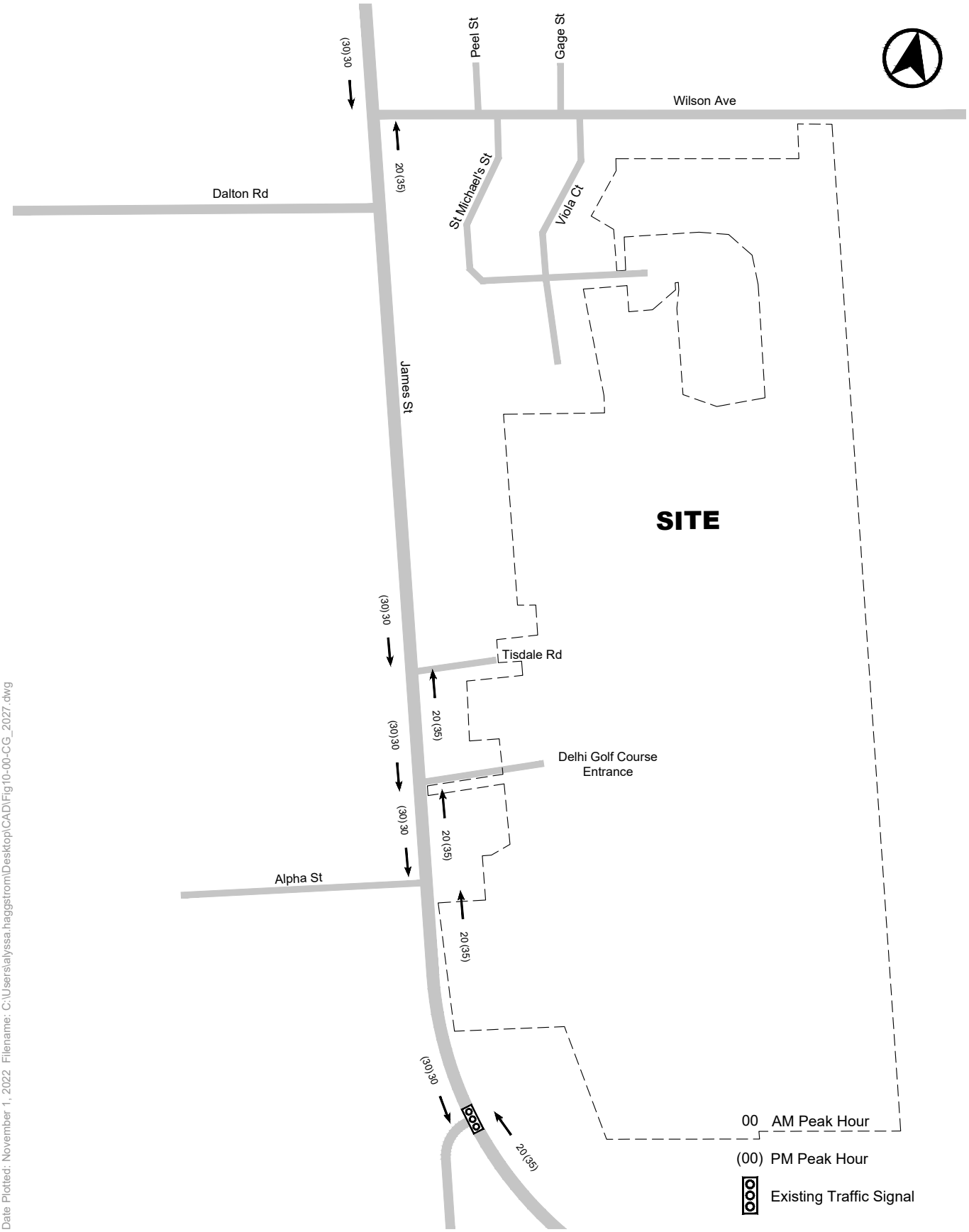


FIGURE 10 CORRIDOR GROWTH TRAFFIC VOLUMES (2028)

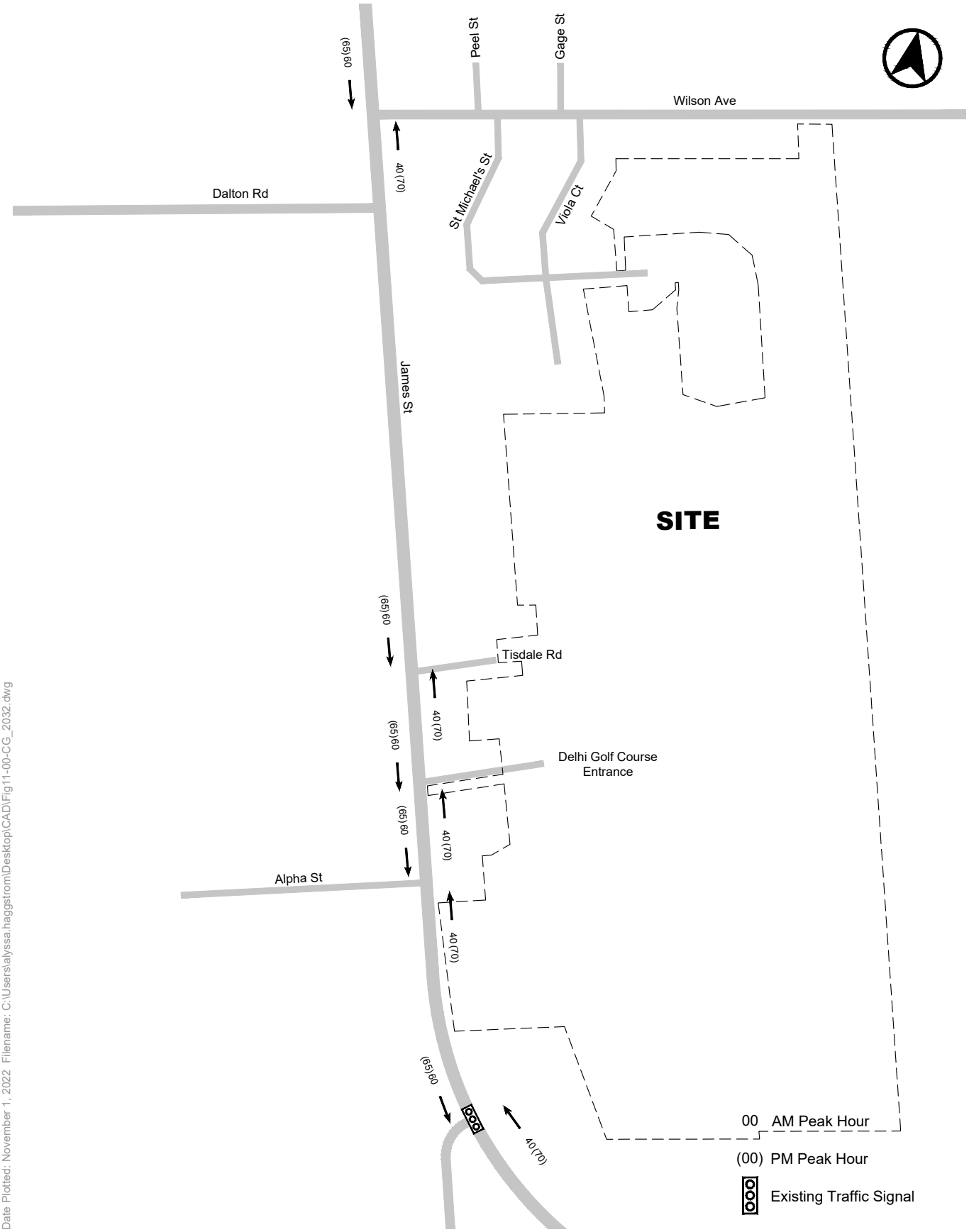


FIGURE 11 CORRIDOR GROWTH TRAFFIC VOLUMES (2033)

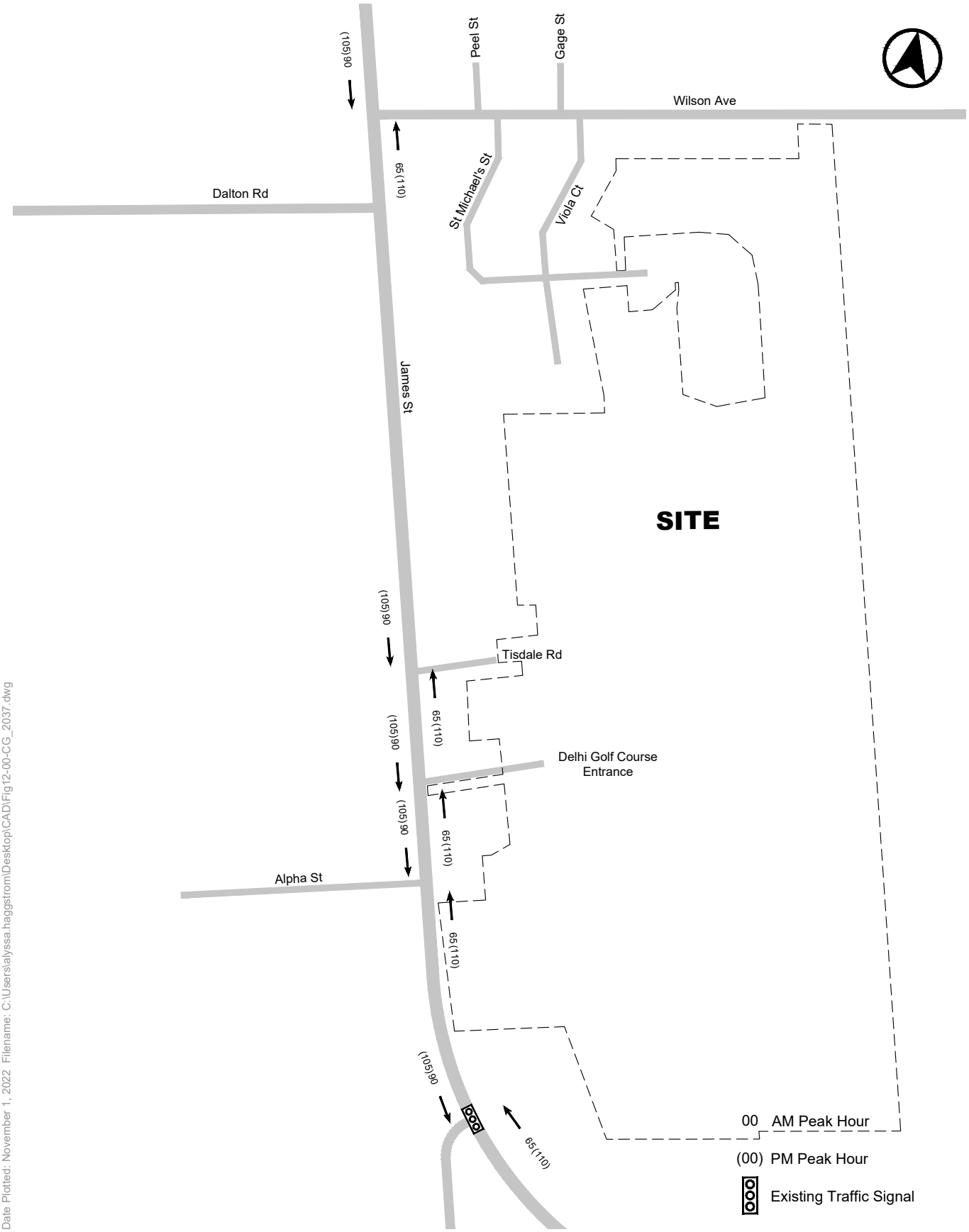
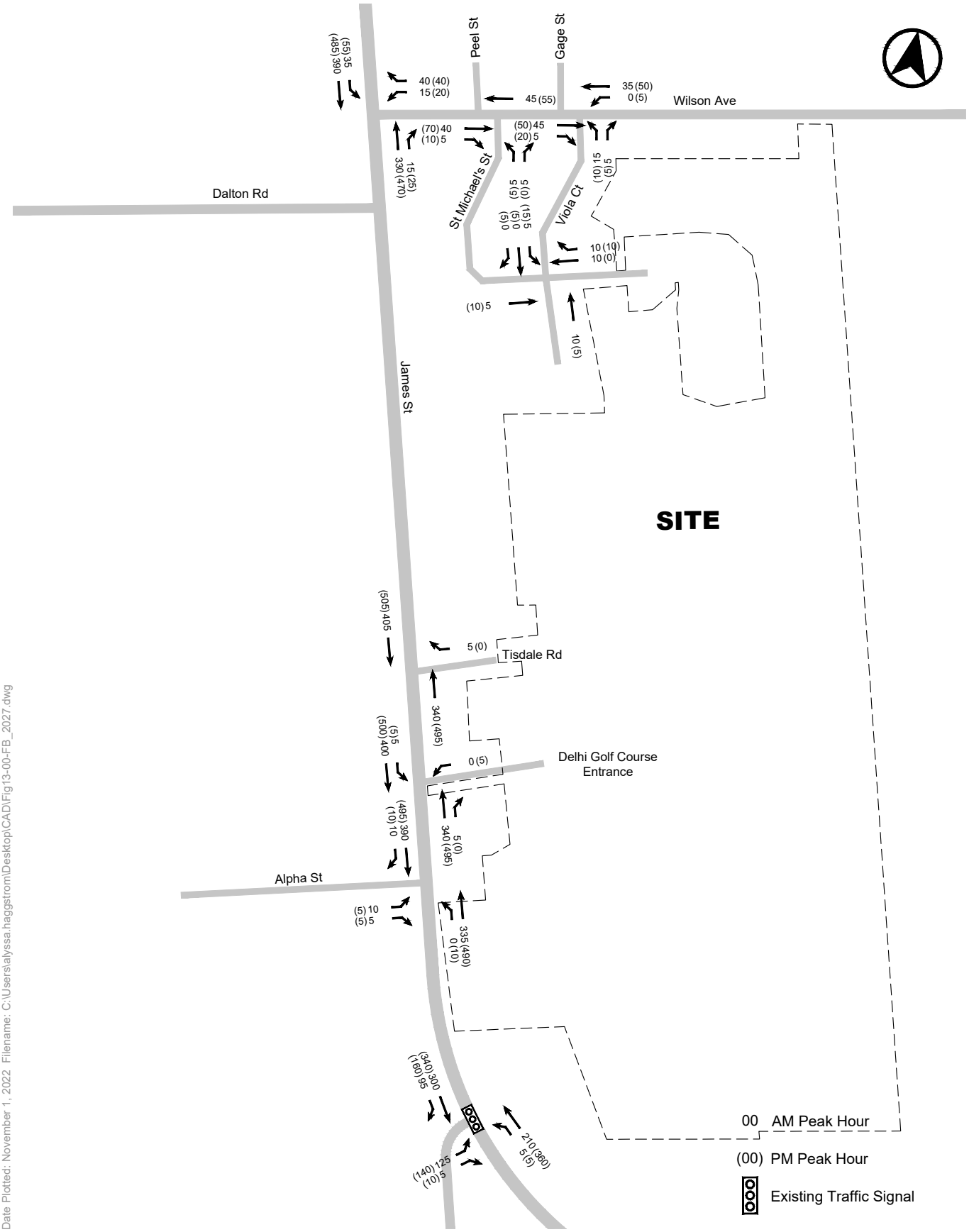


FIGURE 12 CORRIDOR GROWTH TRAFFIC VOLUMES (2038)



Date Plotted: November 1, 2022 Filename: C:\Users\alyssa.haggstrom\Desktop\CAD\Fig13-00-FB_2027.dwg

FIGURE 13 FUTURE BACKGROUND TRAFFIC VOLUMES (2028)

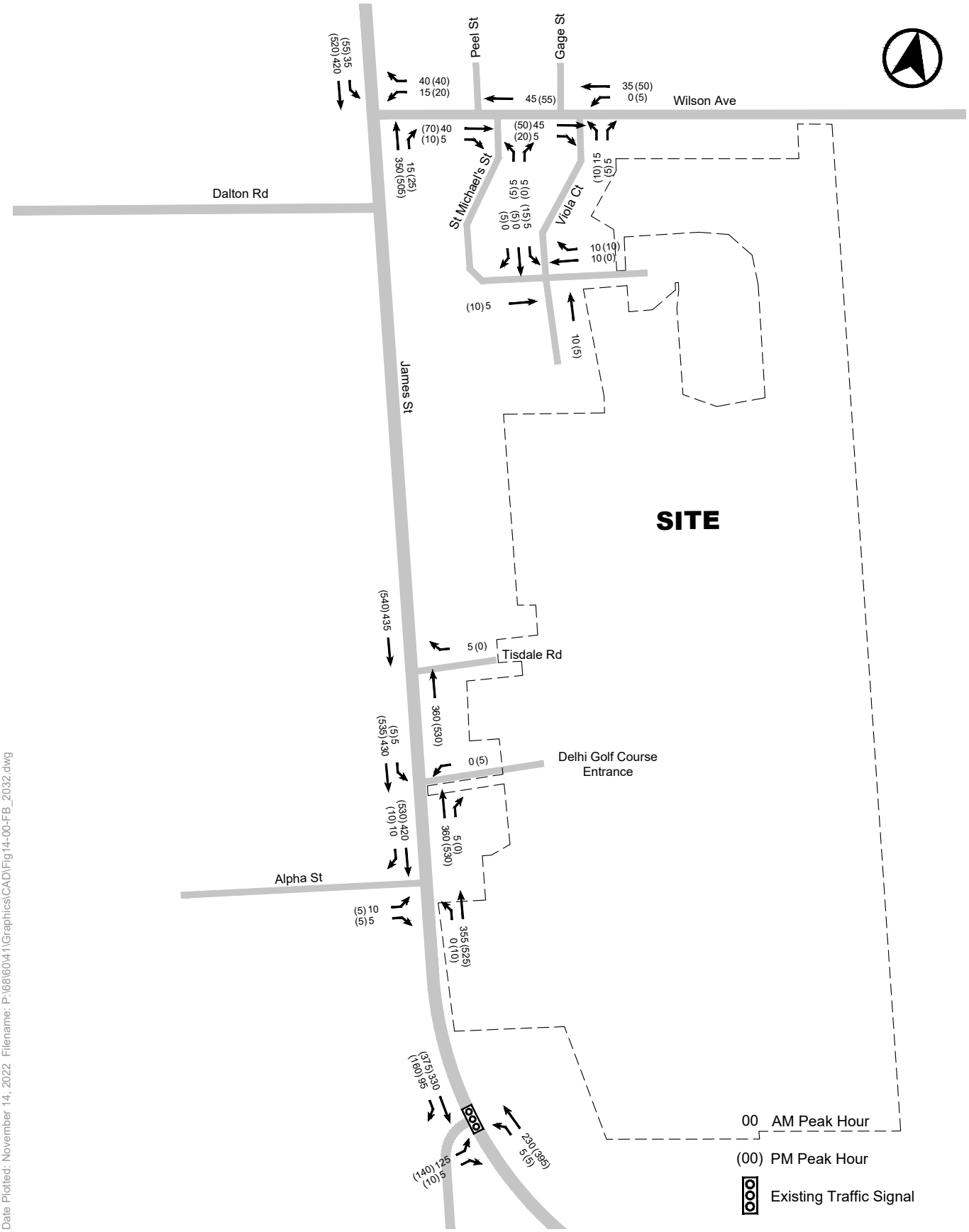


FIGURE 14 FUTURE BACKGROUND TRAFFIC VOLUMES (2033)

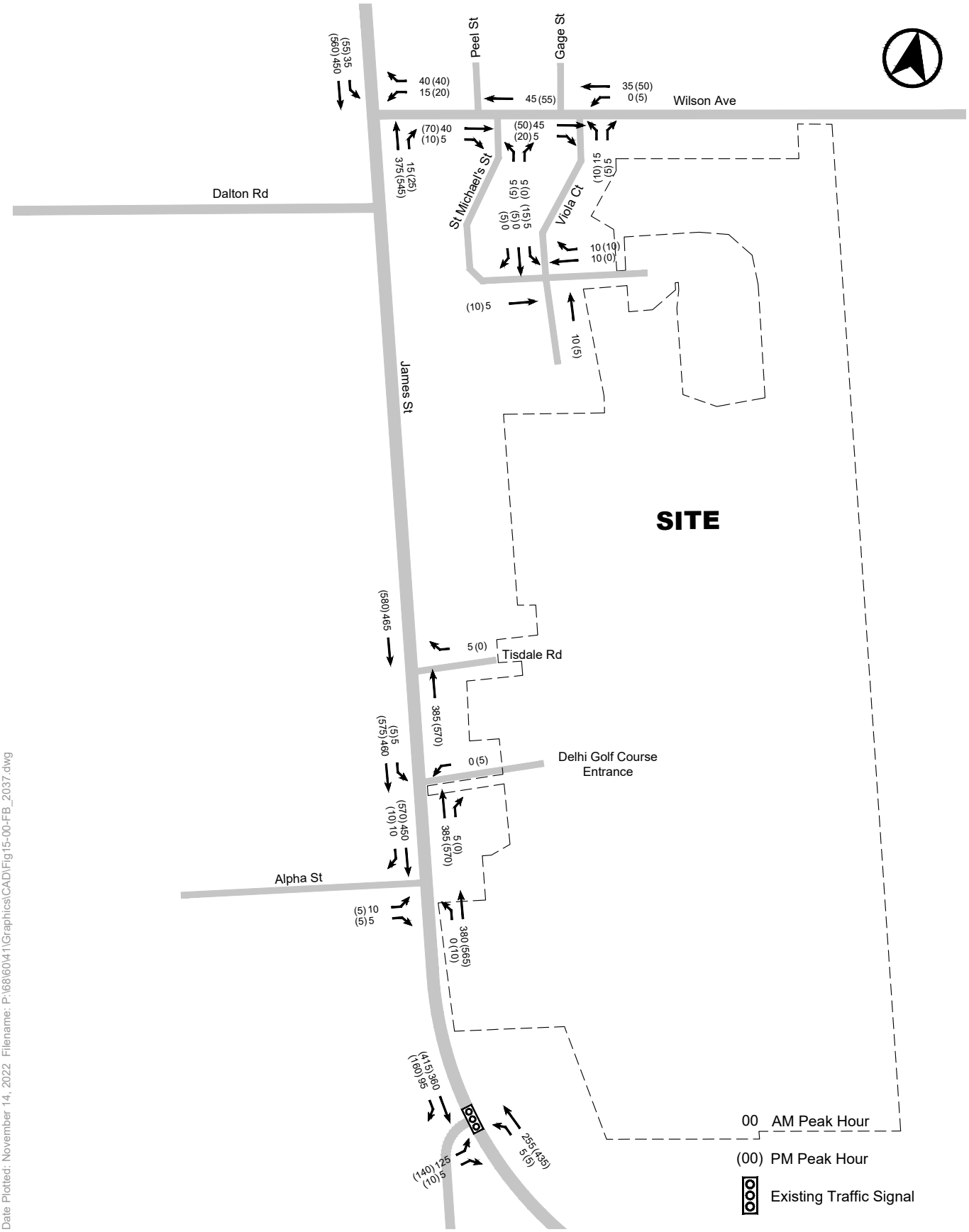
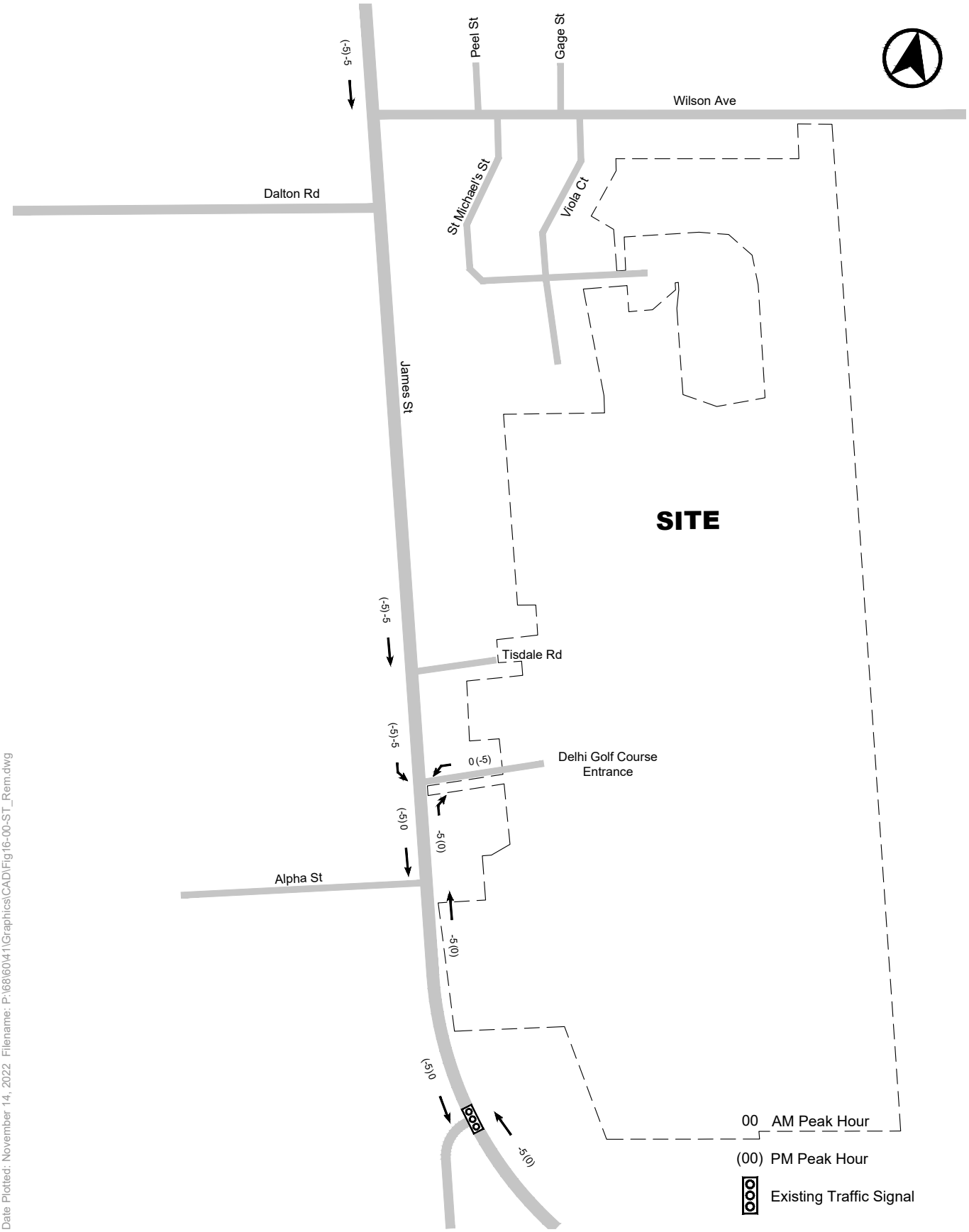
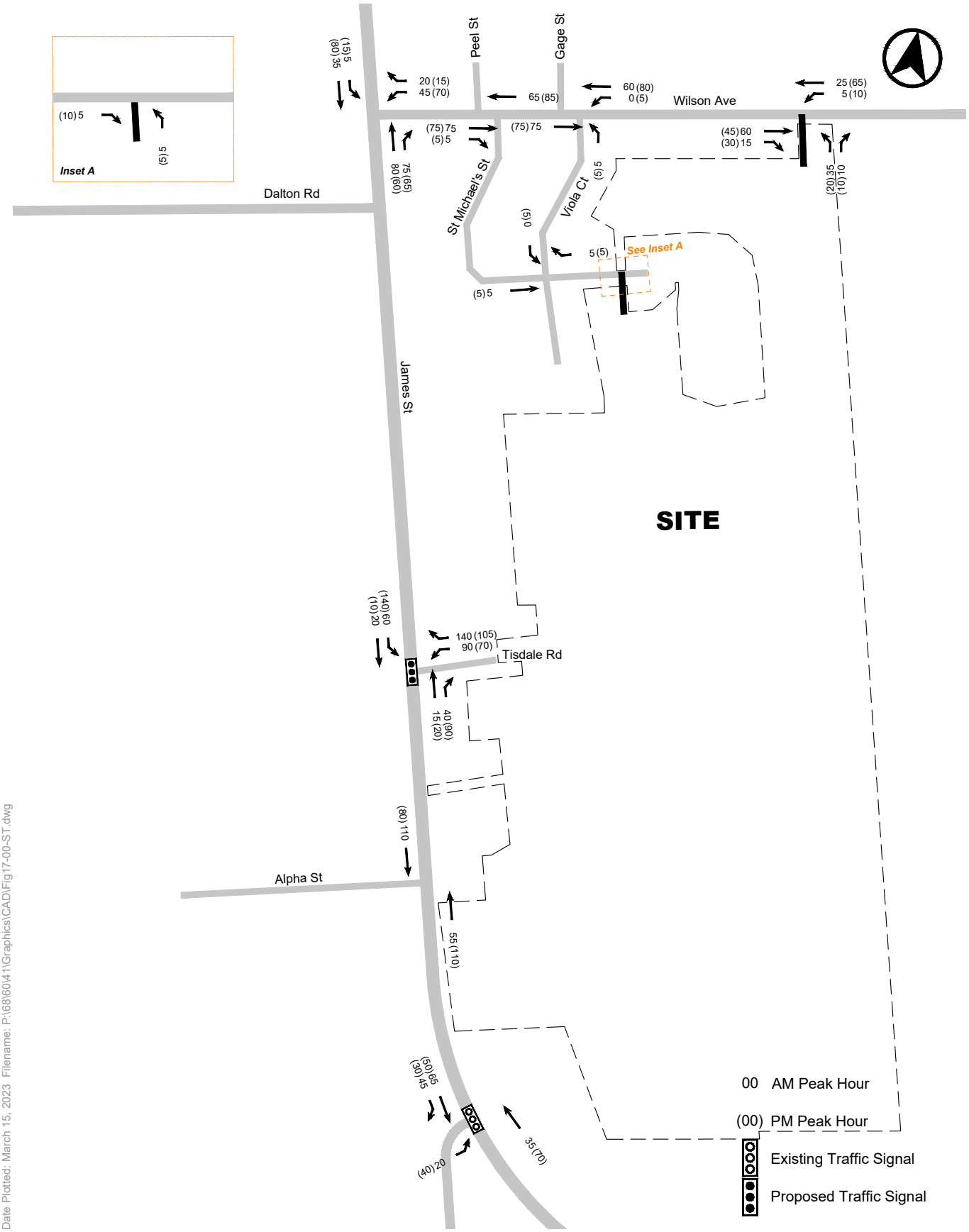


FIGURE 15 FUTURE BACKGROUND TRAFFIC VOLUMES (2038)



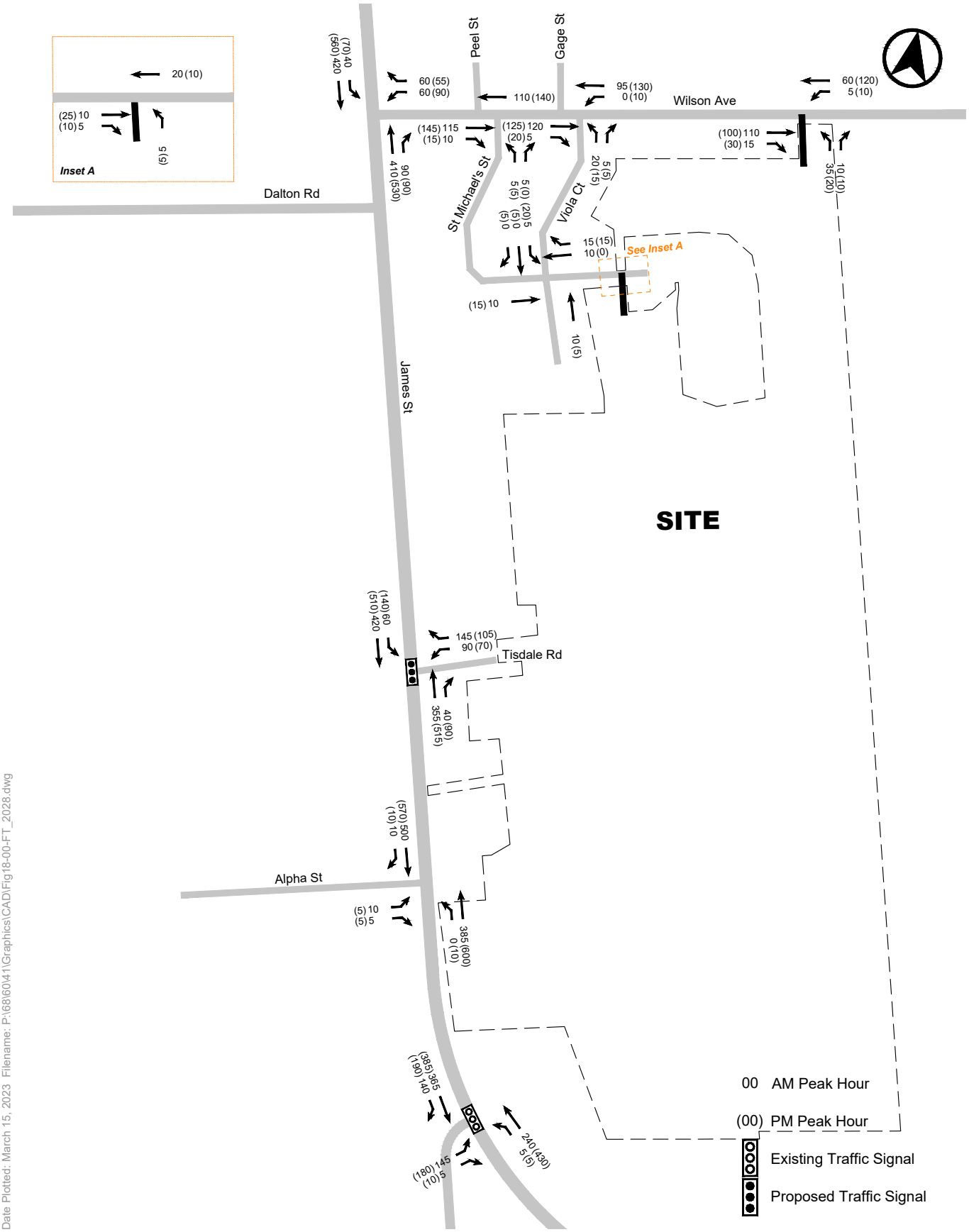
Date Plotted: November 14, 2022 Filename: P:\68\6041\Graphics\CAD\Fig16-00-ST_Rem.dwg

FIGURE 16 EXISTING SITE TRAFFIC VOLUMES REMOVAL



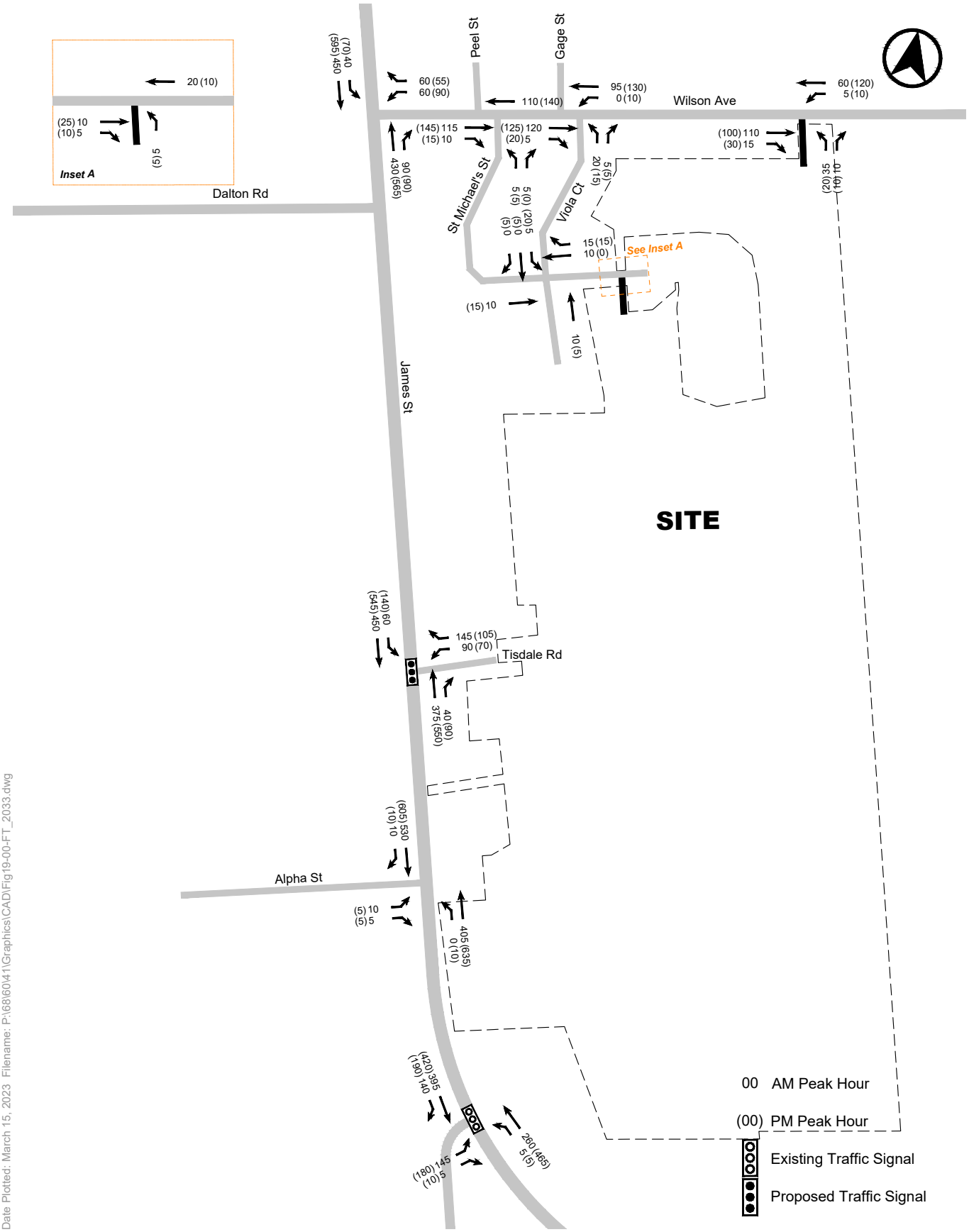
Date Plotted: March 15, 2023 Filename: P:\68\6041\Graphics\CAD\Fig17-00-ST.dwg

FIGURE 17 SITE TRAFFIC VOLUMES



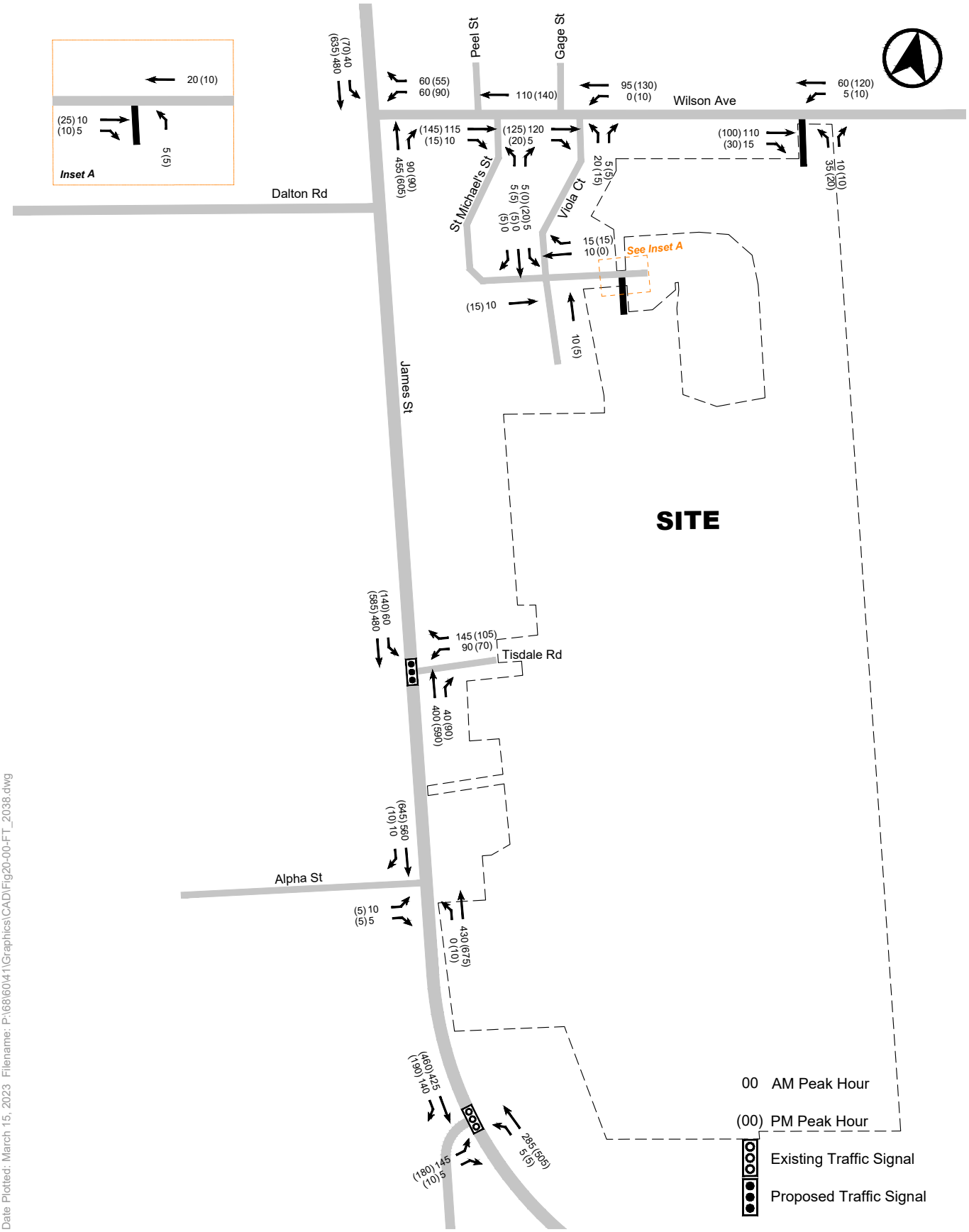
Date Plotted: March 15, 2023 Filename: P:\68\6041\Graphics\CAD\Fig18-00-FT_2028.dwg

FIGURE 18 FUTURE TOTAL TRAFFIC VOLUMES (2028)



Date Plotted: March 15, 2023 Filename: P:\68\6041\Graphics\CAD\Fig19-00-FT_2033.dwg

FIGURE 19 FUTURE TOTAL TRAFFIC VOLUMES (2033)



Date Plotted: March 15, 2023 Filename: P:\68\6041\Graphics\CAD\Fig20-00-FT_2038.dwg

FIGURE 20 FUTURE TOTAL TRAFFIC VOLUMES (2038)

6.0 OPERATION ANALYSIS

6.1 Analysis Methodology

Synchro Version 11 and the Highway Capacity Manual (HCM) methodology were used to analyze the study area intersections and site access points.

For signalized intersections, the volume-to-capacity ratio (v/c) is an indicator of the capacity utilization for the key movements in the intersection. A v/c of 1.00 indicates that a traffic movement through an intersection is operating at or near maximum capacity.

Further to the above, it is noted that MTO TIS Guidelines specify that at signalized intersections, a v/c ratio of greater than 0.85 is deemed to be "critical" in terms of operations and that movements which experience a v/c ratio of 0.85 or greater would be consideration for geometric improvement.

For unsignalized intersections, level of service (LOS) characterizes operational conditions for key movements in terms of average delay experienced by vehicles attempting to complete a manoeuvre through the intersection. LOS 'A' represents a good level of service with short delays, while LOS 'F' represents a poor level of service with extended delays.

Synchro summary tables and detailed analysis worksheets are attached in **Appendix E**.

6.2 Analysis Assumptions and Parameters

A base saturation flow of 1,900 vehicles per hour per lane was assumed and a lost time adjustment of 0 seconds was utilized. Peak hour factors and heavy vehicle percentages were calculated based on existing traffic volume data extracted from the traffic counts utilized in this study.

Existing traffic signal timing plans for the signalized intersections within the study area were obtained from the MTO and are attached in **Appendix F**. Analyses were undertaken using these signal timing plans.

6.3 Intersection Operations Analysis

6.3.1 James Street (Highway 3) / Pine Grove Road

The intersection of James Street (Highway 3) / Pine Grove Road is signalized. Under existing conditions, the intersection operates at overall v/c ratios of 0.28 and 0.33 during the AM and PM peak hours, respectively.

Under future background conditions, the intersection is projected to operate at the following overall v/c ratios:

- **2028 Horizon:** 0.30 and 0.36 in the AM and PM peak hours, respectively.
- **2033 Horizon:** 0.32 and 0.38 in the AM and PM peak hours, respectively.
- **2038 Horizon:** 0.34 and 0.41 in the AM and PM peak hours, respectively.

Under future total conditions, the intersection is projected to operate at the following overall v/c ratios:

- **2028 Horizon:** 0.36 and 0.44 in the AM and PM peak hours, respectively.
- **2033 Horizon:** 0.38 and 0.46 in the AM and PM peak hours, respectively.
- **2038 Horizon:** 0.40 and 0.49 in the AM and PM peak hours, respectively.

Overall, it is projected that site traffic can be accommodated at this intersection. Detailed Synchro summary tables are provided in **Appendix E**.

6.3.2 James Street (Highway 3) / Alpha Street

The intersection of James Street (Highway 3) / Alpha Street is unsignalized and is projected to operate at LOS D or better in all analysis scenarios.

Overall, it is projected that site traffic can be accommodated at this intersection with minimal impacts. Detailed Synchro summary tables are provided in **Appendix E**.

6.3.3 James Street (Highway 3) / Tisdale Drive

The intersection of James Street (Highway 3) / Tisdale Drive is unsignalized. All movements at the intersection operate with an LOS B or better under existing conditions and this is projected to continue under future background conditions.

It is noted that under future total conditions, modifications are proposed at this intersection, including construction of a southbound left turn lane and a northbound right turn lane on James Street (Highway 3) to facilitate left and right turns into Area A.

As an unsignalized intersection with the proposed modifications in place, the westbound movements are anticipated to operate at LOS F during the PM peak hour under all future total scenarios, with the following projected average delay and v/c ratios:

- **2028 Horizon:** Average delay of 65.5 seconds and v/c ratio of 0.82
- **2033 Horizon:** Average delay of 86.1 seconds and v/c ratio of 0.90
- **2038 Horizon:** Average delay of 119.3 seconds and v/c ratio of 1.01

On the basis of the above, it is proposed to construct a signal at this intersection. A signal warrant was undertaken which indicates that a signal is warranted at this location based on the projected volumes, as discussed further in **Section 8.2.1**.

Under a signalized configuration, the intersection is projected to operate at the following overall v/c ratios:

- **2028 Horizon:** 0.41 and 0.43 in the AM and PM peak hours, respectively.
- **2033 Horizon:** 0.43 and 0.46 in the AM and PM peak hours, respectively.
- **2038 Horizon:** 0.46 and 0.49 in the AM and PM peak hours, respectively.

Overall, it is projected that site traffic can be accommodated at this intersection under the proposed signalized configuration. Detailed Synchro summary tables are provided in **Appendix E**.

6.3.4 James Street (Highway 3) / Wilson Avenue

The intersection of James Street (Highway 3) / Wilson Avenue is unsignalized and is generally projected to operate at LOS E or better in all analysis scenarios. The exception to this is in the future total 2038 horizon, an LOS F is projected for the westbound movements in the PM peak hour (52.3 seconds). As noted, this is only projected to occur in the long-term 2038 horizon, with the increased delay between time horizons a result of assumed corridor growth which has conservatively been set to 2% per annum, notwithstanding that the growth analysis indicates historical growth below this value. It is also noted that under this horizon, these movements are projected to remain well within capacity, with a v/c ratio of 0.71.

Signal warrants were undertaken for this intersection, and the results are dependent on whether the intersection is defined as “restricted flow” (not warranted) or “free flow” (warranted) conditions, for which the site area exhibits characteristics of both. This is discussed further in **Section 8.3.1**.

Overall, given the LOS F is projected to occur in the long-term 2038 horizon, the intersection is projected to continue to operate within capacity, and the mixed context of “restricted flow” and “free flow” conditions as defined by OTM for the justification of traffic signals, it is recommended that operations of this intersection be monitored and may be a candidate for signalization in the future.

Detailed Synchro summary tables are provided in **Appendix E**.

6.3.5 St. Michael's Street / Wilson Avenue

The intersection of St. Michael's Street / Wilson Avenue is unsignalized and is projected to operate at LOS B or better in all analysis scenarios.

Overall, it is projected that site traffic can be accommodated at this intersection with minimal impacts. Detailed Synchro summary tables are provided in **Appendix E**.

6.3.6 Viola Court / Wilson Avenue

The intersection of Viola Court / Wilson Avenue is unsignalized and is projected to operate at LOS B or better in all analysis scenarios.

Overall, it is projected that site traffic can be accommodated at this intersection with minimal impacts. Detailed Synchro summary tables are provided in **Appendix E**.

6.3.7 Viola Court / St. Michael's Street

The intersection of Viola Court / St. Michael's Street is unsignalized and is projected to operate at LOS A or better in all analysis scenarios.

Overall, it is projected that site traffic can be accommodated at this intersection with minimal impacts. Detailed Synchro summary tables are provided in **Appendix E**.

6.4 Driveway Results Operations Analysis

6.4.1 St. Michael's Street / Site Driveway

The future St. Michael's Street / Site Driveway intersection is proposed to be unsignalized. Under future total conditions the intersection is projected to operate at LOS A or better in all analysis scenarios.

Overall, it is projected that site traffic can be accommodated at this intersection. Detailed Synchro summary tables are provided in **Appendix E**.

6.4.2 Wilson Avenue / Site Driveway

The future Wilson Avenue / Site Driveway intersection is proposed to be unsignalized. Under future total conditions the intersection is projected to operate at LOS A or better in all analysis scenarios.

Overall, it is projected that site traffic can be accommodated at this intersection. Detailed Synchro summary tables are provided in **Appendix E**.

7.0 TRANSPORTATION DEMAND MANAGEMENT

7.1 Mobility Choice Travel Plan

The location of the site and its surrounding uses greatly influence the success of a Mobility Choice Travel Plan. The purpose of the Mobility Choice Travel Plan is to guide the provision of viable alternative personal transportation options beyond the single-occupant, private automobile. This plan intends to support the proposed redevelopment by outlining Transportation Demand Management (TDM) measures and the suite of strategies under consideration to promote the use of more active and sustainable transportation modes; respond to the mobility needs of residents and visitors of the site; and to reduce the overall dependence on the private automobile.

Four specific objectives define the policy framework for the Mobility Choice Travel Plan:

- Encourage the use of alternate travel modes (transit, cycling, walking);
- Increase vehicle occupancy;
- Shift travel to off-peak periods; and
- Reduce vehicle kilometres travelled.

7.2 Organizational Framework

The four broader objectives can be organized within the following categories:

- Encourage Transit Use;
- Encourage and Facilitate Bicycle Use;
- Enhance Pedestrian Access and Walkability;
- Facilitation of Reduced Car Ownership and Usage;
- Vehicular Parking Supply and Management;
- Land Use and Building Infrastructure; and
- Coordination, Communication, and Promotion.

Potential Mobility Choice Travel Plan Strategies for the proposed redevelopment are summarized in **Table 7**.

Table 7 Potential Mobility Choice Travel Plan Strategies

TRANSIT USE		**Intent:** **Encourage Transit Use** Support for and the promotion of the use of area transit services for both short and long-distance travel by residents, visitors, and employees will reduce the overall use of a vehicle and the need to own one.	**Existing and Future Context:** • Norfolk County operate transit services under their "Out of Town" schedule, which start and end at Simcoe Library and travel through other nearby communities, including Delhi. The services also operate via Brantford which provide access to local Brantford Transit services, along with further regional connections via GO Transit and VIA Rail. **Mobility Strategies:** • At first occupancy, provide new residents with a transit information package detailing available transit services in the area
BICYCLE FACILITIES		**Intent:** **Encourage Bicycle Use** Provide cycling infrastructure that supports and promotes cycling as a convenient and viable travel alternative to the personal automobile.	**Existing and Future Context:** • Wilson Avenue and James Street (Highway 3) between Wilson Avenue and William Street are identified in the Norfolk OP as an on-road cycling route and include "Share the Road" signage on Wilson Avenue. • Under future conditions, James Street (Highway 3) is to be considered for a "Complete Street" redesign, including consideration for cyclists. A signed bicycle route with sharrows is also proposed on Wilson Avenue between James Street (Highway 3) and Viola Court. **Mobility Strategies:** • At first occupancy, provide new residents with a cycling information package detailing available routes in the area

PEDESTRIAN CONNECTIVITY		**Intent:** **Encourage Pedestrian Use** A high-quality, safe, connection between the site and transit stations / stops, cycling network, and public street system encourages residents, employees and visitors to travel around the site area without a vehicle.	**Existing and Future Context:** • Intermittent sidewalks are provided along the east side of James Street (Highway 3). • Under future conditions, James Street (Highway 3) is to be considered for a "Complete Street" redesign, including consideration for cyclists. Construction of a sidewalk on Wilson Avenue between James Street (Highway 3) and Viola Court is also proposed. **Mobility Strategies:** • Provision of sidewalks along one side of proposed roads within the site, in accordance with Norfolk County requirements

8.0 DESIGN CONSIDERATIONS

8.1 Emergency Vehicle Access

A second access to James Street (Highway 3) for Area A is proposed for emergency vehicles only in order to ensure appropriate and safe access opportunities are provided into this area in the event the primary vehicle access is blocked.

The emergency vehicle access location is currently proposed via the existing golf club entrance.

8.2 James Street (Highway 3) / Tisdale Drive Intersection

8.2.1 Signal Warrant

A signal warrant analysis has been prepared for the James Street (Highway 3) / Tisdale Drive intersection and is attached in **Appendix G**. The analysis indicates that signals are warranted at this intersection under future total conditions based on Justification 3 (Volume/Delay Combination) and Justification 4 (Minimum Four-Hour Vehicle Volume).

8.2.2 Turn Lane Warrants

8.2.2.1 LEFT TURN LANE

Section E.9 of the Geometric Design Standards for Ontario Highways provides warrants for the provision of left turn lanes at unsignalized intersections. The warrant analysis for the proposed James Street (Highway 3) / Tisdale Drive intersection is attached in **Appendix G** and assumes a design speed of 80 kilometres per hour.

Overall, the projected volumes warrant the provision of a left turn lane with a total length of 245 metres, including 65 metres for storage (as per Appendix A of the Geometric Design Standards for Ontario Highways) plus a 50 metre parallel lane and 130 metre taper (as per Table E9-1 of the Geometric Design Standards for Ontario Highways). This is also considered appropriate for a signalized intersection.

8.2.2.2 RIGHT TURN LANE

Section E.7.1 of the Geometric Design Standards for Ontario Highways states that for right turn lanes, a 60 metre taper may be provided, with some deceleration of turning vehicles able to start on the through lane.

Section E.7.2 of the Geometric Design Standards for Ontario Highways notes that when the volume of right turning vehicles is such that it creates a hazard and reduces capacity at an intersection or when volume approaches channelization criteria (i.e. 60 or more right turning vehicles per hour), consideration should be given to the provision of a deceleration lane in the form of a taper and parallel lane for the right turning traffic. The proposed redevelopment is projected to generate up to 80 vehicles in the peak hour. As such, a right turn lane with a total length of 130 metres is proposed, including a 60 metre parallel lane and 70 metre taper (as per Table E7-1 of the Geometric Design Standards for Ontario Highways). This is also considered appropriate for a signalized intersection.

8.2.3 Concept Functional Plan

The James Street (Highway 3) / Tisdale Drive intersection is proposed to be signalized to accommodate the proposed redevelopment. As part of the signalization it is proposed to construct a southbound left turn lane and a northbound right turn lane on James Street (Highway 3) to facilitate left and right turns into Area A, and to widen the existing Tisdale Drive pavement to 9.5 metres in accordance with Section 6.2.2 of the Norfolk County Design Criteria, dated August 2017 (herein referred to as the “NCDC”) for a minor collector road. A preliminary concept functional plan which shows the proposed modifications is attached in **Appendix B**.

8.3 James Street (Highway 3) / Wilson Avenue Intersection

8.3.1 Signal Warrant

Section 4.2 of the Ontario Traffic Manual (OTM) Book 12 defines two types of flow conditions for the justification of traffic signals, classed as “restricted flow” and “free flow” conditions. OTM notes that “restricted flow” conditions apply to roads with operating or posted speeds of less than 70 kilometres per hour and are normally encountered in urban areas where side friction on the roadway (due to parking, numerous entrances, etc) reduces the operating speed.

At Wilson Avenue, James Street (Highway 3) operates with a speed limit of 60 kilometres per hour south of the intersection and 50 kilometres per hour north of the intersection. Furthermore, James Street (Highway 3) has an increasingly urban context at Wilson Avenue, with a number of residential and commercial driveways in the vicinity. In this respect, application of “restricted flow” conditions is considered appropriate.

Notwithstanding the above, OTM also notes that “free flow” conditions are also used for isolated communities with a population of less than 10,000, which is relevant for the community of Delhi.

As such, signal warrant analyses have been prepared for the James Street (Highway 3) / Wilson Avenue intersection under both “restricted flow” and “free flow” conditions and are attached in **Appendix G**. The analysis indicates that under “restricted flow” conditions, signals are not warranted and under “free flow” conditions, signals are warranted under future conditions based on Justification 2 (Delay to Cross Traffic).

Given the mixed context of “restricted flow” and “free flow” conditions as defined by OTM and the operations results as discussed in **Section 6.3.4**, it is recommended that operations of this intersection be monitored and may be a candidate for signalization in the future.

8.4 Concept Road Plan

A concept road plan has been prepared and is attached in **Appendix B**. Road right of way and pavement widths, curb radii’s, intersection angles and cul-de-sacs are designed in accordance with Norfolk County Design Criteria.

8.5 On-Street Parking

The current concept plan does not currently show driveway locations. However, high level estimates have been made assuming parking is permitted on one side of streets within the site and based on driveway width and spacing assumptions. Accordingly, an on-street parking plan is attached in **Appendix H**, which estimates in the order of 269 on-street car parking spaces for the proposed 580 detached dwellings and street townhouses in Area A (0.46 spaces per dwelling) and in the order of 9 on-street car parking spaces for the proposed 15 detached dwellings in Area B (0.60 spaces per dwelling).

To assess the adequacy of the on-street car parking provision, reference has been made to the zoning by-law requirement for visitor parking at condominium developments (i.e. 1 space per 3 dwellings, or 0.33 spaces per dwelling). The resultant on-street car parking provision of 0.46 spaces per dwelling in Area A and 0.60 spaces per dwelling in Area B exceeds the abovementioned rate of 0.33 spaces per dwelling, and is considered to be adequate.

9.0 SUMMARY AND CONCLUSIONS

Proposal Overview

1. The proposal is for a residential subdivision comprising a total of 724 residential units and a retirement home comprising 150 units.
2. An internal road network is proposed to service the subdivision, with proposed roads in accordance with Norfolk County Design Criteria.
3. Access to the subdivision is proposed via three locations as follows:
    - The James Street (Highway 3) / Tisdale Drive intersection is proposed to be signalized to accommodate the proposed redevelopment. As part of the signalization it is proposed to construct a southbound left turn lane and a northbound right turn lane on James Street (Highway 3) to facilitate left and right turns into Area A, and to widen the existing Tisdale Drive pavement to 9.5 metres in accordance with Section 6.2.2 of the NCDC for a minor collector road.
    - A new unsignalized intersection to St. Michael's Street
    - A new unsignalized intersection to Wilson Avenue
4. A secondary emergency access is also proposed to James Street (Highway 3), via the existing golf club entrance.

Car Parking

5. The following minimum car parking rates are proposed:
    - 2 spaces per dwelling for residents of the proposed detached and townhouse dwellings;
    - 1 space per 3 dwellings for visitors of the proposed condominium townhouses; and
    - 1 space per 3 units for the retirement home

Traffic Analysis

6. Analysis has been completed for the following scenarios during the AM and PM peak hour:
    - Existing Conditions (2023)
    - Future Background Conditions (2028)
    - Future Background Conditions (2033)
    - Future Background Conditions (2038)
    - Future Total Conditions (2028)
    - Future Total Conditions (2033)
    - Future Total Conditions (2038)
7. Capacity analysis was undertaken to determine the site vehicular traffic impact within the analysis study area listed below:
    - Wilson Avenue / Viola Court
    - Wilson Avenue / St. Michael's Street
    - Viola Court / St. Michael's Street
    - James Street (Highway 3) / Wilson Avenue
    - James Street (Highway 3) / Tisdale Drive
    - James Street (Highway 3) / Alpha Street
    - James Street (Highway 3) / Pine Grove Road
    - St. Michael's Street / Site Driveway

- Wilson Avenue / Site Driveway

8. The proposed redevelopment is expected to generate in the order of 405 and 490 two-way vehicle trips during the AM and PM peak hours respectively.

9. As an unsignalized intersection, the westbound movements at the James Street (Highway 3) / Tisdale Drive intersection during the PM peak hour are projected to operate at LOS F during all future total horizons, with theoretical capacity for this movement during the PM peak hour projected to be exceeded under the 2038 future total horizon. Therefore, it is proposed to construct a signal at this intersection. A signal warrant was undertaken which indicates that a signal is warranted at this location based on the projected volumes. Overall, it is projected that site traffic can be accommodated at this intersection under the proposed signalized configuration.

10. The unsignalized intersection of James Street (Highway 3) / Wilson Avenue is generally projected to operate at LOS E or better in all analysis scenarios. The exception to this is in the 2038 horizon, an LOS F is projected for the westbound movements in the PM peak hour (52.3 seconds). As noted, this is only projected to occur in the long-term 2038 horizon, with the increased delay between time horizons a result of assumed corridor growth which has conservatively been set to 2% per annum, notwithstanding that the growth analysis indicates historical growth below this value. It is also noted that under this horizon, these movements are projected to remain well within capacity, with a v/c ratio of 0.71.

11. Signal warrants were undertaken for the James Street (Highway 3) / Wilson Avenue intersection, and the results are dependent on whether the intersection is defined as “restricted flow” (not warranted) or “free flow” (warranted) conditions, for which the site area exhibits characteristics of both.

12. Overall, given the LOS F is projected to occur in the long-term 2038 horizon, the intersection is projected to continue to operate within capacity, and the mixed context of “restricted flow” and “free flow” conditions as defined by OTM for the justification of traffic signals, it is recommended that operations of the James Street (Highway 3) / Wilson Avenue intersection be monitored and may be a candidate for signalization in the future.

13. It is projected that traffic associated with the proposed redevelopment can be suitably accommodated at all other intersections within the study area with minimal capacity impacts.

Transportation Demand Management

14. Proposed Transportation Demand Management measures include:

    - Provision of transit information package
    - Provision of cycling information package
    - Provision of sidewalks within the site

Design Considerations

15. The James Street (Highway 3) / Tisdale Drive intersection is proposed to be signalized to accommodate the proposed redevelopment. As part of the signalization it is proposed to construct a southbound left turn lane and a northbound right turn lane on James Street (Highway 3) to facilitate left and right turns into Area A, and to widen the existing Tisdale Drive pavement to 9.5 metres in accordance with Section 6.2.2 of the NCDC for a minor collector road. A signal warrant analysis has also been prepared for the James Street (Highway 3) / Tisdale Drive intersection which indicates that signals are warranted at this intersection.

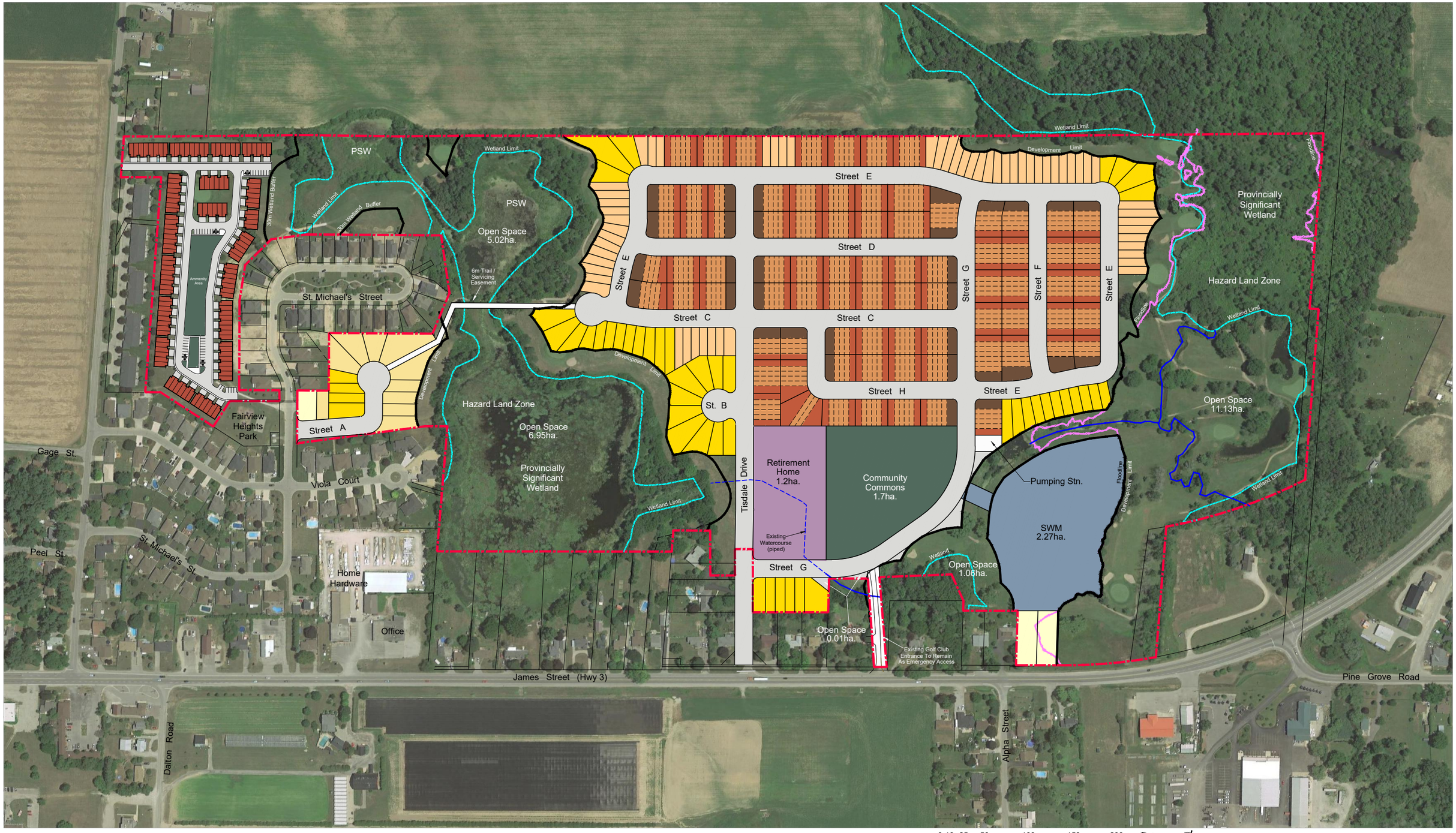
16. Signal warrant analyses have been prepared for the James Street (Highway 3) / Wilson Avenue intersection under both “restricted flow” and “free flow” conditions, for which the site area exhibits characteristics of both. The analysis indicates that under “restricted flow” conditions, signals are not warranted and under “free flow” conditions, signals are warranted under future conditions based on Justification 2 (Delay to Cross Traffic).

17. Given the mixed context of “restricted flow” and “free flow” conditions as defined by OTM and the operations results as discussed above, it is recommended that operations of the James Street (Highway 3) / Wilson Avenue intersection be monitored and may be a candidate for signalization in the future.

18. Road right of way and pavement widths, curb radii's, intersection angles and cul-de-sacs are designed in accordance with Norfolk County Design Criteria.

19. An on-street parking plan has been prepared which estimates in the order of 269 on-street car parking spaces for the proposed 580 detached dwellings and street townhouses in Area A (0.46 spaces per dwelling) and in the order of 9 on-street car parking spaces for the proposed 15 detached dwellings in Area B (0.60 spaces per dwelling). To assess the adequacy of the on-street car parking provision, reference has been made to the zoning by-law requirement for visitor parking at condominium developments (i.e. 1 space per 3 dwellings, or 0.33 spaces per dwelling). The resultant on-street car parking provision of 0.46 spaces per dwelling in Area A and 0.60 spaces per dwelling in Area B exceeds the abovementioned rate of 0.33 spaces per dwelling, and is considered to be adequate.

APPENDIX A:
Concept Plan (not to scale)



Delhi Development Inc.

DEVELOPMENT CONCEPT

Delhi Golf & Country Club

Site Area: 55.32ha. (136.7ac.)
Developable Area: 29.73ha. (73.4ac)
No. of Lots / Units: 874

- 18' Townhouses (129)
- 18' Street Townhouses (313)
- 20' Street Townhouses (130)
- 22' Street Townhouses (32)
- 30' Lots (57)
- 36' Lots (50)
- 44' Lots (10)
- 60' Lots (3)
- Retirement Home (150)

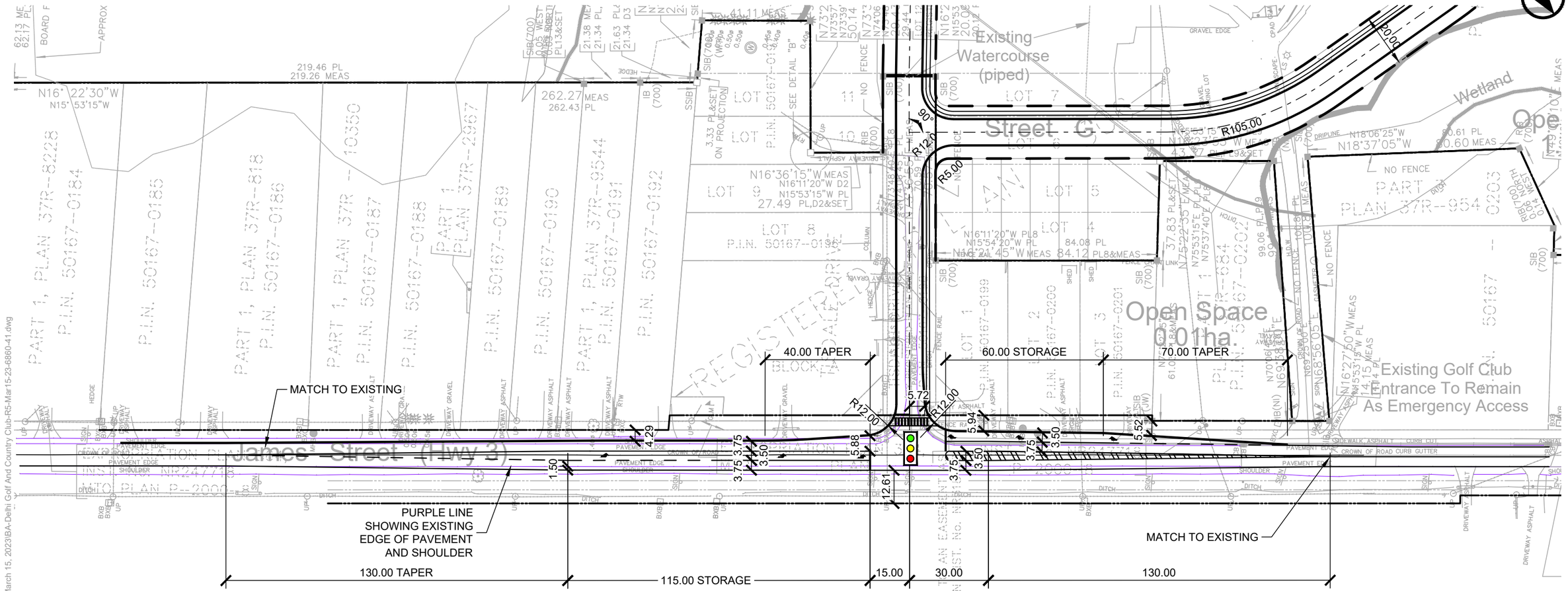
0 10 25 50 100 150 200
Metres

NOTE: This concept should be considered as a preliminary demonstration model that illustrates an 'order of magnitude' development scenario for the site and is subject to municipal planning approvals.

Scale 1:4,000 | February 23, 2023 | Project No.: 21208 | Drawn By: SL

GSP group

APPENDIX B:
Concept Road Plan and Highway 3 Functional Plan



Date Plotted: March 17, 2023 Filename: J:\6860-41\BA\Concept Plan\5. March 15, 2023\BA-Delhi Golf And Country Club-R5-Mar15-23-6860-41.dwg

BA Group

DELHI GOLF AND COUNTRY CLUB

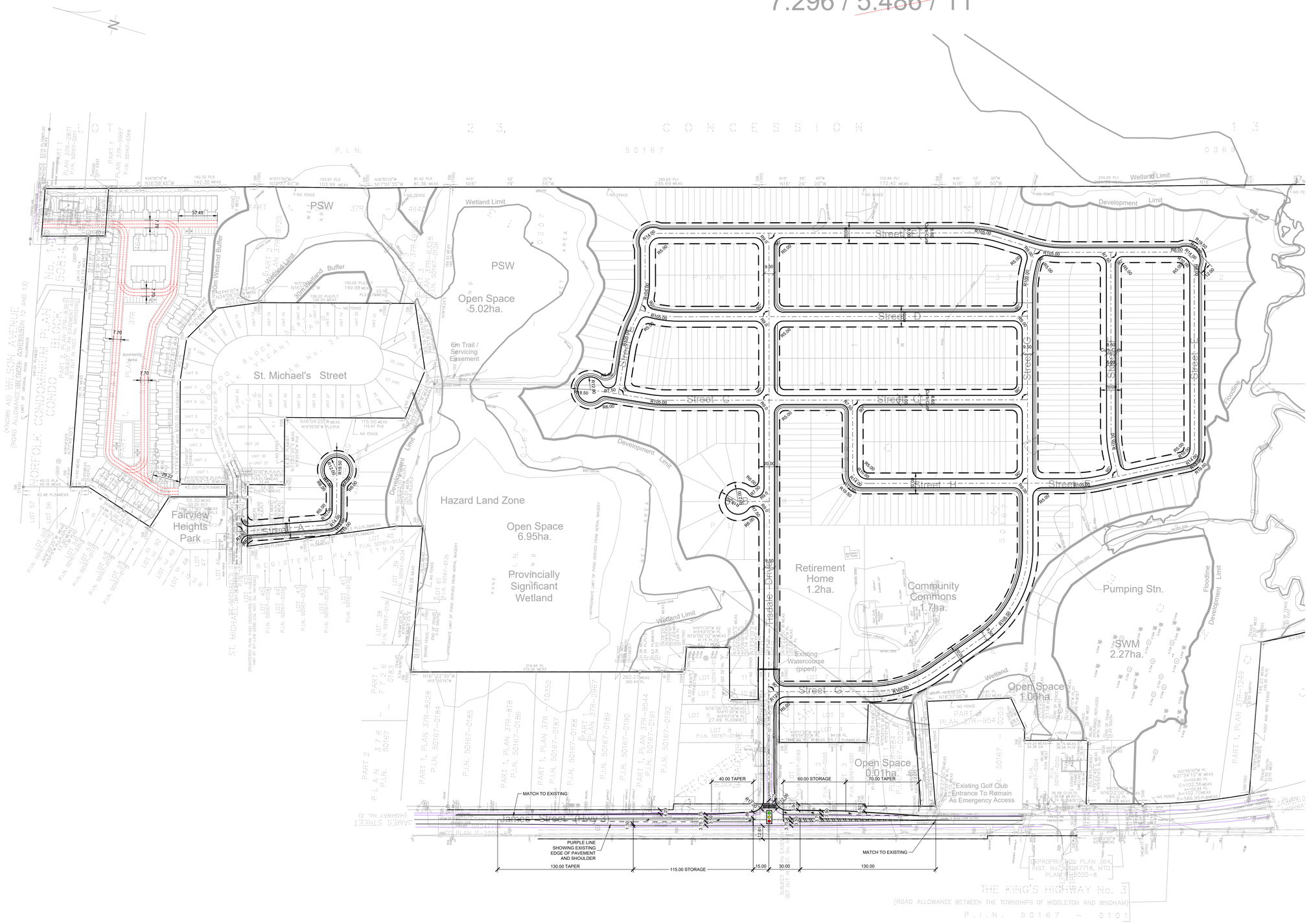
James Street (Hwy 3) Functional Design

Project:	Delhi Golf & Country Club
Project No.	6860-41
Date:	March 17, 2023
Revised:	--

Scale 1:1,500 (0, 25, 50m)

Drawing No. FD-01

7.296 / 5.486 / 11



18' Townhouses (129)
18' Street Townhouses (313)
20' Street Townhouses (130)
22' Street Townhouses (32)
36' Lots (50)
44' Lots (10)
60' Lots (3)

GENERAL NOTES

1. ARCHITECTURAL GROUND FLOOR PLAN DATED FEBRUARY 23, 2023, PREPARED BY GSP GROUP.
2. SURVEY DATED SEPTEMBER 8, 2022, PREPARED BY R-PE SURVEYING LTD.
3. CURB / GUTTER DIMENSION HAS BEEN ADOPTED AS PER OPSD 600.040 STANDARD.
4. LOCATION OF MAILBOX AND FIRE HYDRANTS HAVE NOT BEEN DETERMINED AT THIS STAGE, WHICH WILL IMPACT ON-STREET PARKING SPACES.
5. THE SIDEWALK LOCATION IS SUBJECT TO CONFIRMATION THROUGH THE DESIGN PROCESS.
6. THE ROAD ALIGNMENT AND THE SIDEWALK SHOULD TIE INTO EXISTING.
7. THIS PLAN IS ILLUSTRATIVE FOR THE PURPOSE OF SHOWING FUNCTIONAL ROAD ALIGNMENT AND SHALL NOT BE RELIED UPON FOR DETAILED DESIGN OR CONSTRUCTION.

01	03-16-23	WGC	ISSUED FOR RESUBMISSION
00	MM-DD-YR	INT	REVISION NOTE

BA Group

BA Consulting Group Ltd.
300 - 45 St. Clair Ave. W.
Toronto ON M4V 1K9
TEL 416.961.7110
EMAIL bagroup@bagroup.com

MOVEMENT IN URBAN ENVIRONMENTS
BAGROUP.COM

DELHI GOLF AND COUNTRY CLUB

INTERNAL ROAD PLAN WITH TYPICAL STREET DESIGN ELEMENTS

Date: March 17, 2023

Project No.: 6860-41

Scale: 1:1,500 (0, 25, 50m)

RP-01

Date Plotted: March 17, 2023 Filename: J:\6860-41\BA\Concept Plan\5. March 15, 2023\BA-Delhi Golf And Country Club-R5-Mar15-23-6860-41.dwg

37.45

7.70

7.70

7.70

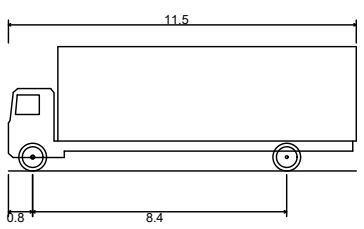
Ammenity Area

30m Wetland Buffer

29.22

Fairview Heights

Design Vehicle - TAC HSU (Heavy Single Unit)



Overall Length	11.50m
Overall Width	2.60m
Overall Body Height	4.11m
Outside Turning Radius	14.56m
Inside Turning Radius	8.69m

BA Group

DELHI GOLF AND COUNTRY CLUB

Vehicular Manoeuvring Diagram
TAC HSU - Townhouse Block

Project:	Delhi Golf & Country Club
Project No.	6860-41
Date:	March 17, 2023
Revised:	--

Scale 1:1,000 (0 10 20 30 40 50m)

Drawing No. VMD-01

Date Plotted: March 17, 2023 Filename: J:\6860-41\BA\Concept Plan\5. March 15, 2023\BA-Delhi Golf And Country Club-R5-Mar15-23-6860-41.dwg

APPENDIX C:
Traffic Counts

Spectrum

Turning Movement Count
Location Name: HWY 3 (JAMES ST) & PINE GROVE RD
Date: Wed, May 25, 2022 Deployment Lead:

BA Group
300 45 ST. CLAIR AVE W
TORONTO ONTARIO, M4V 1K9
CANADA

Turning Movement Count (1 . HWY 3 (JAMES ST) & PINE GROVE RD)

Start Time	N Approach HWY 3 (JAMES ST)					S Approach HWY 3 (JAMES ST)					W Approach PINE GROVE RD					Int. Total (15 min)	Int. Total (1 hr)
	Right N:W	Thru N:S	UTurn N:N	Peds N:	Approach Total	Thru S:N	Left S:W	UTurn S:S	Peds S:	Approach Total	Right W:S	Left W:N	UTurn W:W	Peds W:	Approach Total		
07:00:00	17	44	0	0	61	33	1	0	0	34	0	12	0	0	12	107	
07:15:00	15	52	0	0	67	34	0	0	0	34	2	18	0	0	20	121	
07:30:00	22	85	0	0	107	41	2	0	0	43	1	24	0	0	25	175	
07:45:00	26	56	0	0	82	54	4	0	0	58	3	20	0	0	23	163	566
08:00:00	22	47	0	0	69	42	0	0	0	42	2	33	0	0	35	146	605
08:15:00	23	78	0	0	101	40	0	0	0	40	0	37	0	0	37	178	662
08:30:00	16	70	0	0	86	39	2	0	0	41	0	34	0	0	34	161	648
08:45:00	20	54	0	0	74	53	1	0	0	54	2	37	0	0	39	167	652
BREAK																	
16:00:00	44	62	0	0	106	68	2	0	0	70	3	44	0	0	47	223	
16:15:00	35	78	0	0	113	77	2	0	0	79	1	34	0	0	35	227	
16:30:00	48	72	0	0	120	65	1	0	0	66	2	28	0	0	30	216	
16:45:00	36	60	0	0	96	81	0	0	0	81	0	20	0	0	20	197	863
17:00:00	33	72	0	0	105	65	2	0	0	67	9	43	0	0	52	224	864
17:15:00	32	60	0	0	92	91	1	0	0	92	4	30	0	0	34	218	855
17:30:00	34	61	0	0	95	61	1	0	0	62	1	30	0	0	31	188	827
17:45:00	24	40	0	0	64	69	0	0	0	69	0	37	0	0	37	170	800
Grand Total	447	991	0	0	1438	913	19	0	0	932	30	481	0	0	511	**2881**	-
Approach%	31.1%	68.9%	0%		-	98%	2%	0%		-	5.9%	94.1%	0%		-	**-**	-
Totals %	15.5%	34.4%	0%		49.9%	31.7%	0.7%	0%		32.3%	1%	16.7%	0%		17.7%	**-**	-
Heavy	22	61	0		-	55	2	0		-	3	16	0		-	**-**	-
Heavy %	4.9%	6.2%	0%		-	6%	10.5%	0%		-	10%	3.3%	0%		-	**-**	-
Bicycles	-	-	-		-	-	-	-		-	-	-	-		-	**-**	-
Bicycle %	-	-	-		-	-	-	-		-	-	-	-		-	**-**	-

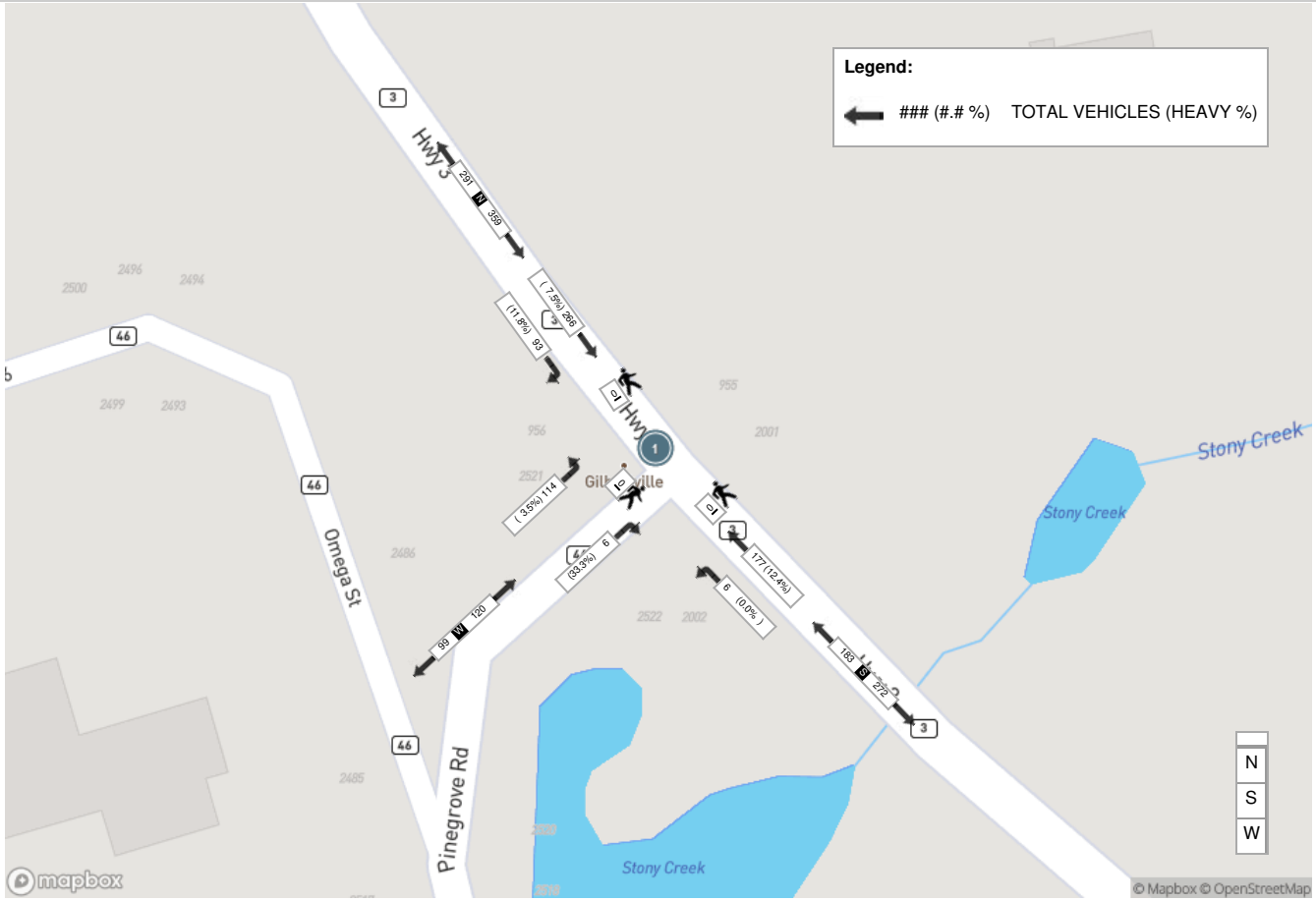
Peak Hour: 07:30 AM - 08:30 AM Weather: Overcast Clouds (9.42 °C)

Start Time	N Approach HWY 3 (JAMES ST)					S Approach HWY 3 (JAMES ST)					W Approach PINE GROVE RD					Int. Total (15 min)
	Right	Thru	UTurn	Peds	Approach Total	Thru	Left	UTurn	Peds	Approach Total	Right	Left	UTurn	Peds	Approach Total	
07:30:00	22	85	0	0	107	41	2	0	0	43	1	24	0	0	25	175
07:45:00	26	56	0	0	82	54	4	0	0	58	3	20	0	0	23	163
08:00:00	22	47	0	0	69	42	0	0	0	42	2	33	0	0	35	146
08:15:00	23	78	0	0	101	40	0	0	0	40	0	37	0	0	37	178
Grand Total	93	266	0	0	359	177	6	0	0	183	6	114	0	0	120	**662**
Approach%	25.9%	74.1%	0%		-	96.7%	3.3%	0%		-	5%	95%	0%		-	**-**
Totals %	14%	40.2%	0%		54.2%	26.7%	0.9%	0%		27.6%	0.9%	17.2%	0%		18.1%	**-**
PHF	0.89	0.78	0		0.84	0.82	0.38	0		0.79	0.5	0.77	0		0.81	**-**
Heavy	11	20	0		31	22	0	0		22	2	4	0		6	**-**
Heavy %	11.8%	7.5%	0%		8.6%	12.4%	0%	0%		12%	33.3%	3.5%	0%		5%	**-**
Lights	82	246	0		328	155	6	0		161	4	110	0		114	**-**
Lights %	88.2%	92.5%	0%		91.4%	87.6%	100%	0%		88%	66.7%	96.5%	0%		95%	**-**
Single-Unit Trucks	5	7	0		12	13	0	0		13	0	2	0		2	**-**
Single-Unit Trucks %	5.4%	2.6%	0%		3.3%	7.3%	0%	0%		7.1%	0%	1.8%	0%		1.7%	**-**
Buses	4	5	0		9	4	0	0		4	2	2	0		4	**-**
Buses %	4.3%	1.9%	0%		2.5%	2.3%	0%	0%		2.2%	33.3%	1.8%	0%		3.3%	**-**
Articulated Trucks	2	8	0		10	5	0	0		5	0	0	0		0	**-**
Articulated Trucks %	2.2%	3%	0%		2.8%	2.8%	0%	0%		2.7%	0%	0%	0%		0%	**-**

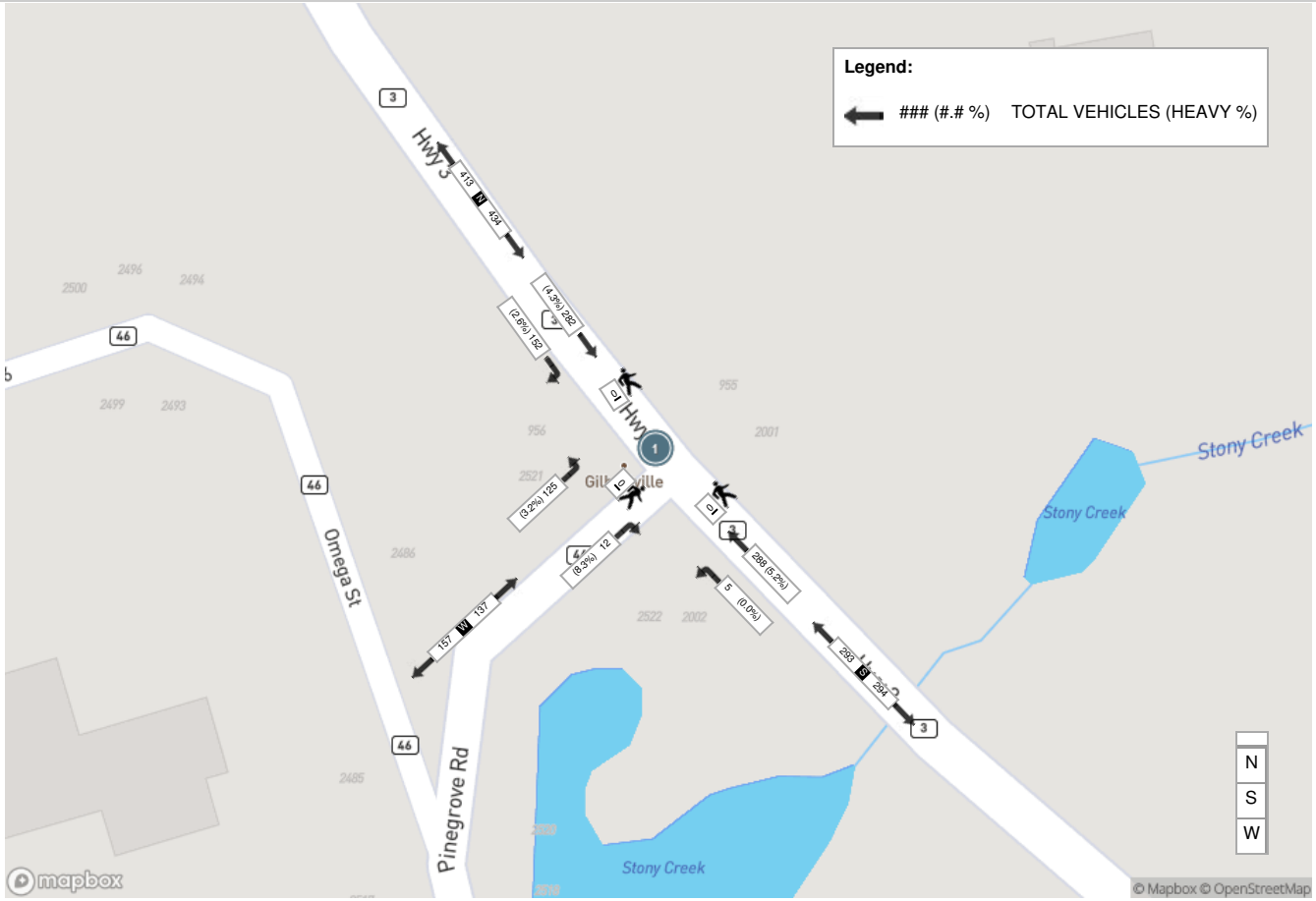
Peak Hour: 04:15 PM - 05:15 PM Weather: Overcast Clouds (21.08 °C)

Start Time	N Approach HWY 3 (JAMES ST)					S Approach HWY 3 (JAMES ST)					W Approach PINE GROVE RD					Int. Total (15 min)
	Right	Thru	UTurn	Peds	Approach Total	Thru	Left	UTurn	Peds	Approach Total	Right	Left	UTurn	Peds	Approach Total	
16:15:00	35	78	0	0	113	77	2	0	0	79	1	34	0	0	35	227
16:30:00	48	72	0	0	120	65	1	0	0	66	2	28	0	0	30	216
16:45:00	36	60	0	0	96	81	0	0	0	81	0	20	0	0	20	197
17:00:00	33	72	0	0	105	65	2	0	0	67	9	43	0	0	52	224
Grand Total	152	282	0	0	434	288	5	0	0	293	12	125	0	0	137	**864**
Approach%	35%	65%	0%		-	98.3%	1.7%	0%		-	8.8%	91.2%	0%		-	**-**
Totals %	17.6%	32.6%	0%		50.2%	33.3%	0.6%	0%		33.9%	1.4%	14.5%	0%		15.9%	**-**
PHF	0.79	0.9	0		0.9	0.89	0.63	0		0.9	0.33	0.73	0		0.66	**-**
Heavy	4	12	0		16	15	0	0		15	1	4	0		5	**-**
Heavy %	2.6%	4.3%	0%		3.7%	5.2%	0%	0%		5.1%	8.3%	3.2%	0%		3.6%	**-**
Lights	148	270	0		418	273	5	0		278	11	121	0		132	**-**
Lights %	97.4%	95.7%	0%		96.3%	94.8%	100%	0%		94.9%	91.7%	96.8%	0%		96.4%	**-**
Single-Unit Trucks	4	3	0		7	4	0	0		4	0	3	0		3	**-**
Single-Unit Trucks %	2.6%	1.1%	0%		1.6%	1.4%	0%	0%		1.4%	0%	2.4%	0%		2.2%	**-**
Buses	0	1	0		1	0	0	0		0	0	1	0		1	**-**
Buses %	0%	0.4%	0%		0.2%	0%	0%	0%		0%	0%	0.8%	0%		0.7%	**-**
Articulated Trucks	0	8	0		8	11	0	0		11	1	0	0		1	**-**
Articulated Trucks %	0%	2.8%	0%		1.8%	3.8%	0%	0%		3.8%	8.3%	0%	0%		0.7%	**-**

Peak Hour: 07:30 AM - 08:30 AM Weather: Overcast Clouds (9.42 °C)



Peak Hour: 04:15 PM - 05:15 PM Weather: Overcast Clouds (21.08 °C)



Spectrum

Turning Movement Count
Location Name: JAMES ST & ALPHA ST
Date: Wed, May 25, 2022 Deployment Lead:

BA Group
300 45 ST. CLAIR AVE W
TORONTO ONTARIO, M4V 1K9
CANADA

Turning Movement Count (2 . JAMES ST & ALPHA ST)

Start Time	N Approach HWY 3 (JAMES ST)					S Approach HWY 3 (JAMES ST)					W Approach ALPHA ST					Int. Total (15 min)	Int. Total (1 hr)
	Right N:W	Thru N:S	UTurn N:N	Peds N:	Approach Total	Thru S:N	Left S:W	UTurn S:S	Peds S:	Approach Total	Right W:S	Left W:N	UTurn W:W	Peds W:	Approach Total		
07:00:00	0	59	0	0	59	46	0	0	0	46	3	1	0	0	4	109	
07:15:00	2	68	0	0	70	54	0	0	0	54	1	3	0	0	4	128	
07:30:00	0	103	0	0	103	65	1	0	0	66	1	3	0	0	4	173	
07:45:00	2	80	0	0	82	73	1	0	0	74	2	1	0	0	3	159	569
08:00:00	1	67	0	0	68	74	0	0	0	74	3	1	0	0	4	146	606
08:15:00	1	97	0	0	98	77	0	0	0	77	2	4	0	0	6	181	659
08:30:00	4	85	0	0	89	73	0	0	0	73	0	3	0	0	3	165	651
08:45:00	2	75	0	0	77	88	0	0	0	88	1	3	0	0	4	169	661
09:00:00	0	77	0	0	77	46	1	0	0	47	1	2	0	0	3	127	642
09:15:00	1	66	0	0	67	68	0	0	0	68	2	2	0	0	4	139	600
09:30:00	1	82	0	0	83	68	0	1	0	69	1	1	0	0	2	154	589
09:45:00	0	70	0	0	70	65	2	0	0	67	2	1	0	0	3	140	560
10:00:00	0	66	0	0	66	59	0	0	0	59	1	1	0	0	2	127	560
10:15:00	0	76	0	0	76	72	0	1	0	73	2	0	0	0	2	151	572
10:30:00	1	84	0	0	85	73	0	0	0	73	2	1	0	0	3	161	579
10:45:00	4	68	0	0	72	81	1	0	0	82	3	0	0	0	3	157	596
11:00:00	1	64	0	0	65	78	2	0	0	80	0	1	0	0	1	146	615
11:15:00	3	73	0	0	76	65	1	0	0	66	0	1	0	0	1	143	607
11:30:00	1	72	0	0	73	65	1	0	0	66	0	3	0	0	3	142	588
11:45:00	0	64	0	0	64	67	1	0	0	68	0	1	0	0	1	133	564
12:00:00	1	73	0	0	74	82	0	0	0	82	0	1	0	0	1	157	575
12:15:00	1	75	0	0	76	78	0	0	0	78	3	1	0	0	4	158	590
12:30:00	2	82	0	0	84	84	3	0	0	87	0	4	0	0	4	175	623
12:45:00	2	82	0	0	84	81	1	0	0	82	0	0	0	0	0	166	656
13:00:00	4	73	0	0	77	57	1	0	0	58	1	3	0	0	4	139	638
13:15:00	2	82	0	0	84	80	0	0	0	80	0	2	0	0	2	166	646
13:30:00	1	71	0	0	72	62	1	0	1	63	3	4	0	0	7	142	613
13:45:00	2	81	0	0	83	69	1	0	1	70	1	1	0	0	2	155	602
14:00:00	4	100	0	0	104	59	0	1	0	60	0	1	0	0	1	165	628
14:15:00	2	58	0	0	60	88	1	0	0	89	2	0	0	0	2	151	613
14:30:00	2	91	0	0	93	90	0	0	0	90	1	1	0	0	2	185	656
14:45:00	2	65	0	0	67	90	0	0	0	90	0	4	0	0	4	161	662
15:00:00	1	70	0	0	71	73	0	1	0	74	0	1	0	0	1	146	643
15:15:00	6	94	0	0	100	91	1	0	0	92	1	1	0	0	2	194	686

15:30:00	2	105	0	0	107	76	3	0	0	79	0	2	0	0	2	188	689
15:45:00	1	97	0	0	98	119	3	0	0	122	2	1	0	0	3	223	751
16:00:00	5	100	0	0	105	108	4	0	0	112	1	1	0	0	2	219	824
16:15:00	4	112	0	0	116	113	0	0	0	113	2	3	0	0	5	234	864
16:30:00	2	114	0	0	116	87	3	0	0	90	2	1	0	0	3	209	885
16:45:00	4	106	0	0	110	104	0	0	0	104	0	3	0	0	3	217	879
17:00:00	3	99	0	0	102	105	3	0	0	108	0	2	0	0	2	212	872
17:15:00	4	91	0	0	95	122	0	0	0	122	0	3	0	0	3	220	858
17:30:00	4	87	0	0	91	88	1	0	0	89	3	6	0	0	9	189	838
17:45:00	2	67	0	0	69	105	2	0	0	107	0	6	0	0	6	182	803
18:00:00	3	63	0	0	66	71	3	0	0	74	0	2	0	0	2	142	733
18:15:00	2	62	0	0	64	66	2	0	0	68	1	2	0	0	3	135	648
18:30:00	2	54	0	0	56	56	0	0	0	56	1	0	0	0	1	113	572
18:45:00	3	50	0	0	53	45	1	0	0	46	0	2	0	0	2	101	491
Grand Total	97	3800	0	0	3897	3706	45	4	2	3755	51	91	0	0	142	**7794**	-
Approach%	2.5%	97.5%	0%		-	98.7%	1.2%	0.1%		-	35.9%	64.1%	0%		-	**-**	-
Totals %	1.2%	48.8%	0%		50%	47.5%	0.6%	0.1%		48.2%	0.7%	1.2%	0%		1.8%	**-**	-
Heavy	2	282	0		-	275	2	0		-	4	0	0		-	**-**	-
Heavy %	2.1%	7.4%	0%		-	7.4%	4.4%	0%		-	7.8%	0%	0%		-	**-**	-
Bicycles	1	5	0		-	1	0	0		-	0	1	0		-	**-**	-
Bicycle %	1%	0.1%	0%		-	0%	0%	0%		-	0%	1.1%	0%		-	**-**	-

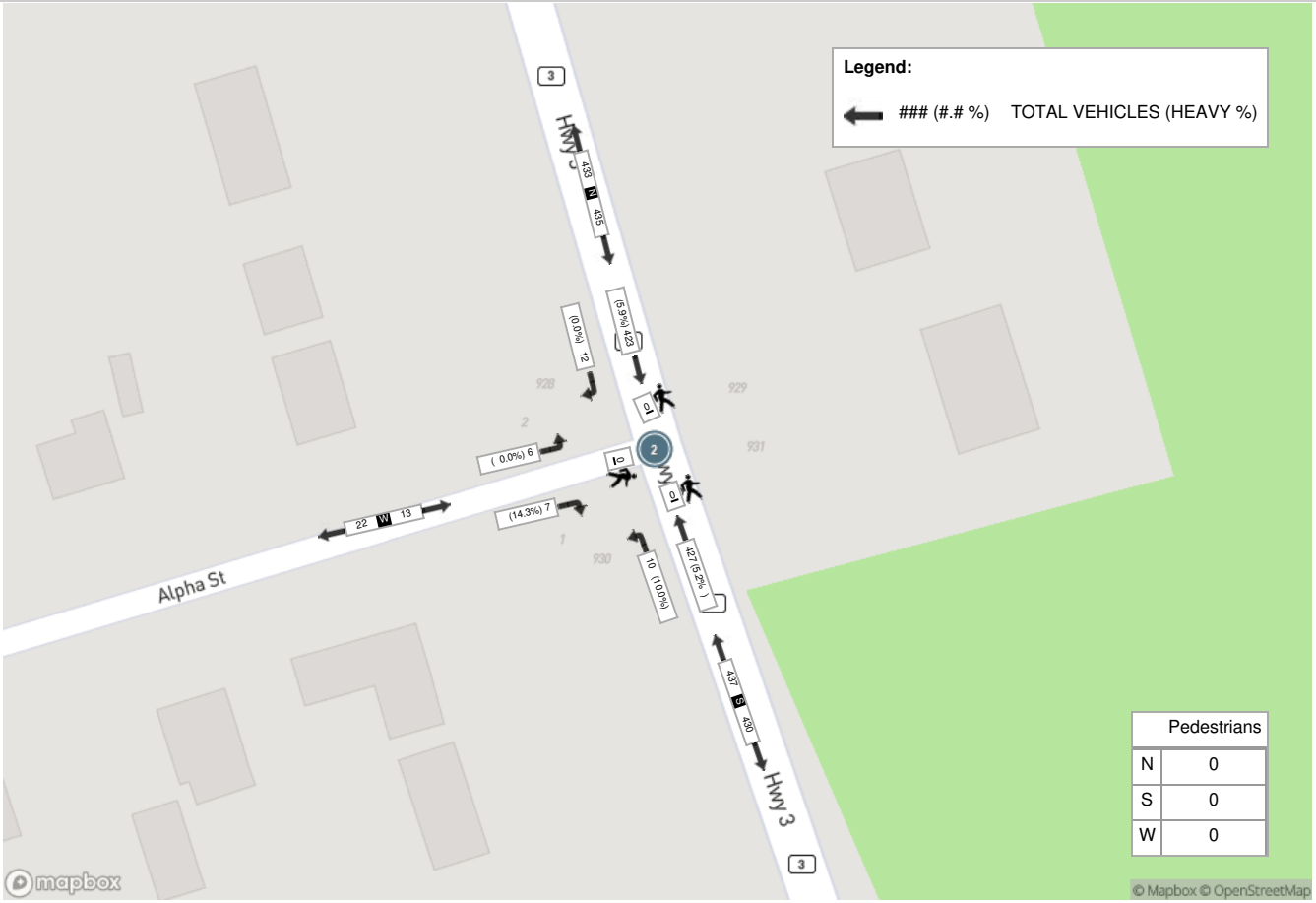
Peak Hour: 03:45 PM - 04:45 PM Weather: Overcast Clouds (9.42 °C)

Start Time	N Approach HWY 3 (JAMES ST)					S Approach HWY 3 (JAMES ST)					W Approach ALPHA ST					Int. Total (15 min)
	Right	Thru	UTurn	Peds	Approach Total	Thru	Left	UTurn	Peds	Approach Total	Right	Left	UTurn	Peds	Approach Total	
15:45:00	1	97	0	0	98	119	3	0	0	122	2	1	0	0	3	223
16:00:00	5	100	0	0	105	108	4	0	0	112	1	1	0	0	2	219
16:15:00	4	112	0	0	116	113	0	0	0	113	2	3	0	0	5	234
16:30:00	2	114	0	0	116	87	3	0	0	90	2	1	0	0	3	209
Grand Total	12	423	0	0	435	427	10	0	0	437	7	6	0	0	13	**885**
Approach%	2.8%	97.2%	0%		-	97.7%	2.3%	0%		-	53.8%	46.2%	0%		-	**-**
Totals %	1.4%	47.8%	0%		49.2%	48.2%	1.1%	0%		49.4%	0.8%	0.7%	0%		1.5%	**-**
PHF	0.6	0.93	0		0.94	0.9	0.63	0		0.9	0.88	0.5	0		0.65	**-**
Heavy	0	25	0		25	22	1	0		23	1	0	0		1	**-**
Heavy %	0%	5.9%	0%		5.7%	5.2%	10%	0%		5.3%	14.3%	0%	0%		7.7%	**-**
Lights	12	398	0		410	405	9	0		414	6	6	0		12	**-**
Lights %	100%	94.1%	0%		94.3%	94.8%	90%	0%		94.7%	85.7%	100%	0%		92.3%	**-**
Single-Unit Trucks	0	14	0		14	9	0	0		9	0	0	0		0	**-**
Single-Unit Trucks %	0%	3.3%	0%		3.2%	2.1%	0%	0%		2.1%	0%	0%	0%		0%	**-**
Buses	0	4	0		4	3	1	0		4	1	0	0		1	**-**
Buses %	0%	0.9%	0%		0.9%	0.7%	10%	0%		0.9%	14.3%	0%	0%		7.7%	**-**
Articulated Trucks	0	7	0		7	10	0	0		10	0	0	0		0	**-**
Articulated Trucks %	0%	1.7%	0%		1.6%	2.3%	0%	0%		2.3%	0%	0%	0%		0%	**-**
Pedestrians	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	**-**
Pedestrians%	-	-	-	0%		-	-	-	0%		-	-	-	0%		**-**
Bicycles on Road	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	**-**
Bicycles on Road%	-	-	-	0%		-	-	-	0%		-	-	-	0%		**-**

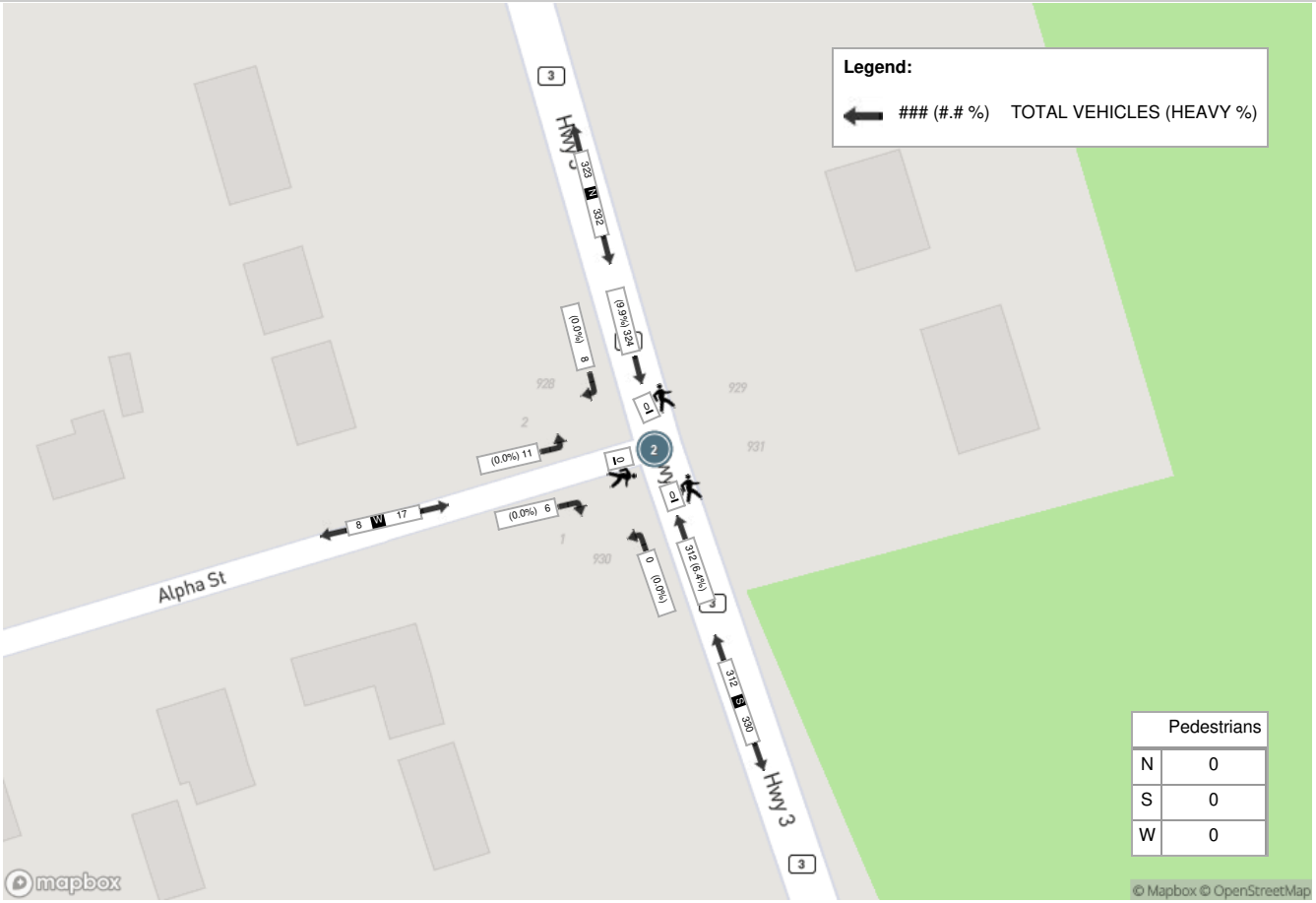
Selected Hour: 08:00 AM - 09:00 AM Weather:

Start Time	N Approach HWY 3 (JAMES ST)					S Approach HWY 3 (JAMES ST)					W Approach ALPHA ST					Int. Total (15 min)
	Right	Thru	UTurn	Peds	Approach Total	Thru	Left	UTurn	Peds	Approach Total	Right	Left	UTurn	Peds	Approach Total	
08:00:00	1	67	0	0	68	74	0	0	0	74	3	1	0	0	4	146
08:15:00	1	97	0	0	98	77	0	0	0	77	2	4	0	0	6	181
08:30:00	4	85	0	0	89	73	0	0	0	73	0	3	0	0	3	165
08:45:00	2	75	0	0	77	88	0	0	0	88	1	3	0	0	4	169
Grand Total	8	324	0	0	332	312	0	0	0	312	6	11	0	0	17	**661**
Approach%	2.4%	97.6%	0%		-	100%	0%	0%		-	35.3%	64.7%	0%		-	**-**
Totals %	1.2%	49%	0%		50.2%	47.2%	0%	0%		47.2%	0.9%	1.7%	0%		2.6%	**-**
PHF	0.5	0.84	0		0.85	0.89	0	0		0.89	0.5	0.69	0		0.71	**-**
Heavy	0	32	0		32	20	0	0		20	0	0	0		0	**-**
Heavy %	0%	9.9%	0%		9.6%	6.4%	0%	0%		6.4%	0%	0%	0%		0%	**-**
Lights	8	292	0		300	292	0	0		292	6	11	0		17	**-**
Lights %	100%	90.1%	0%		90.4%	93.6%	0%	0%		93.6%	100%	100%	0%		100%	**-**
Single-Unit Trucks	0	11	0		11	7	0	0		7	0	0	0		0	**-**
Single-Unit Trucks %	0%	3.4%	0%		3.3%	2.2%	0%	0%		2.2%	0%	0%	0%		0%	**-**
Buses	0	7	0		7	6	0	0		6	0	0	0		0	**-**
Buses %	0%	2.2%	0%		2.1%	1.9%	0%	0%		1.9%	0%	0%	0%		0%	**-**
Articulated Trucks	0	14	0		14	7	0	0		7	0	0	0		0	**-**
Articulated Trucks %	0%	4.3%	0%		4.2%	2.2%	0%	0%		2.2%	0%	0%	0%		0%	**-**
Pedestrians	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	**-**
Pedestrians%	-	-	-	0%		-	-	-	0%		-	-	-	0%		**-**
Bicycles on Road	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	**-**
Bicycles on Road%	-	-	-	0%		-	-	-	0%		-	-	-	0%		**-**

Peak Hour: 03:45 PM - 04:45 PM Weather: Overcast Clouds (9.42 °C)



Selected Hour: 08:00 AM - 09:00 AM Weather:



BA Group
300 45 ST. CLAIR AVE W
TORONTO ONTARIO, M4V 1K9
CANADA

Turning Movement Count (3 . JAMES ST & DELHI GOLF COURSE ACCESS)

Start Time	N Approach JAMES ST					E Approach DELHI GOLF COURSE ACCESS					S Approach JAMES ST					Int. Total (15 min)	Int. Total (1 hr)
	Thru N:S	Left N:E	UTurn N:N	Peds N:	Approach Total	Right E:N	Left E:S	UTurn E:E	Peds E:	Approach Total	Right S:E	Thru S:N	UTurn S:S	Peds S:	Approach Total		
07:00:00	61	1	0	0	62	0	0	0	0	0	0	46	0	0	46	108	
07:15:00	69	0	0	0	69	0	0	0	0	0	0	56	0	0	56	125	
07:30:00	104	0	0	0	104	0	0	0	0	0	1	68	0	0	69	173	
07:45:00	81	1	0	0	82	0	0	0	0	0	1	75	0	0	76	158	564
08:00:00	68	2	0	0	70	0	1	0	0	1	2	70	0	0	72	143	599
08:15:00	98	2	0	0	100	0	0	0	0	0	2	80	0	0	82	182	656
08:30:00	90	2	0	0	92	0	0	0	0	0	3	73	0	0	76	168	651
08:45:00	77	0	0	0	77	0	0	0	0	0	0	90	0	0	90	167	660
BREAK																	
16:00:00	107	2	0	0	109	0	0	0	0	0	0	109	0	0	109	218	
16:15:00	116	0	0	0	116	0	0	0	0	0	1	112	0	0	113	229	
16:30:00	116	1	0	0	117	0	1	0	0	1	0	94	0	0	94	212	
16:45:00	107	1	0	0	108	2	2	0	0	4	0	109	0	0	109	221	880
17:00:00	103	1	0	0	104	1	0	0	0	1	1	105	0	0	106	211	873
17:15:00	95	1	0	0	96	0	1	0	0	1	0	127	0	0	127	224	868
17:30:00	90	2	0	0	92	3	1	0	0	4	1	92	0	0	93	189	845
17:45:00	70	4	0	0	74	0	0	0	0	0	0	112	0	0	112	186	810
Grand Total	1452	20	0	0	1472	6	6	0	0	12	12	1418	0	0	1430	**2914**	-
Approach%	98.6%	1.4%	0%		-	50%	50%	0%		-	0.8%	99.2%	0%		-	**-**	-
Totals %	49.8%	0.7%	0%		50.5%	0.2%	0.2%	0%		0.4%	0.4%	48.7%	0%		49.1%	**-**	-
Heavy	82	0	0		-	0	0	0		-	0	69	0		-	**-**	-
Heavy %	5.6%	0%	0%		-	0%	0%	0%		-	0%	4.9%	0%		-	**-**	-
Bicycles	1	0	0		-	0	0	0		-	0	3	0		-	**-**	-
Bicycle %	0.1%	0%	0%		-	0%	0%	0%		-	0%	0.2%	0%		-	**-**	-

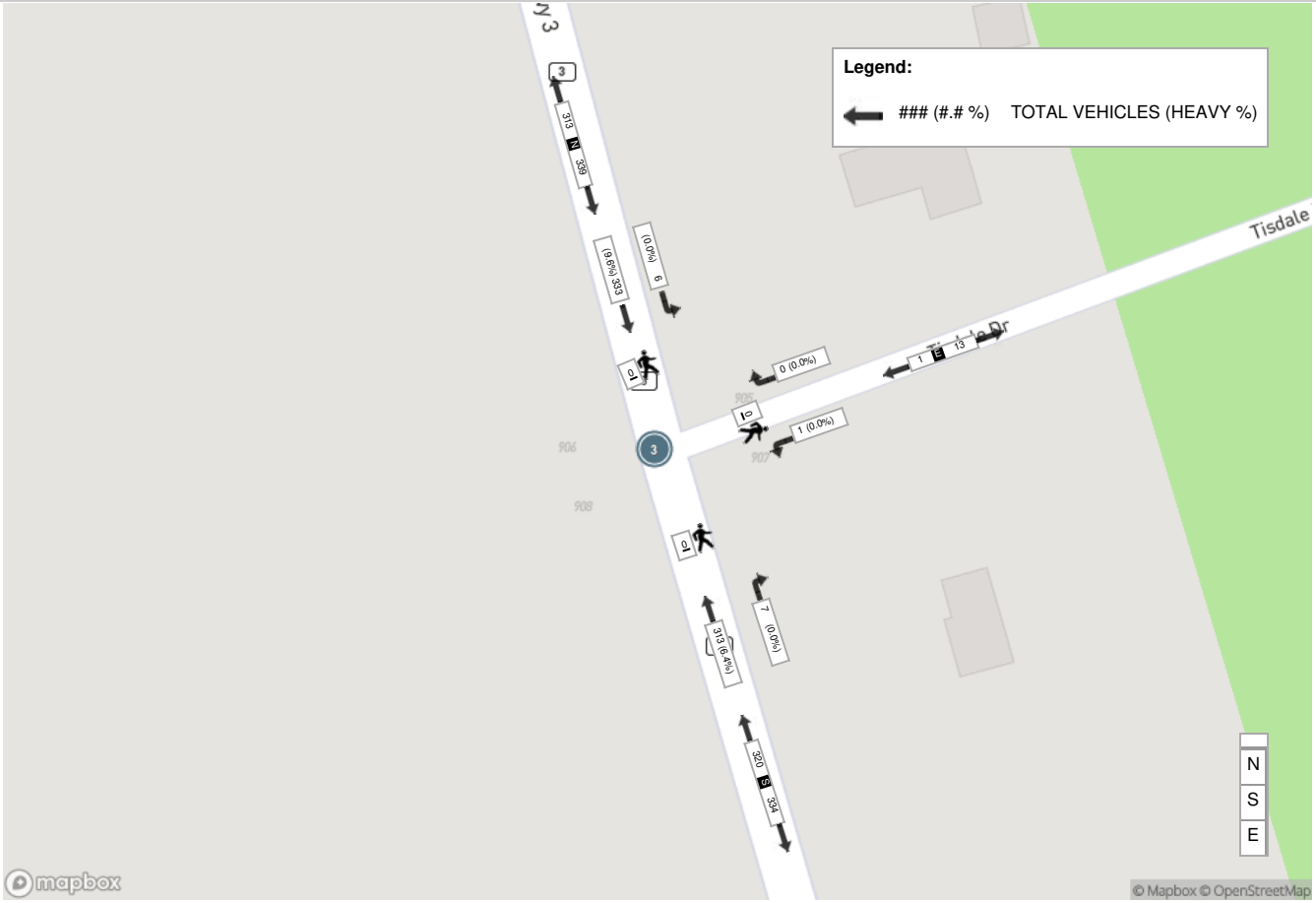
Peak Hour: 08:00 AM - 09:00 AM Weather: Overcast Clouds (9.42 °C)

Start Time	N Approach JAMES ST					E Approach DELHI GOLF COURSE ACCESS					S Approach JAMES ST					Int. Total (15 min)
	Thru	Left	UTurn	Peds	Approach Total	Right	Left	UTurn	Peds	Approach Total	Right	Thru	UTurn	Peds	Approach Total	
08:00:00	68	2	0	0	70	0	1	0	0	1	2	70	0	0	72	143
08:15:00	98	2	0	0	100	0	0	0	0	0	2	80	0	0	82	182
08:30:00	90	2	0	0	92	0	0	0	0	0	3	73	0	0	76	168
08:45:00	77	0	0	0	77	0	0	0	0	0	0	90	0	0	90	167
Grand Total	333	6	0	0	339	0	1	0	0	1	7	313	0	0	320	**660**
Approach%	98.2%	1.8%	0%		-	0%	100%	0%		-	2.2%	97.8%	0%		-	**-**
Totals %	50.5%	0.9%	0%		51.4%	0%	0.2%	0%		0.2%	1.1%	47.4%	0%		48.5%	**-**
PHF	0.85	0.75	0		0.85	0	0.25	0		0.25	0.58	0.87	0		0.89	**-**
Heavy	32	0	0		32	0	0	0		0	0	20	0		20	**-**
Heavy %	9.6%	0%	0%		9.4%	0%	0%	0%		0%	0%	6.4%	0%		6.3%	**-**
Lights	301	6	0		307	0	1	0		1	7	293	0		300	**-**
Lights %	90.4%	100%	0%		90.6%	0%	100%	0%		100%	100%	93.6%	0%		93.8%	**-**
Single-Unit Trucks	12	0	0		12	0	0	0		0	0	7	0		7	**-**
Single-Unit Trucks %	3.6%	0%	0%		3.5%	0%	0%	0%		0%	0%	2.2%	0%		2.2%	**-**
Buses	7	0	0		7	0	0	0		0	0	6	0		6	**-**
Buses %	2.1%	0%	0%		2.1%	0%	0%	0%		0%	0%	1.9%	0%		1.9%	**-**
Articulated Trucks	13	0	0		13	0	0	0		0	0	7	0		7	**-**
Articulated Trucks %	3.9%	0%	0%		3.8%	0%	0%	0%		0%	0%	2.2%	0%		2.2%	**-**
Bicycles on Road	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	**-**
Bicycles on Road%	-	-	-	%		-	-	-	%		-	-	-	%		**-**

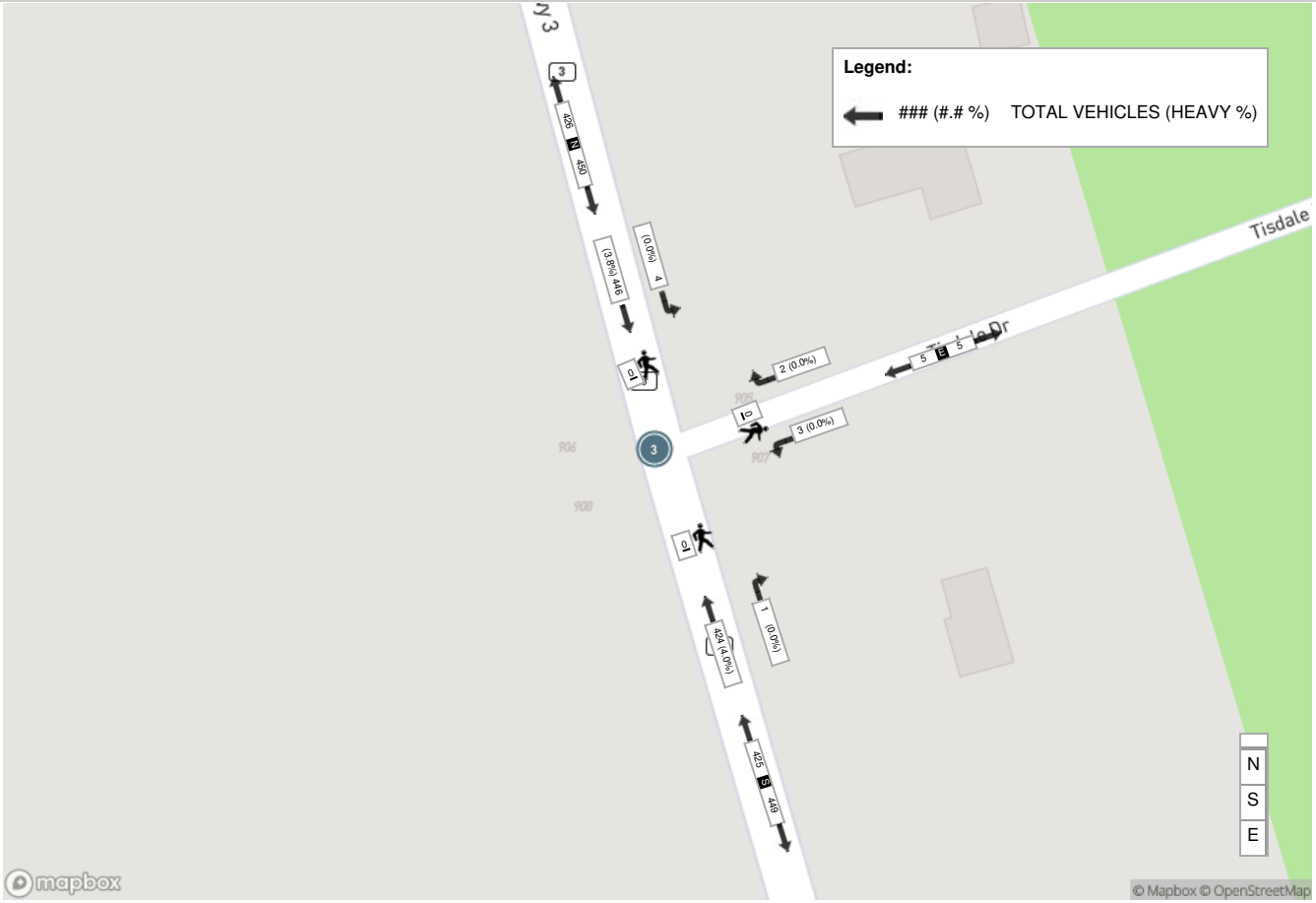
Peak Hour: 04:00 PM - 05:00 PM Weather: Overcast Clouds (21.08 °C)

Start Time	N Approach JAMES ST					E Approach DELHI GOLF COURSE ACCESS					S Approach JAMES ST					Int. Total (15 min)
	Thru	Left	UTurn	Peds	Approach Total	Right	Left	UTurn	Peds	Approach Total	Right	Thru	UTurn	Peds	Approach Total	
16:00:00	107	2	0	0	109	0	0	0	0	0	0	109	0	0	109	218
16:15:00	116	0	0	0	116	0	0	0	0	0	1	112	0	0	113	229
16:30:00	116	1	0	0	117	0	1	0	0	1	0	94	0	0	94	212
16:45:00	107	1	0	0	108	2	2	0	0	4	0	109	0	0	109	221
Grand Total	446	4	0	0	450	2	3	0	0	5	1	424	0	0	425	**880**
Approach%	99.1%	0.9%	0%		-	40%	60%	0%		-	0.2%	99.8%	0%		-	**-**
Totals %	50.7%	0.5%	0%		51.1%	0.2%	0.3%	0%		0.6%	0.1%	48.2%	0%		48.3%	**-**
PHF	0.96	0.5	0		0.96	0.25	0.38	0		0.31	0.25	0.95	0		0.94	**-**
Heavy	17	0	0		17	0	0	0		0	0	17	0		17	**-**
Heavy %	3.8%	0%	0%		3.8%	0%	0%	0%		0%	0%	4%	0%		4%	**-**
Lights	429	4	0		433	2	3	0		5	1	407	0		408	**-**
Lights %	96.2%	100%	0%		96.2%	100%	100%	0%		100%	100%	96%	0%		96%	**-**
Single-Unit Trucks	9	0	0		9	0	0	0		0	0	7	0		7	**-**
Single-Unit Trucks %	2%	0%	0%		2%	0%	0%	0%		0%	0%	1.7%	0%		1.6%	**-**
Buses	1	0	0		1	0	0	0		0	0	2	0		2	**-**
Buses %	0.2%	0%	0%		0.2%	0%	0%	0%		0%	0%	0.5%	0%		0.5%	**-**
Articulated Trucks	7	0	0		7	0	0	0		0	0	8	0		8	**-**
Articulated Trucks %	1.6%	0%	0%		1.6%	0%	0%	0%		0%	0%	1.9%	0%		1.9%	**-**
Bicycles on Road	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	**-**
Bicycles on Road%	-	-	-	%		-	-	-	%		-	-	-	%		**-**

Peak Hour: 08:00 AM - 09:00 AM Weather: Overcast Clouds (9.42 °C)



Peak Hour: 04:00 PM - 05:00 PM Weather: Overcast Clouds (21.08 °C)



Spectrum

Turning Movement Count
Location Name: JAMES ST & TISDALE DR
Date: Wed, May 25, 2022 Deployment Lead:

BA Group
300 45 ST. CLAIR AVE W
TORONTO ONTARIO, M4V 1K9
CANADA

Turning Movement Count (4 . JAMES ST & TISDALE DR)

Start Time	N Approach JAMES ST					E Approach TISDALE DR					S Approach JAMES ST					Int. Total (15 min)	Int. Total (1 hr)
	Thru N:S	Left N:E	UTurn N:N	Peds N:	Approach Total	Right E:N	Left E:S	UTurn E:E	Peds E:	Approach Total	Right S:E	Thru S:N	UTurn S:S	Peds S:	Approach Total		
07:00:00	61	0	0	0	61	0	0	0	0	0	0	44	0	0	44	105	
07:15:00	69	0	0	0	69	0	0	0	0	0	0	56	0	0	56	125	
07:30:00	105	0	0	0	105	0	0	0	0	0	0	69	0	0	69	174	
07:45:00	84	1	0	0	85	2	0	0	0	2	0	75	0	0	75	162	566
08:00:00	71	0	0	0	71	0	0	0	1	0	0	71	0	1	71	142	603
08:15:00	100	0	0	0	100	1	1	0	0	2	0	77	0	0	77	179	657
08:30:00	90	0	0	0	90	0	0	0	0	0	0	74	0	0	74	164	647
08:45:00	79	0	0	0	79	0	0	0	0	0	0	92	0	0	92	171	656
BREAK																	
16:00:00	109	1	0	0	110	1	0	0	0	1	0	112	0	0	112	223	
16:15:00	116	1	0	0	117	0	0	0	0	0	0	114	0	0	114	231	
16:30:00	119	0	0	0	119	1	0	0	0	1	0	94	0	0	94	214	
16:45:00	104	0	0	0	104	0	0	0	0	0	0	109	0	0	109	213	881
17:00:00	107	1	0	0	108	2	0	0	0	2	0	107	0	0	107	217	875
17:15:00	96	0	0	0	96	0	0	0	0	0	0	126	0	0	126	222	866
17:30:00	93	0	0	0	93	1	0	0	0	1	0	92	0	0	92	186	838
17:45:00	74	2	0	0	76	0	0	0	0	0	0	118	0	0	118	194	819
Grand Total	1477	6	0	0	1483	8	1	0	1	9	0	1430	0	1	1430	**2922**	-
Approach%	99.6%	0.4%	0%		-	88.9%	11.1%	0%		-	0%	100%	0%		-	**-**	-
Totals %	50.5%	0.2%	0%		50.8%	0.3%	0%	0%		0.3%	0%	48.9%	0%		48.9%	**-**	-
Heavy	82	0	0		-	0	0	0		-	0	69	0		-	**-**	-
Heavy %	5.6%	0%	0%		-	0%	0%	0%		-	0%	4.8%	0%		-	**-**	-
Bicycles	1	0	0		-	0	0	0		-	0	3	0		-	**-**	-
Bicycle %	0.1%	0%	0%		-	0%	0%	0%		-	0%	0.2%	0%		-	**-**	-

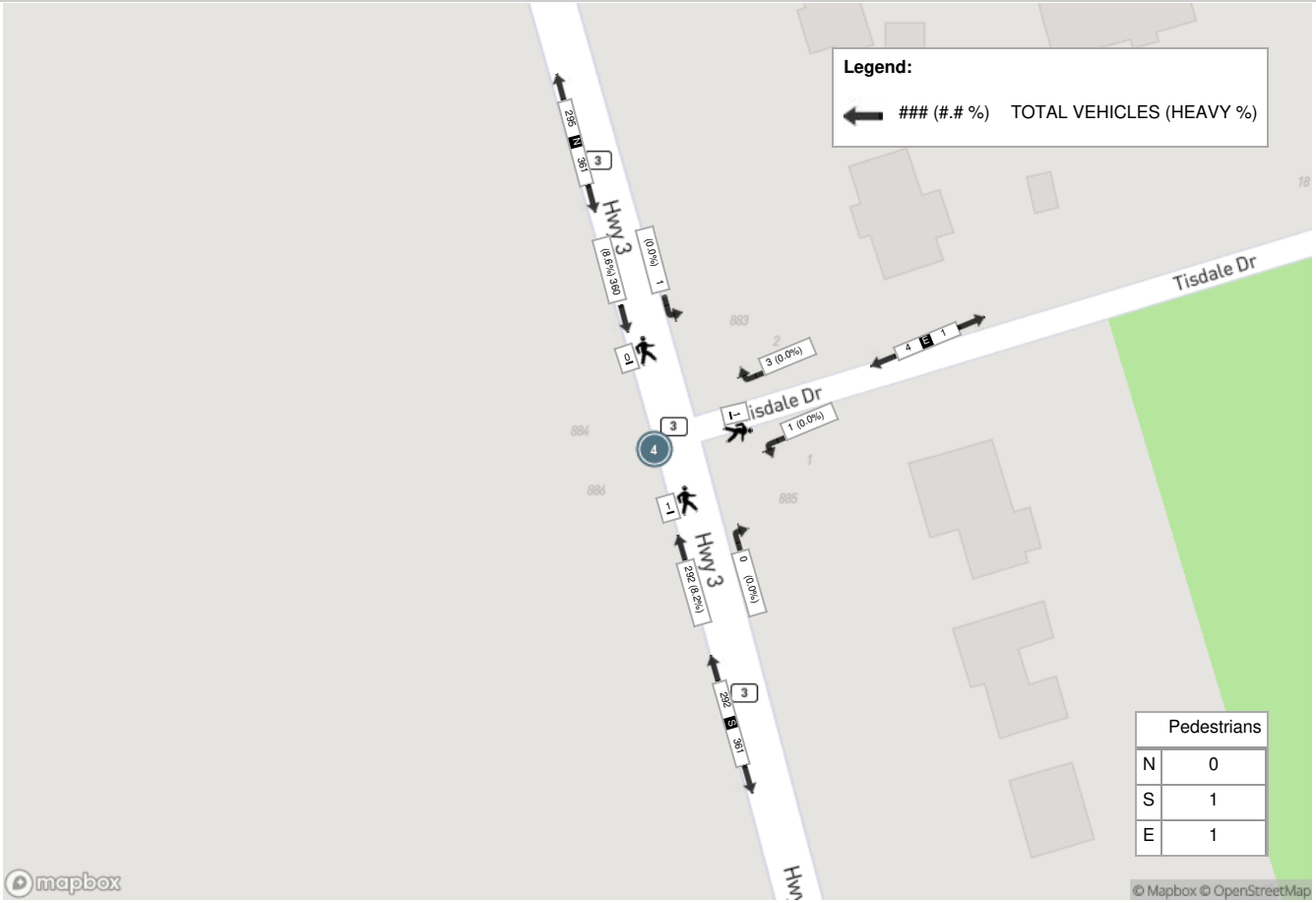
Peak Hour: 07:30 AM - 08:30 AM Weather: Overcast Clouds (9.42 °C)

Start Time	N Approach JAMES ST					E Approach TISDALE DR					S Approach JAMES ST					Int. Total (15 min)
	Thru	Left	UTurn	Peds	Approach Total	Right	Left	UTurn	Peds	Approach Total	Right	Thru	UTurn	Peds	Approach Total	
07:30:00	105	0	0	0	105	0	0	0	0	0	0	69	0	0	69	174
07:45:00	84	1	0	0	85	2	0	0	0	2	0	75	0	0	75	162
08:00:00	71	0	0	0	71	0	0	0	1	0	0	71	0	1	71	142
08:15:00	100	0	0	0	100	1	1	0	0	2	0	77	0	0	77	179
Grand Total	360	1	0	0	361	3	1	0	1	4	0	292	0	1	292	**657**
Approach%	99.7%	0.3%	0%		-	75%	25%	0%		-	0%	100%	0%		-	**-**
Totals %	54.8%	0.2%	0%		54.9%	0.5%	0.2%	0%		0.6%	0%	44.4%	0%		44.4%	**-**
PHF	0.86	0.25	0		0.86	0.38	0.25	0		0.5	0	0.95	0		0.95	**-**
Heavy	31	0	0		31	0	0	0		0	0	24	0		24	**-**
Heavy %	8.6%	0%	0%		8.6%	0%	0%	0%		0%	0%	8.2%	0%		8.2%	**-**
Lights	329	1	0		330	3	1	0		4	0	268	0		268	**-**
Lights %	91.4%	100%	0%		91.4%	100%	100%	0%		100%	0%	91.8%	0%		91.8%	**-**
Single-Unit Trucks	12	0	0		12	0	0	0		0	0	13	0		13	**-**
Single-Unit Trucks %	3.3%	0%	0%		3.3%	0%	0%	0%		0%	0%	4.5%	0%		4.5%	**-**
Buses	9	0	0		9	0	0	0		0	0	6	0		6	**-**
Buses %	2.5%	0%	0%		2.5%	0%	0%	0%		0%	0%	2.1%	0%		2.1%	**-**
Articulated Trucks	10	0	0		10	0	0	0		0	0	5	0		5	**-**
Articulated Trucks %	2.8%	0%	0%		2.8%	0%	0%	0%		0%	0%	1.7%	0%		1.7%	**-**
Pedestrians	-	-	-	0	-	-	-	-	1	-	-	-	-	1	-	**-**
Pedestrians%	-	-	-	0%		-	-	-	50%		-	-	-	50%		**-**
Bicycles on Road	0	0	0	0	-	0	0	0	0	-	0	1	0	0	-	**-**
Bicycles on Road%	-	-	-	0%		-	-	-	0%		-	-	-	0%		**-**

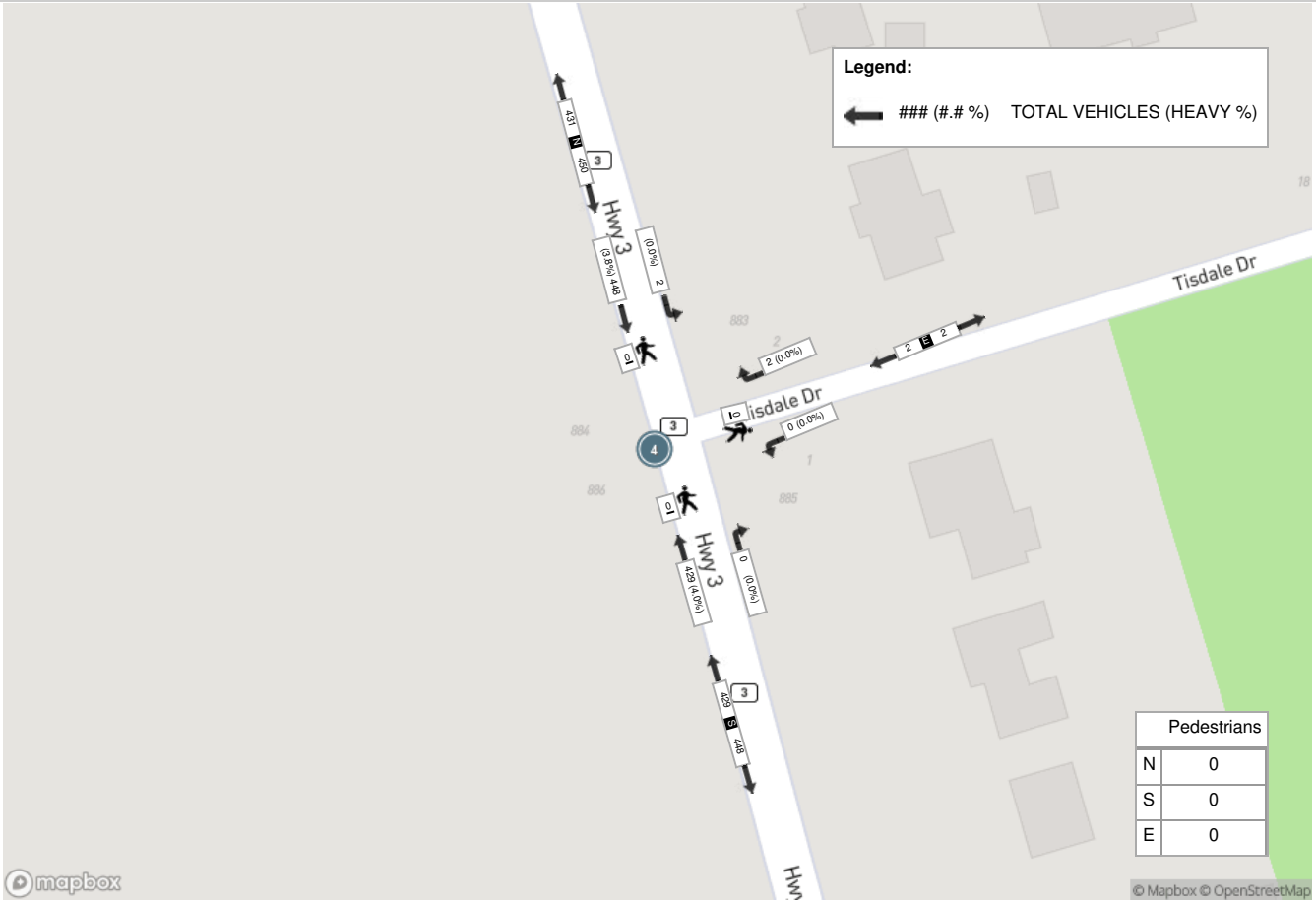
Peak Hour: 04:00 PM - 05:00 PM Weather: Overcast Clouds (21.08 °C)

Start Time	N Approach JAMES ST					E Approach TISDALE DR					S Approach JAMES ST					Int. Total (15 min)
	Thru	Left	UTurn	Peds	Approach Total	Right	Left	UTurn	Peds	Approach Total	Right	Thru	UTurn	Peds	Approach Total	
16:00:00	109	1	0	0	110	1	0	0	0	1	0	112	0	0	112	223
16:15:00	116	1	0	0	117	0	0	0	0	0	0	114	0	0	114	231
16:30:00	119	0	0	0	119	1	0	0	0	1	0	94	0	0	94	214
16:45:00	104	0	0	0	104	0	0	0	0	0	0	109	0	0	109	213
Grand Total	448	2	0	0	450	2	0	0	0	2	0	429	0	0	429	**881**
Approach%	99.6%	0.4%	0%		-	100%	0%	0%		-	0%	100%	0%		-	**-**
Totals %	50.9%	0.2%	0%		51.1%	0.2%	0%	0%		0.2%	0%	48.7%	0%		48.7%	**-**
PHF	0.94	0.5	0		0.95	0.5	0	0		0.5	0	0.94	0		0.94	**-**
Heavy	17	0	0		17	0	0	0		0	0	17	0		17	**-**
Heavy %	3.8%	0%	0%		3.8%	0%	0%	0%		0%	0%	4%	0%		4%	**-**
Lights	431	2	0		433	2	0	0		2	0	412	0		412	**-**
Lights %	96.2%	100%	0%		96.2%	100%	0%	0%		100%	0%	96%	0%		96%	**-**
Single-Unit Trucks	9	0	0		9	0	0	0		0	0	6	0		6	**-**
Single-Unit Trucks %	2%	0%	0%		2%	0%	0%	0%		0%	0%	1.4%	0%		1.4%	**-**
Buses	1	0	0		1	0	0	0		0	0	2	0		2	**-**
Buses %	0.2%	0%	0%		0.2%	0%	0%	0%		0%	0%	0.5%	0%		0.5%	**-**
Articulated Trucks	7	0	0		7	0	0	0		0	0	9	0		9	**-**
Articulated Trucks %	1.6%	0%	0%		1.6%	0%	0%	0%		0%	0%	2.1%	0%		2.1%	**-**
Pedestrians	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	**-**
Pedestrians%	-	-	-	0%		-	-	-	0%		-	-	-	0%		**-**
Bicycles on Road	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	**-**
Bicycles on Road%	-	-	-	0%		-	-	-	0%		-	-	-	0%		**-**

Peak Hour: 07:30 AM - 08:30 AM Weather: Overcast Clouds (9.42 °C)



Peak Hour: 04:00 PM - 05:00 PM Weather: Overcast Clouds (21.08 °C)



Spectrum

Turning Movement Count
Location Name: JAMES ST & WILSON AVE
Date: Wed, May 25, 2022 Deployment Lead:

BA Group
300 45 ST. CLAIR AVE W
TORONTO ONTARIO, M4V 1K9
CANADA

Turning Movement Count (5 . JAMES ST & WILSON AVE)

Start Time	N Approach JAMES ST					E Approach WILSON AVE					S Approach JAMES ST					Int. Total (15 min)	Int. Total (1 hr)
	Thru N:S	Left N:E	UTurn N:N	Peds N:	Approach Total	Right E:N	Left E:S	UTurn E:E	Peds E:	Approach Total	Right S:E	Thru S:N	UTurn S:S	Peds S:	Approach Total		
07:00:00	63	4	0	0	67	5	5	0	0	10	5	43	0	0	48	125	
07:15:00	67	5	0	0	72	6	3	0	1	9	4	58	0	0	62	143	
07:30:00	105	4	0	0	109	5	5	0	1	10	2	68	0	0	70	189	
07:45:00	80	8	0	0	88	13	7	0	1	20	5	77	0	0	82	190	647
08:00:00	71	5	0	0	76	4	2	0	0	6	2	73	0	0	75	157	679
08:15:00	104	7	0	1	111	9	3	0	0	12	4	71	0	0	75	198	734
08:30:00	98	4	0	0	102	13	3	0	1	16	4	70	0	0	74	192	737
08:45:00	78	16	0	0	94	7	6	0	2	13	3	95	0	0	98	205	752
BREAK																	
16:00:00	125	10	0	0	135	8	4	0	1	12	9	118	0	0	127	274	
16:15:00	113	9	0	1	122	8	5	0	0	13	7	108	0	0	115	250	
16:30:00	109	13	0	1	122	10	5	0	0	15	6	96	0	0	102	239	
16:45:00	103	14	0	0	117	12	4	0	0	16	5	112	0	0	117	250	1013
17:00:00	99	6	0	1	105	12	5	0	1	17	4	109	0	0	113	235	974
17:15:00	107	9	0	0	116	9	1	0	0	10	2	118	0	0	120	246	970
17:30:00	87	4	0	1	91	13	9	0	1	22	2	93	0	0	95	208	939
17:45:00	82	5	0	0	87	21	10	0	1	31	4	93	0	0	97	215	904
Grand Total	1491	123	0	5	1614	155	77	0	10	232	68	1402	0	0	1470	**3316**	-
Approach%	92.4%	7.6%	0%		-	66.8%	33.2%	0%		-	4.6%	95.4%	0%		-	**-**	-
Totals %	45%	3.7%	0%		48.7%	4.7%	2.3%	0%		7%	2.1%	42.3%	0%		44.3%	**-**	-
Heavy	79	3	0		-	1	3	0		-	4	69	0		-	**-**	-
Heavy %	5.3%	2.4%	0%		-	0.6%	3.9%	0%		-	5.9%	4.9%	0%		-	**-**	-
Bicycles	0	1	0		-	0	0	0		-	0	0	0		-	**-**	-
Bicycle %	0%	0.8%	0%		-	0%	0%	0%		-	0%	0%	0%		-	**-**	-

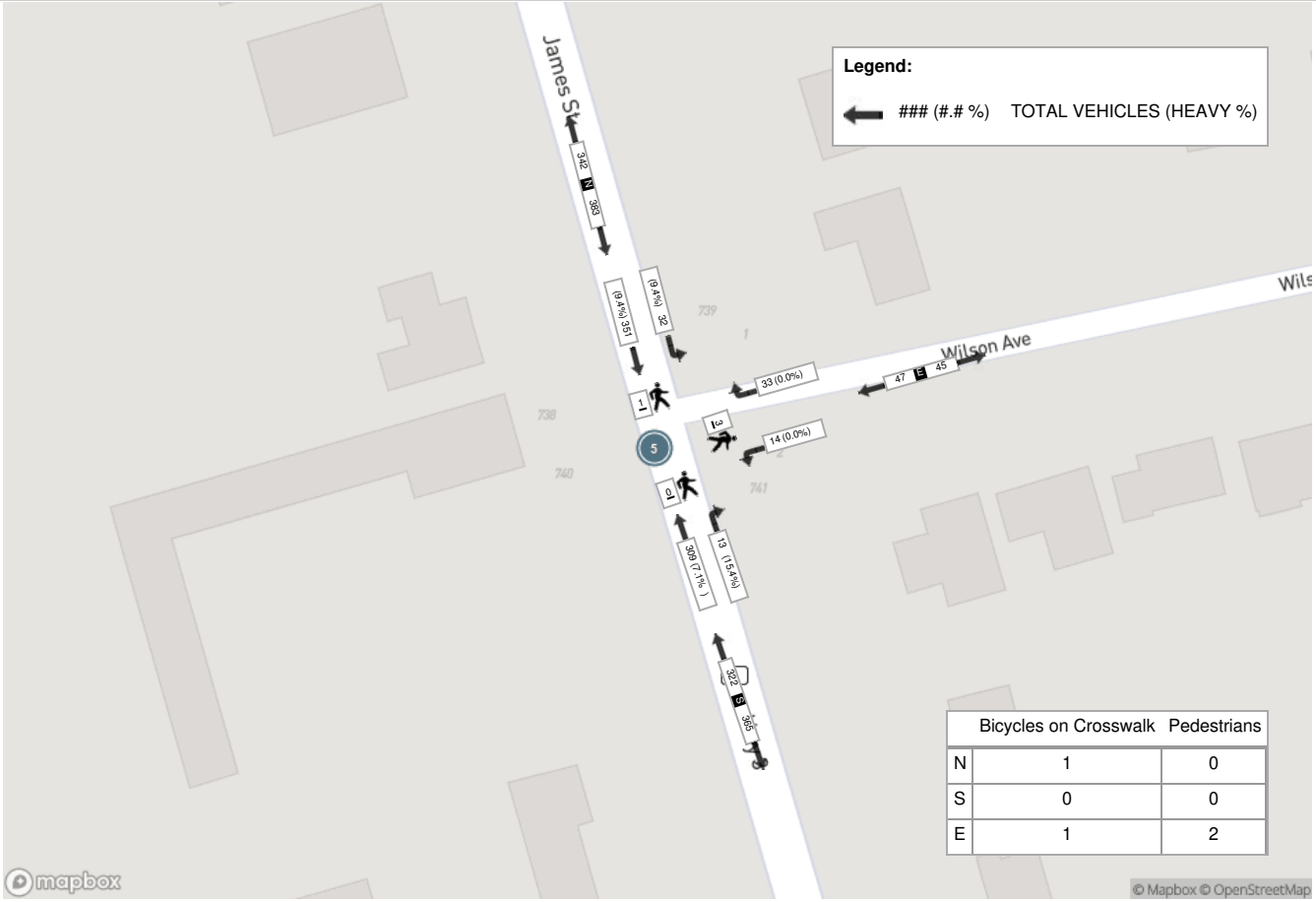
Peak Hour: 08:00 AM - 09:00 AM Weather: Overcast Clouds (9.42 °C)

Start Time	N Approach JAMES ST					E Approach WILSON AVE					S Approach JAMES ST					Int. Total (15 min)
	Thru	Left	UTurn	Peds	Approach Total	Right	Left	UTurn	Peds	Approach Total	Right	Thru	UTurn	Peds	Approach Total	
08:00:00	71	5	0	0	76	4	2	0	0	6	2	73	0	0	75	157
08:15:00	104	7	0	1	111	9	3	0	0	12	4	71	0	0	75	198
08:30:00	98	4	0	0	102	13	3	0	1	16	4	70	0	0	74	192
08:45:00	78	16	0	0	94	7	6	0	2	13	3	95	0	0	98	205
Grand Total	351	32	0	1	383	33	14	0	3	47	13	309	0	0	322	**752**
Approach%	91.6%	8.4%	0%		-	70.2%	29.8%	0%		-	4%	96%	0%		-	**-**
Totals %	46.7%	4.3%	0%		50.9%	4.4%	1.9%	0%		6.3%	1.7%	41.1%	0%		42.8%	**-**
PHF	0.84	0.5	0		0.86	0.63	0.58	0		0.73	0.81	0.81	0		0.82	**-**
Heavy	33	3	0		36	0	0	0		0	2	22	0		24	**-**
Heavy %	9.4%	9.4%	0%		9.4%	0%	0%	0%		0%	15.4%	7.1%	0%		7.5%	**-**
Lights	318	29	0		347	33	14	0		47	11	287	0		298	**-**
Lights %	90.6%	90.6%	0%		90.6%	100%	100%	0%		100%	84.6%	92.9%	0%		92.5%	**-**
Single-Unit Trucks	12	1	0		13	0	0	0		0	1	9	0		10	**-**
Single-Unit Trucks %	3.4%	3.1%	0%		3.4%	0%	0%	0%		0%	7.7%	2.9%	0%		3.1%	**-**
Buses	7	1	0		8	0	0	0		0	1	6	0		7	**-**
Buses %	2%	3.1%	0%		2.1%	0%	0%	0%		0%	7.7%	1.9%	0%		2.2%	**-**
Articulated Trucks	14	1	0		15	0	0	0		0	0	7	0		7	**-**
Articulated Trucks %	4%	3.1%	0%		3.9%	0%	0%	0%		0%	0%	2.3%	0%		2.2%	**-**
Pedestrians	-	-	-	0	-	-	-	-	2	-	-	-	-	0	-	**-**
Pedestrians%	-	-	-	0%		-	-	-	50%		-	-	-	0%		**-**
Bicycles on Crosswalk	-	-	-	1	-	-	-	-	1	-	-	-	-	0	-	**-**
Bicycles on Crosswalk%	-	-	-	25%		-	-	-	25%		-	-	-	0%		**-**
Bicycles on Road	0	1	0	0	-	0	0	0	0	-	0	0	0	0	-	**-**
Bicycles on Road%	-	-	-	0%		-	-	-	0%		-	-	-	0%		**-**

Peak Hour: 04:00 PM - 05:00 PM Weather: Overcast Clouds (21.08 °C)

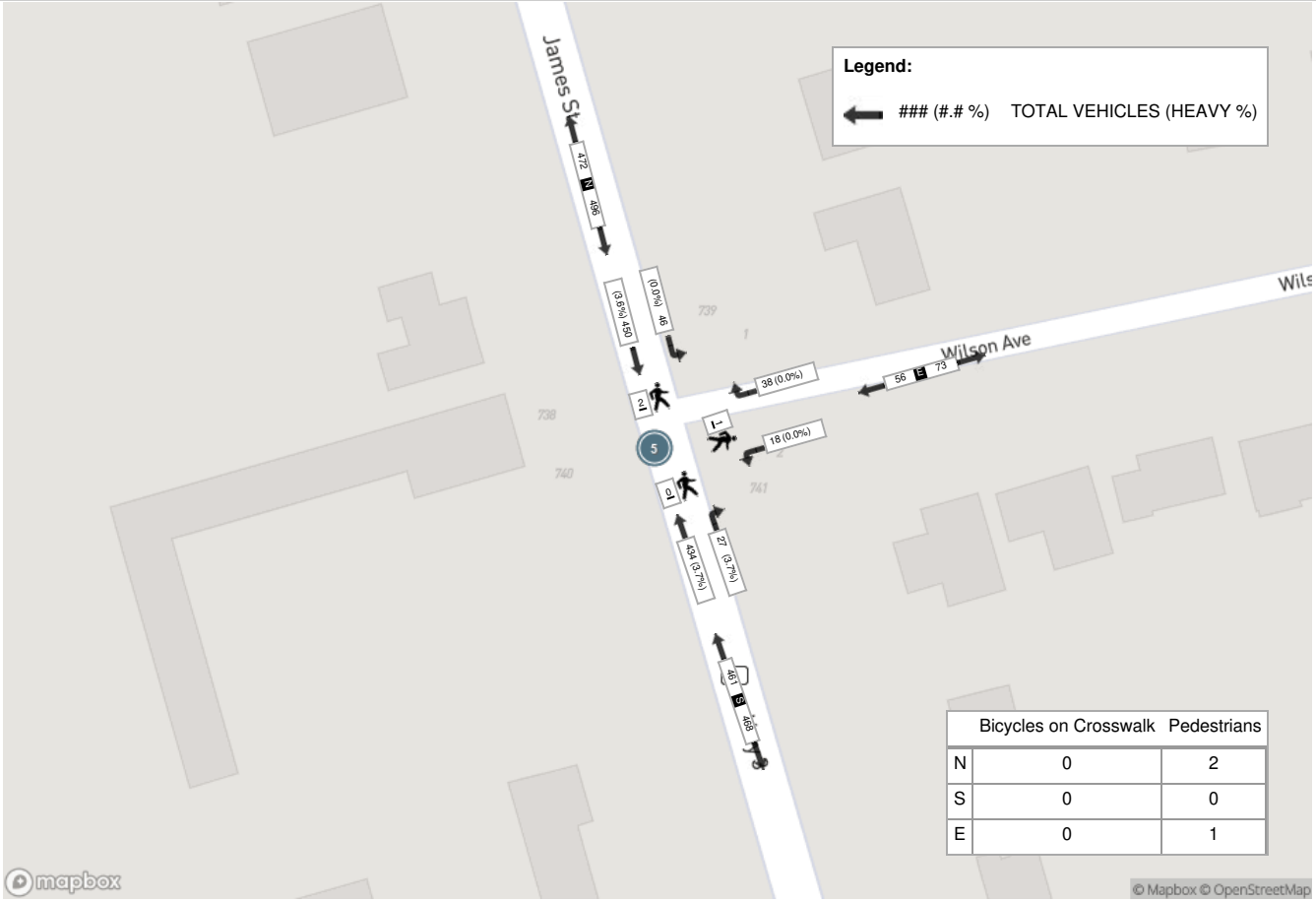
Start Time	N Approach JAMES ST					E Approach WILSON AVE					S Approach JAMES ST					Int. Total (15 min)
	Thru	Left	UTurn	Peds	Approach Total	Right	Left	UTurn	Peds	Approach Total	Right	Thru	UTurn	Peds	Approach Total	
16:00:00	125	10	0	0	135	8	4	0	1	12	9	118	0	0	127	274
16:15:00	113	9	0	1	122	8	5	0	0	13	7	108	0	0	115	250
16:30:00	109	13	0	1	122	10	5	0	0	15	6	96	0	0	102	239
16:45:00	103	14	0	0	117	12	4	0	0	16	5	112	0	0	117	250
Grand Total	450	46	0	2	496	38	18	0	1	56	27	434	0	0	461	**1013**
Approach%	90.7%	9.3%	0%		-	67.9%	32.1%	0%		-	5.9%	94.1%	0%		-	**-**
Totals %	44.4%	4.5%	0%		49%	3.8%	1.8%	0%		5.5%	2.7%	42.8%	0%		45.5%	**-**
PHF	0.9	0.82	0		0.92	0.79	0.9	0		0.88	0.75	0.92	0		0.91	**-**
Heavy	16	0	0		16	0	0	0		0	1	16	0		17	**-**
Heavy %	3.6%	0%	0%		3.2%	0%	0%	0%		0%	3.7%	3.7%	0%		3.7%	**-**
Lights	434	46	0		480	38	18	0		56	26	418	0		444	**-**
Lights %	96.4%	100%	0%		96.8%	100%	100%	0%		100%	96.3%	96.3%	0%		96.3%	**-**
Single-Unit Trucks	9	0	0		9	0	0	0		0	0	6	0		6	**-**
Single-Unit Trucks %	2%	0%	0%		1.8%	0%	0%	0%		0%	0%	1.4%	0%		1.3%	**-**
Buses	1	0	0		1	0	0	0		0	1	1	0		2	**-**
Buses %	0.2%	0%	0%		0.2%	0%	0%	0%		0%	3.7%	0.2%	0%		0.4%	**-**
Articulated Trucks	6	0	0		6	0	0	0		0	0	9	0		9	**-**
Articulated Trucks %	1.3%	0%	0%		1.2%	0%	0%	0%		0%	0%	2.1%	0%		2%	**-**
Pedestrians	-	-	-	2	-	-	-	-	1	-	-	-	-	0	-	**-**
Pedestrians%	-	-	-	66.7%		-	-	-	33.3%		-	-	-	0%		**-**
Bicycles on Crosswalk	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	**-**
Bicycles on Crosswalk%	-	-	-	0%		-	-	-	0%		-	-	-	0%		**-**
Bicycles on Road	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	**-**
Bicycles on Road%	-	-	-	0%		-	-	-	0%		-	-	-	0%		**-**

Peak Hour: 08:00 AM - 09:00 AM Weather: Overcast Clouds (9.42 °C)



	Bicycles on Crosswalk	Pedestrians
N	1	0
S	0	0
E	1	2

Peak Hour: 04:00 PM - 05:00 PM Weather: Overcast Clouds (21.08 °C)



	Bicycles on Crosswalk	Pedestrians
N	0	2
S	0	0
E	0	1

Spectrum

Turning Movement Count
Location Name: VIOLA CT & ST MICHAELS ST
Date: Wed, May 25, 2022 Deployment Lead:

BA Group
300 45 ST. CLAIR AVE W
TORONTO ONTARIO, M4V 1K9
CANADA

Turning Movement Count (8 . VIOLA CT & ST MICHAELS ST)

Start Time	N Approach VIOLA CT						E Approach ST MICHAELS ST						S Approach VIOLA CT						W Approach ST MICHAELS ST						Int. Total (15 min)	Int. Total (1 hr)
	Right N:W	Thru N:S	Left N:E	UTurn N:N	Peds N:	Approach Total	Right E:N	Thru E:W	Left E:S	UTurn E:E	Peds E:	Approach Total	Right S:E	Thru S:N	Left S:W	UTurn S:S	Peds S:	Approach Total	Right W:S	Thru W:E	Left W:N	UTurn W:W	Peds W:	Approach Total		
07:00:00	0	1	0	0	0	1	1	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	3	
07:15:00	0	1	1	0	3	2	0	0	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0	0	5	
07:30:00	1	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	3	
07:45:00	1	0	1	0	0	2	3	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	5	16
08:00:00	1	0	0	0	1	1	1	1	0	0	0	2	0	2	0	0	0	2	0	0	1	0	1	1	6	19
08:15:00	0	0	1	0	0	1	1	2	0	0	1	3	0	0	0	0	0	0	0	0	0	0	1	0	4	18
08:30:00	1	0	1	0	0	2	2	0	1	0	0	3	0	2	0	0	0	2	0	1	0	0	0	1	8	23
08:45:00	0	0	3	0	0	3	1	0	0	0	0	1	0	1	0	0	0	1	0	1	0	0	0	1	6	24
BREAK																										
16:00:00	0	0	1	0	0	1	1	0	0	0	0	1	0	1	0	0	0	1	0	0	2	0	0	2	5	
16:15:00	0	0	1	0	1	1	1	1	0	0	0	2	0	0	0	0	0	0	0	0	1	0	1	1	4	
16:30:00	2	0	4	0	0	6	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	1	8	
16:45:00	0	4	3	0	0	7	1	0	1	0	0	2	0	2	0	0	0	2	0	0	0	0	0	0	11	28
17:00:00	2	0	0	0	0	2	0	1	0	0	0	1	0	3	0	0	0	3	0	0	0	0	0	0	6	29
17:15:00	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	2	27
17:30:00	1	0	1	0	0	2	3	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	5	24
17:45:00	0	1	1	0	0	2	1	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	4	17
Grand Total	10	7	18	0	5	35	16	6	2	0	1	24	0	18	0	0	0	18	1	2	5	0	3	8	**85**	-
Approach%	28.6%	20%	51.4%	0%		-	66.7%	25%	8.3%	0%		-	0%	100%	0%	0%		-	12.5%	25%	62.5%	0%		-	**-**	-
Totals %	11.8%	8.2%	21.2%	0%		41.2%	18.8%	7.1%	2.4%	0%		28.2%	0%	21.2%	0%	0%		21.2%	1.2%	2.4%	5.9%	0%		9.4%	**-**	-
Heavy	2	0	1	0		-	0	0	0	0		-	0	0	0	0		-	0	0	0	0		-	**-**	-
Heavy %	20%	0%	5.6%	0%		-	0%	0%	0%	0%		-	0%	0%	0%	0%		-	0%	0%	0%	0%		-	**-**	-
Bicycles	0	0	0	0		-	1	0	0	0		-	0	0	0	0		-	0	1	0	0		-	**-**	-
Bicycle %	0%	0%	0%	0%		-	6.3%	0%	0%	0%		-	0%	0%	0%	0%		-	0%	50%	0%	0%		-	**-**	-

Spectrum

Turning Movement Count
Location Name: VIOLA CT & ST MICHAELS ST
Date: Wed, May 25, 2022 Deployment Lead:

BA Group
300 45 ST. CLAIR AVE W
TORONTO ONTARIO, M4V 1K9
CANADA

Peak Hour: 08:00 AM - 09:00 AM Weather: Overcast Clouds (9.42 °C)

Start Time	N Approach VIOLA CT						E Approach ST MICHAELS ST						S Approach VIOLA CT						W Approach ST MICHAELS ST						Int. Total (15 min)
	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	
08:00:00	1	0	0	0	1	1	1	1	0	0	0	2	0	2	0	0	0	2	0	0	1	0	1	1	6
08:15:00	0	0	1	0	0	1	1	2	0	0	1	3	0	0	0	0	0	0	0	0	0	0	1	0	4
08:30:00	1	0	1	0	0	2	2	0	1	0	0	3	0	2	0	0	0	2	0	1	0	0	0	1	8
08:45:00	0	0	3	0	0	3	1	0	0	0	0	1	0	1	0	0	0	1	0	1	0	0	0	1	6
Grand Total	2	0	5	0	1	7	5	3	1	0	1	9	0	5	0	0	0	5	0	2	1	0	2	3	**24**
Approach%	28.6%	0%	71.4%	0%		-	55.6%	33.3%	11.1%	0%		-	0%	100%	0%	0%		-	0%	66.7%	33.3%	0%		-	**-**
Totals %	8.3%	0%	20.8%	0%		29.2%	20.8%	12.5%	4.2%	0%		37.5%	0%	20.8%	0%	0%		20.8%	0%	8.3%	4.2%	0%		12.5%	**-**
PHF	0.5	0	0.42	0		0.58	0.63	0.38	0.25	0		0.75	0	0.63	0	0		0.63	0	0.5	0.25	0		0.75	**-**
Heavy	1	0	1	0		2	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	**-**
Heavy %	50%	0%	20%	0%		28.6%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	**-**
Lights	1	0	4	0		5	5	3	1	0		9	0	5	0	0		5	0	2	1	0		3	**-**
Lights %	50%	0%	80%	0%		71.4%	100%	100%	100%	0%		100%	0%	100%	0%	0%		100%	0%	100%	100%	0%		100%	**-**
Buses	1	0	0	0		1	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	**-**
Buses %	50%	0%	0%	0%		14.3%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	**-**
Articulated Trucks	0	0	1	0		1	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	**-**
Articulated Trucks %	0%	0%	20%	0%		14.3%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	**-**
Pedestrians	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	0	-	-	-	-	-	2	-	**-**
Pedestrians%	-	-	-	-	25%		-	-	-	-	25%		-	-	-	-	0%		-	-	-	-	50%		**-**
Bicycles on Road	0	0	0	0	0	-	1	0	0	0	0	-	0	0	0	0	0	-	0	1	0	0	0	-	**-**
Bicycles on Road%	-	-	-	-	0%		-	-	-	-	0%		-	-	-	-	0%		-	-	-	-	0%		**-**

Spectrum

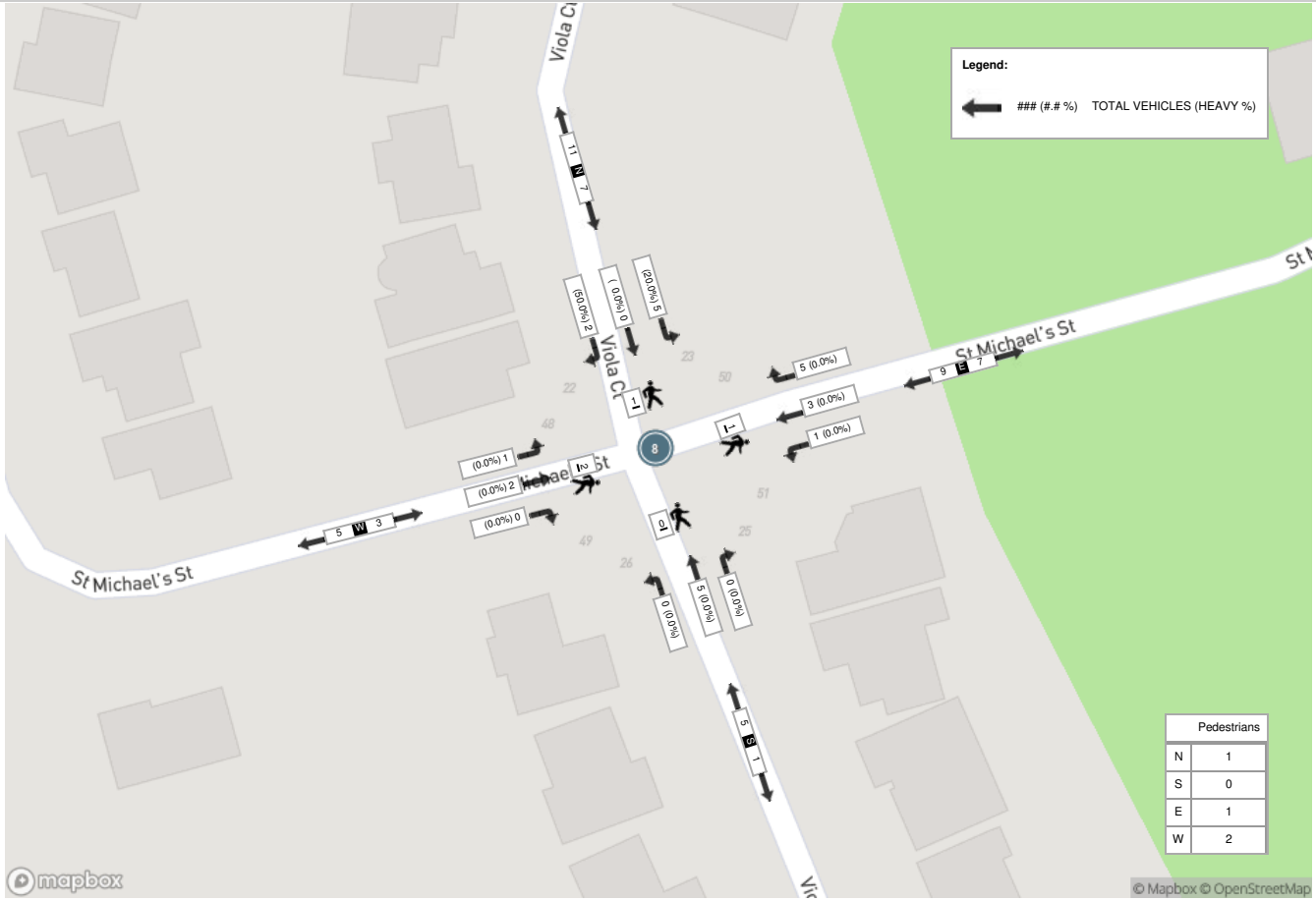
Turning Movement Count
Location Name: VIOLA CT & ST MICHAELS ST
Date: Wed, May 25, 2022 Deployment Lead:

BA Group
300 45 ST. CLAIR AVE W
TORONTO ONTARIO, M4V 1K9
CANADA

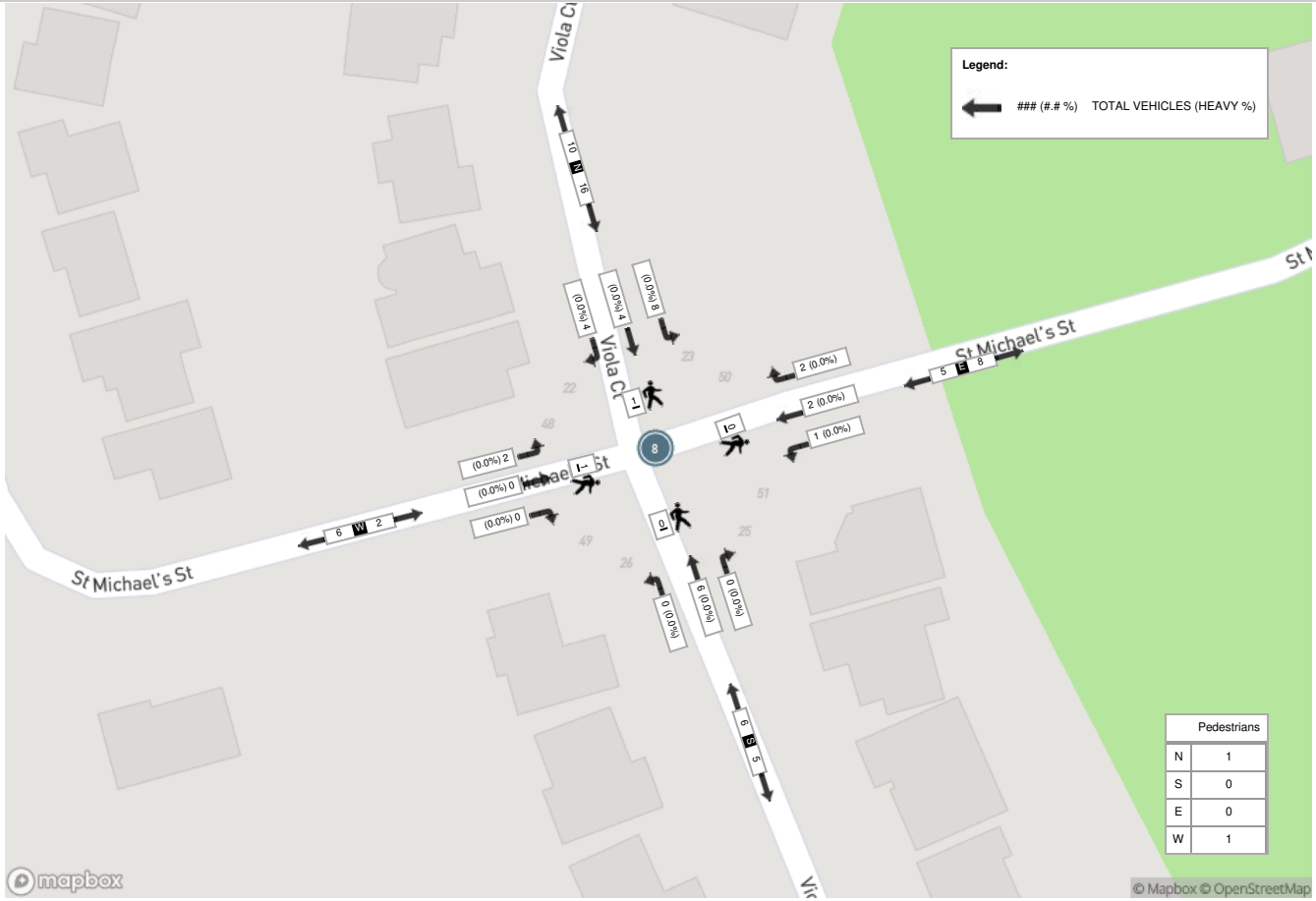
Peak Hour: 04:15 PM - 05:15 PM Weather: Overcast Clouds (21.08 °C)

Start Time	N Approach VIOLA CT						E Approach ST MICHAELS ST						S Approach VIOLA CT						W Approach ST MICHAELS ST						Int. Total (15 min)
	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	
16:15:00	0	0	1	0	1	1	1	1	0	0	0	2	0	0	0	0	0	0	0	0	1	0	1	1	4
16:30:00	2	0	4	0	0	6	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	1	8
16:45:00	0	4	3	0	0	7	1	0	1	0	0	2	0	2	0	0	0	2	0	0	0	0	0	0	11
17:00:00	2	0	0	0	0	2	0	1	0	0	0	1	0	3	0	0	0	3	0	0	0	0	0	0	6
Grand Total	4	4	8	0	1	16	2	2	1	0	0	5	0	6	0	0	0	6	0	0	2	0	1	2	**29**
Approach%	25%	25%	50%	0%		-	40%	40%	20%	0%		-	0%	100%	0%	0%		-	0%	0%	100%	0%		-	**-**
Totals %	13.8%	13.8%	27.6%	0%		55.2%	6.9%	6.9%	3.4%	0%		17.2%	0%	20.7%	0%	0%		20.7%	0%	0%	6.9%	0%		6.9%	**-**
PHF	0.5	0.25	0.5	0		0.57	0.5	0.5	0.25	0		0.63	0	0.5	0	0		0.5	0	0	0.5	0		0.5	**-**
Heavy	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	**-**
Heavy %	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	**-**
Lights	4	4	8	0		16	2	2	1	0		5	0	6	0	0		6	0	0	2	0		2	**-**
Lights %	100%	100%	100%	0%		100%	100%	100%	100%	0%		100%	0%	100%	0%	0%		100%	0%	0%	100%	0%		100%	**-**
Buses	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	**-**
Buses %	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	**-**
Articulated Trucks	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	**-**
Articulated Trucks %	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	**-**
Pedestrians	-	-	-	-	1	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	1	-	**-**
Pedestrians%	-	-	-	-	50%		-	-	-	-	0%		-	-	-	-	0%		-	-	-	-	50%		**-**
Bicycles on Road	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	**-**
Bicycles on Road%	-	-	-	-	0%		-	-	-	-	0%		-	-	-	-	0%		-	-	-	-	0%		**-**

Peak Hour: 08:00 AM - 09:00 AM **Weather: Overcast Clouds (9.42 °C)**



Peak Hour: 04:15 PM - 05:15 PM **Weather: Overcast Clouds (21.08 °C)**



Spectrum

Turning Movement Count
Location Name: WILSON AVE & ST MICHAELS ST
Date: Wed, May 25, 2022 Deployment Lead:

BA Group
300 45 ST. CLAIR AVE W
TORONTO ONTARIO, M4V 1K9
CANADA

Turning Movement Count (6 . WILSON AVE & ST MICHAELS ST)

Start Time	E Approach WILSON AVE						S Approach ST MICHAELS ST						W Approach WILSON AVE						N Approach PEEL ST						Int. Total (15 min)	Int. Total (1 hr)
	Right E:N	Thru E:W	Left E:S	UTurn E:E	Peds E:	Approach Total	Right S:E	Thru S:N	Left S:W	UTurn S:S	Peds S:	Approach Total	Right W:S	Thru W:E	Left W:N	UTurn W:W	Peds W:	Approach Total	Right N:W	Thru N:S	Left N:E	UTurn N:N	Peds N:	Approach Total		
07:00:00	0	6	0	0	0	6	1	0	4	0	0	5	0	8	1	0	0	9	0	0	0	0	0	0	20	
07:15:00	0	6	0	0	0	6	1	0	2	0	2	3	2	7	0	0	2	9	3	0	0	0	0	3	21	
07:30:00	0	7	0	0	0	7	1	0	1	0	0	2	0	6	0	0	1	6	1	0	1	0	1	2	17	
07:45:00	0	15	0	0	0	15	6	0	3	0	0	9	1	12	0	0	1	13	1	0	0	0	0	1	38	96
08:00:00	0	5	1	0	1	6	2	1	0	0	2	3	1	5	2	0	2	8	1	0	0	0	0	1	18	94
08:15:00	0	8	1	0	0	9	0	0	2	0	0	2	1	12	0	0	1	13	2	0	0	0	0	2	26	99
08:30:00	0	16	0	0	0	16	1	0	0	0	0	1	2	6	1	0	2	9	0	0	0	0	0	0	26	108
08:45:00	0	13	0	0	0	13	1	0	0	0	0	1	2	17	0	0	0	19	3	0	0	0	0	3	36	106
BREAK																										
16:00:00	0	10	0	0	0	10	0	0	0	0	0	0	2	15	0	0	1	17	3	0	2	0	0	5	32	
16:15:00	1	10	0	0	0	11	0	0	2	0	0	2	3	12	0	0	0	15	0	0	0	0	0	0	28	
16:30:00	1	15	1	0	0	17	0	0	0	0	1	0	2	17	0	0	1	19	0	0	0	0	0	0	36	
16:45:00	2	16	0	0	0	18	0	0	1	0	0	1	2	17	0	0	0	19	0	0	0	0	0	0	38	134
17:00:00	2	14	1	0	0	17	0	0	2	0	0	2	6	4	0	0	0	10	2	0	0	0	0	2	31	133
17:15:00	0	7	3	0	0	10	1	0	1	0	0	2	4	7	0	0	0	11	1	0	0	0	0	1	24	129
17:30:00	0	14	1	0	0	15	2	0	4	0	0	6	1	5	0	0	0	6	1	0	1	0	0	2	29	122
17:45:00	0	23	1	0	0	24	0	0	4	0	0	4	0	6	2	1	0	9	1	0	0	0	0	1	38	122
Grand Total	6	185	9	0	1	200	16	1	26	0	5	43	29	156	6	1	11	192	19	0	4	0	1	23	**458**	-
Approach%	3%	92.5%	4.5%	0%		-	37.2%	2.3%	60.5%	0%		-	15.1%	81.3%	3.1%	0.5%		-	82.6%	0%	17.4%	0%		-	-	-
Totals %	1.3%	40.4%	2%	0%		43.7%	3.5%	0.2%	5.7%	0%		9.4%	6.3%	34.1%	1.3%	0.2%		41.9%	4.1%	0%	0.9%	0%		5%	-	-
Heavy	0	1	0	0		-	0	1	1	0		-	0	5	2	0		-	2	0	1	0		-	-	-
Heavy %	0%	0.5%	0%	0%		-	0%	100%	3.8%	0%		-	0%	3.2%	33.3%	0%		-	10.5%	0%	25%	0%		-	-	-
Bicycles	0	5	0	0		-	0	1	0	0		-	1	1	0	0		-	0	2	0	0		-	-	-
Bicycle %	0%	2.7%	0%	0%		-	0%	100%	0%	0%		-	3.4%	0.6%	0%	0%		-	0%	0%	0%	0%		-	-	-

Peak Hour: 07:45 AM - 08:45 AM Weather: Overcast Clouds (9.42 °C)

Start Time	E Approach WILSON AVE						S Approach ST MICHAELS ST						W Approach WILSON AVE						N Approach PEEL ST						Int. Total (15 min)
	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	
07:45:00	0	15	0	0	0	15	6	0	3	0	0	9	1	12	0	0	1	13	1	0	0	0	0	1	38
08:00:00	0	5	1	0	1	6	2	1	0	0	2	3	1	5	2	0	2	8	1	0	0	0	0	1	18
08:15:00	0	8	1	0	0	9	0	0	2	0	0	2	1	12	0	0	1	13	2	0	0	0	0	2	26
08:30:00	0	16	0	0	0	16	1	0	0	0	0	1	2	6	1	0	2	9	0	0	0	0	0	0	26
Grand Total	0	44	2	0	1	46	9	1	5	0	2	15	5	35	3	0	6	43	4	0	0	0	0	4	**108**
Approach%	0%	95.7%	4.3%	0%		-	60%	6.7%	33.3%	0%		-	11.6%	81.4%	7%	0%		-	100%	0%	0%	0%		-	**-**
Totals %	0%	40.7%	1.9%	0%		42.6%	8.3%	0.9%	4.6%	0%		13.9%	4.6%	32.4%	2.8%	0%		39.8%	3.7%	0%	0%	0%		3.7%	**-**
PHF	0	0.69	0.5	0		0.72	0.38	0.25	0.42	0		0.42	0.63	0.73	0.38	0		0.83	0.5	0	0	0		0.5	**-**
Heavy	0	1	0	0		1	0	1	0	0		1	0	2	2	0		4	1	0	0	0		1	**-**
Heavy %	0%	2.3%	0%	0%		2.2%	0%	100%	0%	0%		6.7%	0%	5.7%	66.7%	0%		9.3%	25%	0%	0%	0%		25%	**-**
Lights	0	43	2	0		45	9	0	5	0		14	5	33	1	0		39	3	0	0	0		3	**-**
Lights %	0%	97.7%	100%	0%		97.8%	100%	0%	100%	0%		93.3%	100%	94.3%	33.3%	0%		90.7%	75%	0%	0%	0%		75%	**-**
Single-Unit Trucks	0	0	0	0		0	0	0	0	0		0	0	1	0	0		1	0	0	0	0		0	**-**
Single-Unit Trucks %	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	2.9%	0%	0%		2.3%	0%	0%	0%	0%		0%	**-**
Buses	0	1	0	0		1	0	1	0	0		1	0	1	2	0		3	1	0	0	0		1	**-**
Buses %	0%	2.3%	0%	0%		2.2%	0%	100%	0%	0%		6.7%	0%	2.9%	66.7%	0%		7%	25%	0%	0%	0%		25%	**-**
Articulated Trucks	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	**-**
Articulated Trucks %	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	**-**
Pedestrians	-	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	6	-	-	-	-	-	0	-	**-**
Pedestrians%	-	-	-	-	11.1%		-	-	-	-	22.2%		-	-	-	-	66.7%		-	-	-	-	0%		**-**
Bicycles on Road	0	1	0	0	0	-	0	1	0	0	0	-	1	0	0	0	0	-	0	0	0	0	0	-	**-**
Bicycles on Road%	-	-	-	-	0%		-	-	-	-	0%		-	-	-	-	0%		-	-	-	-	0%		**-**

Spectrum

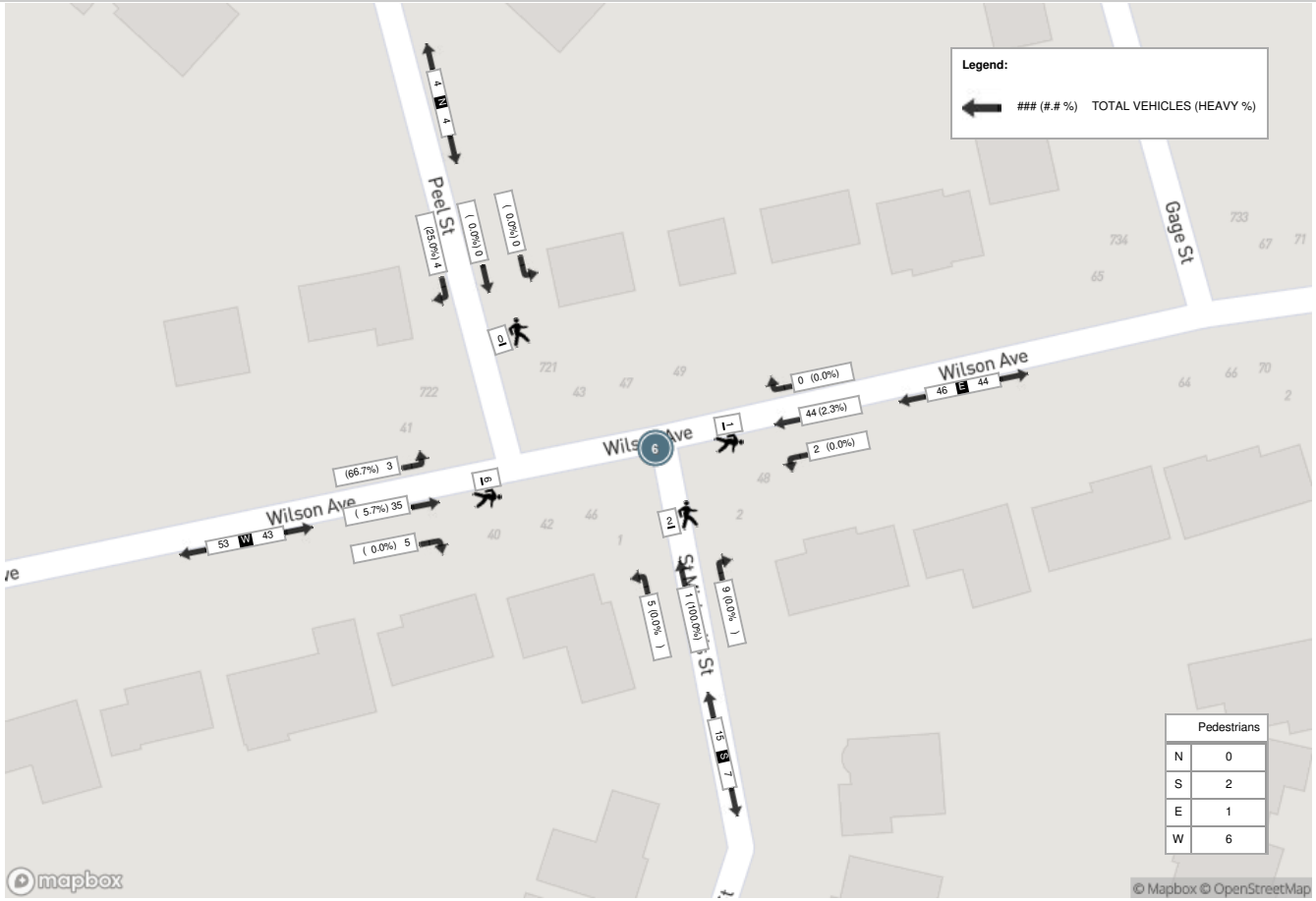
Turning Movement Count
Location Name: WILSON AVE & ST MICHAELS ST
Date: Wed, May 25, 2022 Deployment Lead:

BA Group
300 45 ST. CLAIR AVE W
TORONTO ONTARIO, M4V 1K9
CANADA

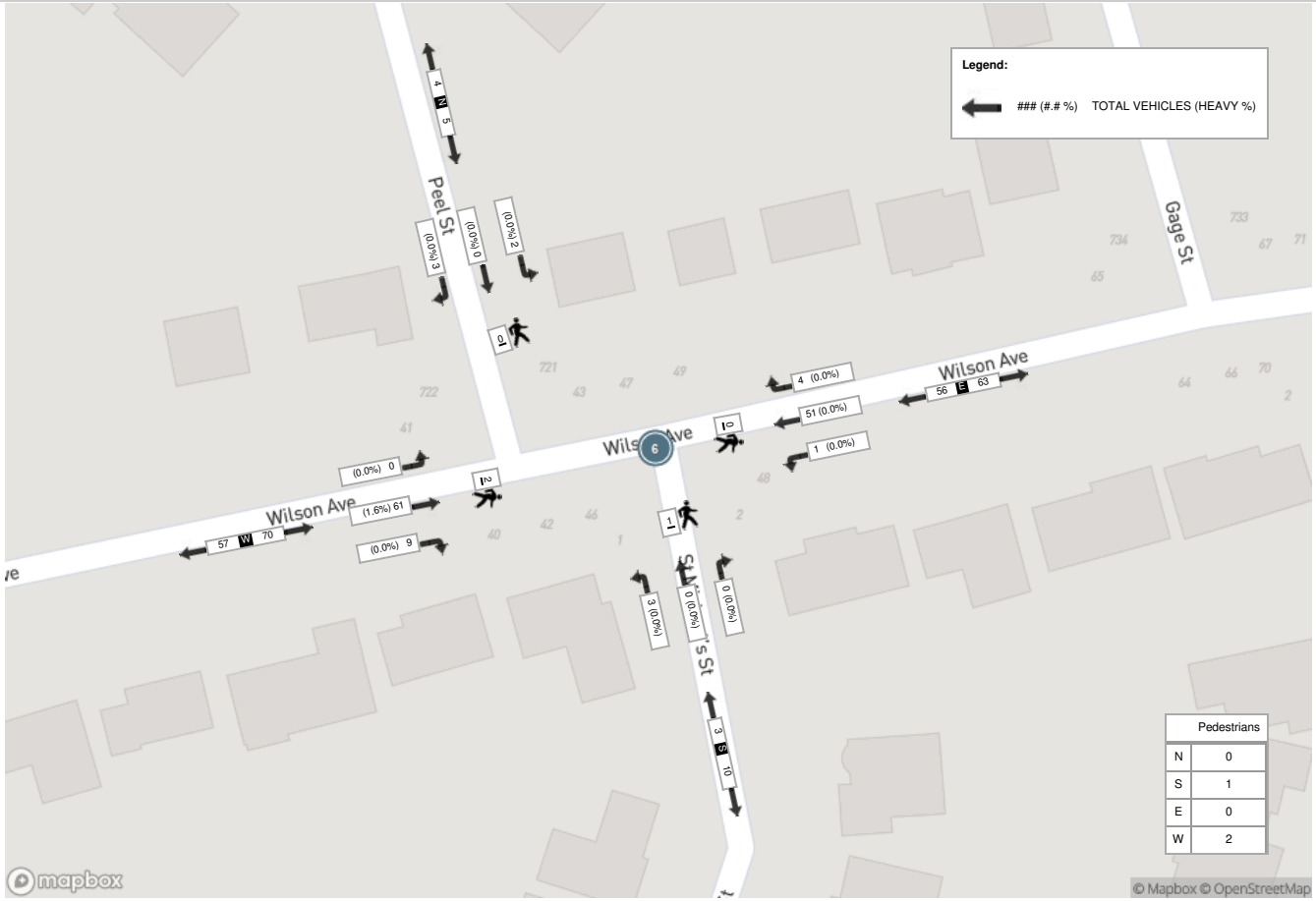
Peak Hour: 04:00 PM - 05:00 PM Weather: Overcast Clouds (21.08 °C)

Start Time	E Approach WILSON AVE						S Approach ST MICHAELS ST						W Approach WILSON AVE						N Approach PEEL ST						Int. Total (15 min)
	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	
16:00:00	0	10	0	0	0	10	0	0	0	0	0	0	2	15	0	0	1	17	3	0	2	0	0	5	32
16:15:00	1	10	0	0	0	11	0	0	2	0	0	2	3	12	0	0	0	15	0	0	0	0	0	0	28
16:30:00	1	15	1	0	0	17	0	0	0	0	1	0	2	17	0	0	1	19	0	0	0	0	0	0	36
16:45:00	2	16	0	0	0	18	0	0	1	0	0	1	2	17	0	0	0	19	0	0	0	0	0	0	38
Grand Total	4	51	1	0	0	56	0	0	3	0	1	3	9	61	0	0	2	70	3	0	2	0	0	5	**134**
Approach%	7.1%	91.1%	1.8%	0%		-	0%	0%	100%	0%		-	12.9%	87.1%	0%	0%		-	60%	0%	40%	0%		-	**-**
Totals %	3%	38.1%	0.7%	0%		41.8%	0%	0%	2.2%	0%		2.2%	6.7%	45.5%	0%	0%		52.2%	2.2%	0%	1.5%	0%		3.7%	**-**
PHF	0.5	0.8	0.25	0		0.78	0	0	0.38	0		0.38	0.75	0.9	0	0		0.92	0.25	0	0.25	0		0.25	**-**
Heavy	0	0	0	0		0	0	0	0	0		0	0	1	0	0		1	0	0	0	0		0	**-**
Heavy %	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	1.6%	0%	0%		1.4%	0%	0%	0%	0%		0%	**-**
Lights	4	51	1	0		56	0	0	3	0		3	9	60	0	0		69	3	0	2	0		5	**-**
Lights %	100%	100%	100%	0%		100%	0%	0%	100%	0%		100%	100%	98.4%	0%	0%		98.6%	100%	0%	100%	0%		100%	**-**
Single-Unit Trucks	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	**-**
Single-Unit Trucks %	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	**-**
Buses	0	0	0	0		0	0	0	0	0		0	0	1	0	0		1	0	0	0	0		0	**-**
Buses %	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	1.6%	0%	0%		1.4%	0%	0%	0%	0%		0%	**-**
Articulated Trucks	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	**-**
Articulated Trucks %	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	**-**
Pedestrians	-	-	-	-	0	-	-	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	0	-	**-**
Pedestrians%	-	-	-	-	0%		-	-	-	-	33.3%		-	-	-	-	66.7%		-	-	-	-	0%		**-**
Bicycles on Road	0	1	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	**-**
Bicycles on Road%	-	-	-	-	0%		-	-	-	-	0%		-	-	-	-	0%		-	-	-	-	0%		**-**

Peak Hour: 07:45 AM - 08:45 AM Weather: Overcast Clouds (9.42 °C)



Peak Hour: 04:00 PM - 05:00 PM **Weather: Overcast Clouds (21.08 °C)**



Spectrum

Turning Movement Count
Location Name: WILSON AVE & VIOLA CT
Date: Wed, May 25, 2022 Deployment Lead:

BA Group
300 45 ST. CLAIR AVE W
TORONTO ONTARIO, M4V 1K9
CANADA

Turning Movement Count (7 . WILSON AVE & VIOLA CT)

Start Time	N Approach GAGE ST						E Approach WILSON AVE						S Approach VIOLA CT						W Approach WILSON AVE						Int. Total (15 min)	Int. Total (1 hr)
	Right N:W	Thru N:S	Left N:E	UTurn N:N	Peds N:	Approach Total	Right E:N	Thru E:W	Left E:S	UTurn E:E	Peds E:	Approach Total	Right S:E	Thru S:N	Left S:W	UTurn S:S	Peds S:	Approach Total	Right W:S	Thru W:E	Left W:N	UTurn W:W	Peds W:	Approach Total		
07:00:00	0	0	0	0	0	0	1	6	0	0	1	7	0	0	0	0	0	0	1	7	0	0	0	8	15	
07:15:00	0	0	0	0	0	0	0	3	0	0	0	3	1	0	2	0	0	3	2	7	0	0	0	9	15	
07:30:00	0	0	1	0	0	1	0	5	1	0	1	6	3	0	3	0	0	6	1	7	0	0	0	8	21	
07:45:00	0	0	2	0	0	2	2	10	0	0	0	12	0	0	4	0	0	4	3	14	1	0	0	18	36	87
08:00:00	0	0	1	0	1	1	1	2	1	0	1	4	1	0	4	0	0	5	0	7	0	0	0	7	17	89
08:15:00	0	0	2	0	0	2	0	6	0	0	1	6	1	0	3	0	0	4	3	9	0	0	0	12	24	98
08:30:00	0	0	2	0	0	2	1	10	1	0	0	12	2	0	5	0	0	7	1	5	1	0	0	7	28	105
08:45:00	0	0	0	0	0	0	0	10	0	0	0	10	1	0	1	0	0	2	4	12	1	0	0	17	29	98
BREAK																										
16:00:00	0	0	1	0	2	1	2	7	0	0	2	9	2	0	3	0	0	5	5	13	1	0	0	19	34	
16:15:00	0	0	0	0	0	0	1	8	0	0	1	9	1	0	4	0	0	5	4	8	0	0	0	12	26	
16:30:00	0	0	0	0	2	0	0	14	1	0	2	15	0	0	3	0	0	3	7	9	1	0	0	17	35	
16:45:00	0	0	1	0	0	1	1	15	2	0	0	18	1	0	2	0	0	3	6	11	0	0	0	17	39	134
17:00:00	0	0	1	0	1	1	1	14	2	0	0	17	3	0	3	0	0	6	1	4	0	0	0	5	29	129
17:15:00	0	0	0	0	0	0	3	9	2	0	0	14	0	0	0	0	0	0	3	4	0	0	0	7	21	124
17:30:00	0	0	0	0	0	0	3	12	3	0	0	18	0	0	4	0	0	4	0	7	1	0	0	8	30	119
17:45:00	0	0	1	0	0	1	0	21	1	0	0	22	0	0	3	0	0	3	1	4	1	0	0	6	32	112
Grand Total	0	0	12	0	6	12	16	152	14	0	9	182	16	0	44	0	0	60	42	128	7	0	0	177	**431**	-
Approach%	0%	0%	100%	0%		-	8.8%	83.5%	7.7%	0%		-	26.7%	0%	73.3%	0%		-	23.7%	72.3%	4%	0%		-	-	-
Totals %	0%	0%	2.8%	0%		2.8%	3.7%	35.3%	3.2%	0%		42.2%	3.7%	0%	10.2%	0%		13.9%	9.7%	29.7%	1.6%	0%		41.1%	-	-
Heavy	0	0	1	0		-	2	2	1	0		-	0	0	0	0		-	2	2	2	0		-	-	-
Heavy %	0%	0%	8.3%	0%		-	12.5%	1.3%	7.1%	0%		-	0%	0%	0%	0%		-	4.8%	1.6%	28.6%	0%		-	-	-
Bicycles	0	0	0	0		-	0	4	0	0		-	0	2	1	0		-	0	1	0	0		-	-	-
Bicycle %	0%	0%	0%	0%		-	0%	2.6%	0%	0%		-	0%	0%	2.3%	0%		-	0%	0.8%	0%	0%		-	-	-

Spectrum

Turning Movement Count
Location Name: WILSON AVE & VIOLA CT
Date: Wed, May 25, 2022 Deployment Lead:

BA Group
300 45 ST. CLAIR AVE W
TORONTO ONTARIO, M4V 1K9
CANADA

Peak Hour: 07:45 AM - 08:45 AM Weather: Overcast Clouds (9.42 °C)

Start Time	N Approach GAGE ST						E Approach WILSON AVE						S Approach VIOLA CT						W Approach WILSON AVE						Int. Total (15 min)
	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	
07:45:00	0	0	2	0	0	2	2	10	0	0	0	12	0	0	4	0	0	4	3	14	1	0	0	18	36
08:00:00	0	0	1	0	1	1	1	2	1	0	1	4	1	0	4	0	0	5	0	7	0	0	0	7	17
08:15:00	0	0	2	0	0	2	0	6	0	0	1	6	1	0	3	0	0	4	3	9	0	0	0	12	24
08:30:00	0	0	2	0	0	2	1	10	1	0	0	12	2	0	5	0	0	7	1	5	1	0	0	7	28
Grand Total	0	0	7	0	1	7	4	28	2	0	2	34	4	0	16	0	0	20	7	35	2	0	0	44	**105**
Approach%	0%	0%	100%	0%		-	11.8%	82.4%	5.9%	0%		-	20%	0%	80%	0%		-	15.9%	79.5%	4.5%	0%		-	**-**
Totals %	0%	0%	6.7%	0%		6.7%	3.8%	26.7%	1.9%	0%		32.4%	3.8%	0%	15.2%	0%		19%	6.7%	33.3%	1.9%	0%		41.9%	**-**
PHF	0	0	0.88	0		0.88	0.5	0.7	0.5	0		0.71	0.5	0	0.8	0		0.71	0.58	0.63	0.5	0		0.61	**-**
Heavy	0	0	1	0		1	1	1	1	0		3	0	0	0	0		0	0	0	2	0		2	**-**
Heavy %	0%	0%	14.3%	0%		14.3%	25%	3.6%	50%	0%		8.8%	0%	0%	0%	0%		0%	0%	0%	100%	0%		4.5%	**-**
Lights	0	0	6	0		6	3	27	1	0		31	4	0	16	0		20	7	35	0	0		42	**-**
Lights %	0%	0%	85.7%	0%		85.7%	75%	96.4%	50%	0%		91.2%	100%	0%	100%	0%		100%	100%	100%	0%	0%		95.5%	**-**
Single-Unit Trucks	0	0	1	0		1	1	0	0	0		1	0	0	0	0		0	0	0	1	0		1	**-**
Single-Unit Trucks %	0%	0%	14.3%	0%		14.3%	25%	0%	0%	0%		2.9%	0%	0%	0%	0%		0%	0%	0%	50%	0%		2.3%	**-**
Buses	0	0	0	0		0	0	1	1	0		2	0	0	0	0		0	0	0	1	0		1	**-**
Buses %	0%	0%	0%	0%		0%	0%	3.6%	50%	0%		5.9%	0%	0%	0%	0%		0%	0%	0%	50%	0%		2.3%	**-**
Articulated Trucks	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	**-**
Articulated Trucks %	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	**-**
Pedestrians	-	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	0	-	-	-	-	-	0	-	**-**
Pedestrians%	-	-	-	-	33.3%		-	-	-	-	66.7%		-	-	-	-	0%		-	-	-	-	0%		**-**
Bicycles on Road	0	0	0	0	0	-	0	0	0	0	0	-	0	0	1	0	0	-	0	0	0	0	0	-	**-**
Bicycles on Road%	-	-	-	-	0%		-	-	-	-	0%		-	-	-	-	0%		-	-	-	-	0%		**-**

Spectrum

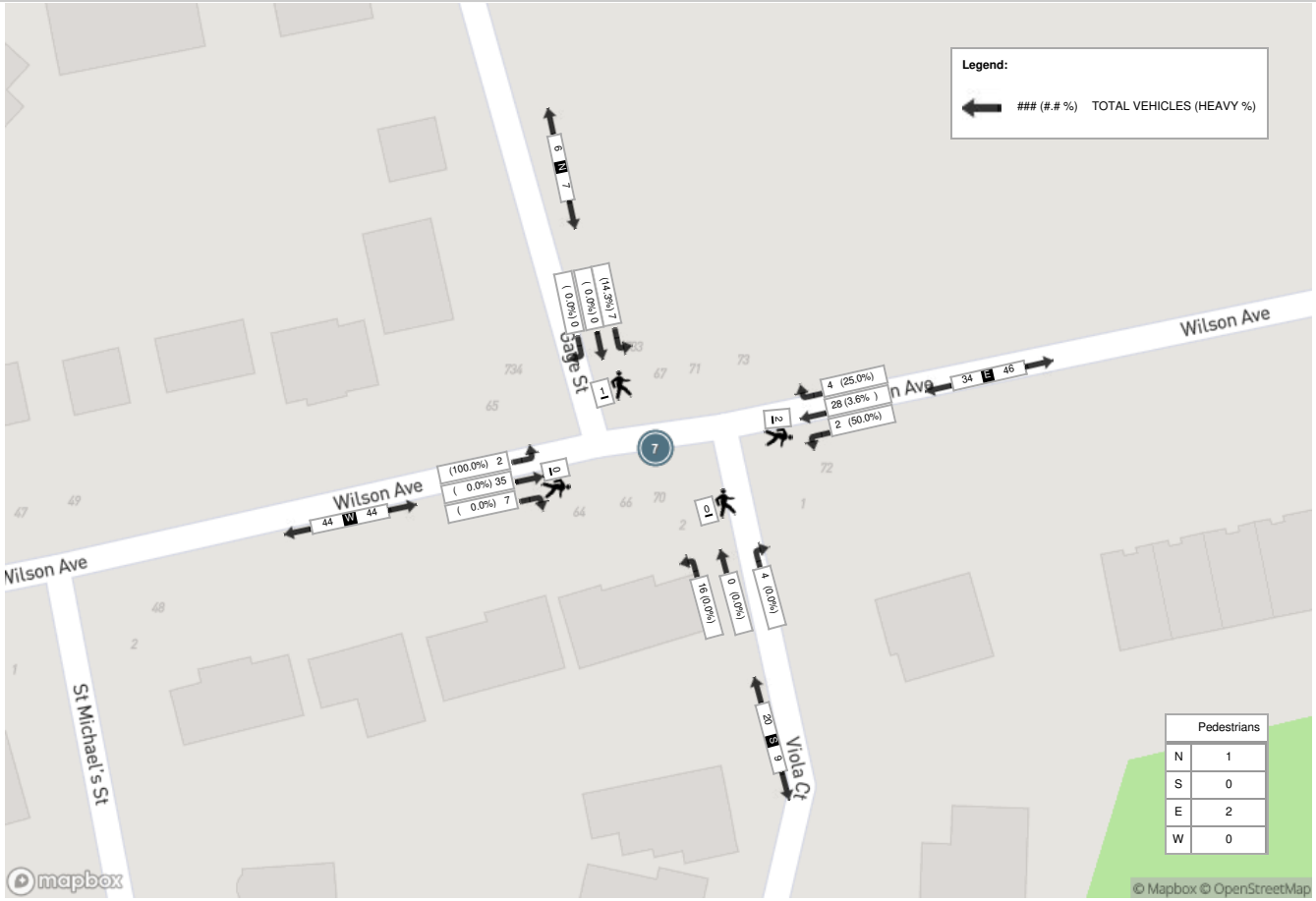
Turning Movement Count
Location Name: WILSON AVE & VIOLA CT
Date: Wed, May 25, 2022 Deployment Lead:

BA Group
300 45 ST. CLAIR AVE W
TORONTO ONTARIO, M4V 1K9
CANADA

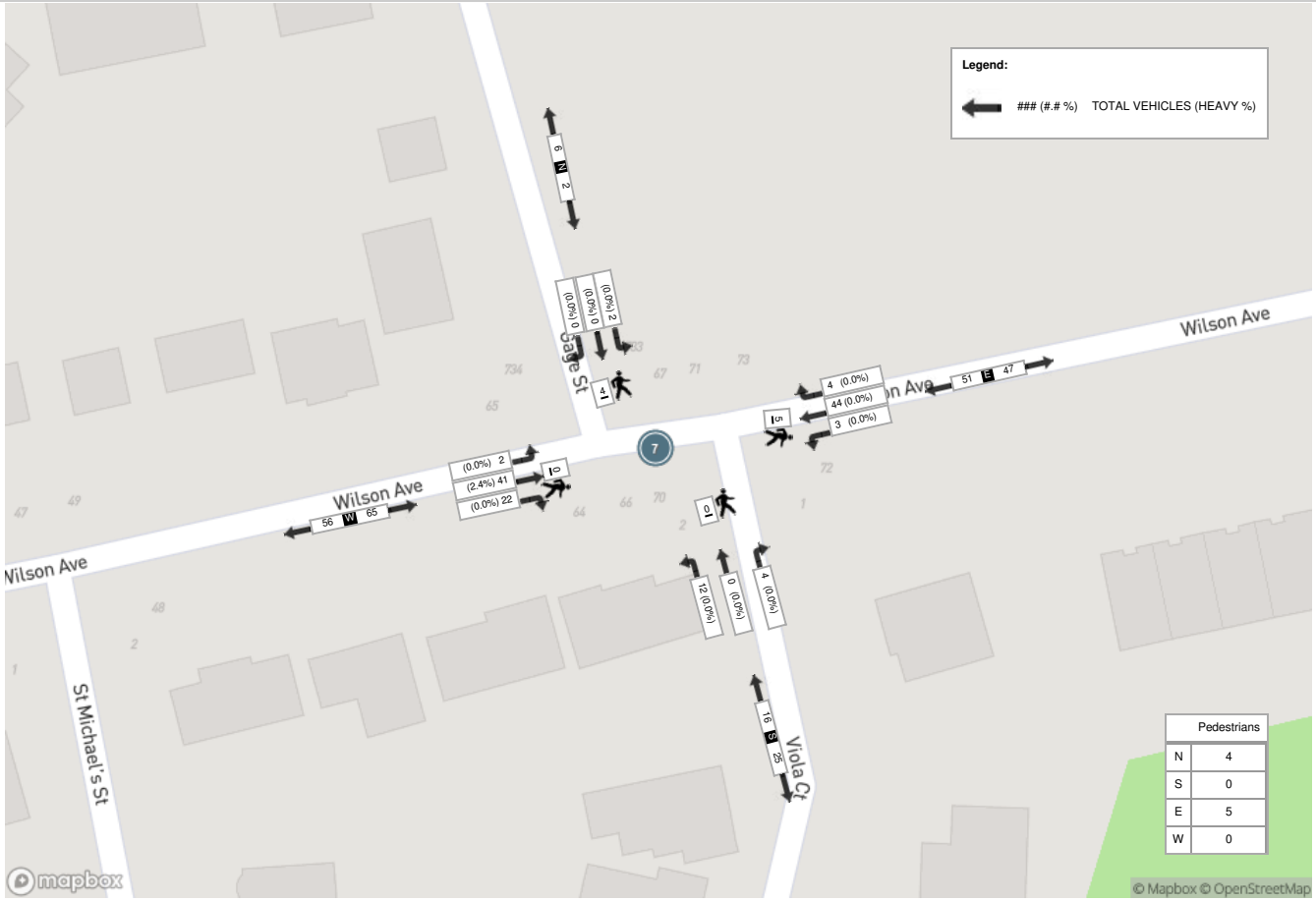
Peak Hour: 04:00 PM - 05:00 PM Weather: Overcast Clouds (21.08 °C)

Start Time	N Approach GAGE ST						E Approach WILSON AVE						S Approach VIOLA CT						W Approach WILSON AVE						Int. Total (15 min)
	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	Right	Thru	Left	UTurn	Peds	Approach Total	
16:00:00	0	0	1	0	2	1	2	7	0	0	2	9	2	0	3	0	0	5	5	13	1	0	0	19	34
16:15:00	0	0	0	0	0	0	1	8	0	0	1	9	1	0	4	0	0	5	4	8	0	0	0	12	26
16:30:00	0	0	0	0	2	0	0	14	1	0	2	15	0	0	3	0	0	3	7	9	1	0	0	17	35
16:45:00	0	0	1	0	0	1	1	15	2	0	0	18	1	0	2	0	0	3	6	11	0	0	0	17	39
Grand Total	0	0	2	0	4	2	4	44	3	0	5	51	4	0	12	0	0	16	22	41	2	0	0	65	**134**
Approach%	0%	0%	100%	0%		-	7.8%	86.3%	5.9%	0%		-	25%	0%	75%	0%		-	33.8%	63.1%	3.1%	0%		-	**-**
Totals %	0%	0%	1.5%	0%		1.5%	3%	32.8%	2.2%	0%		38.1%	3%	0%	9%	0%		11.9%	16.4%	30.6%	1.5%	0%		48.5%	**-**
PHF	0	0	0.5	0		0.5	0.5	0.73	0.38	0		0.71	0.5	0	0.75	0		0.8	0.79	0.79	0.5	0		0.86	**-**
Heavy	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	0	1	0	0		1	**-**
Heavy %	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	2.4%	0%	0%		1.5%	**-**
Lights	0	0	2	0		2	4	44	3	0		51	4	0	12	0		16	22	40	2	0		64	**-**
Lights %	0%	0%	100%	0%		100%	100%	100%	100%	0%		100%	100%	0%	100%	0%		100%	100%	97.6%	100%	0%		98.5%	**-**
Single-Unit Trucks	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	**-**
Single-Unit Trucks %	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	**-**
Buses	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	0	1	0	0		1	**-**
Buses %	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	2.4%	0%	0%		1.5%	**-**
Articulated Trucks	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	**-**
Articulated Trucks %	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	**-**
Pedestrians	-	-	-	-	4	-	-	-	-	-	5	-	-	-	-	-	0	-	-	-	-	-	0	-	**-**
Pedestrians%	-	-	-	-	44.4%		-	-	-	-	55.6%		-	-	-	-	0%		-	-	-	-	0%		**-**
Bicycles on Road	0	0	0	0	0	-	0	1	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	**-**
Bicycles on Road%	-	-	-	-	0%		-	-	-	-	0%		-	-	-	-	0%		-	-	-	-	0%		**-**

Peak Hour: 07:45 AM - 08:45 AM **Weather: Overcast Clouds (9.42 °C)**



Peak Hour: 04:00 PM - 05:00 PM Weather: Overcast Clouds (21.08 °C)

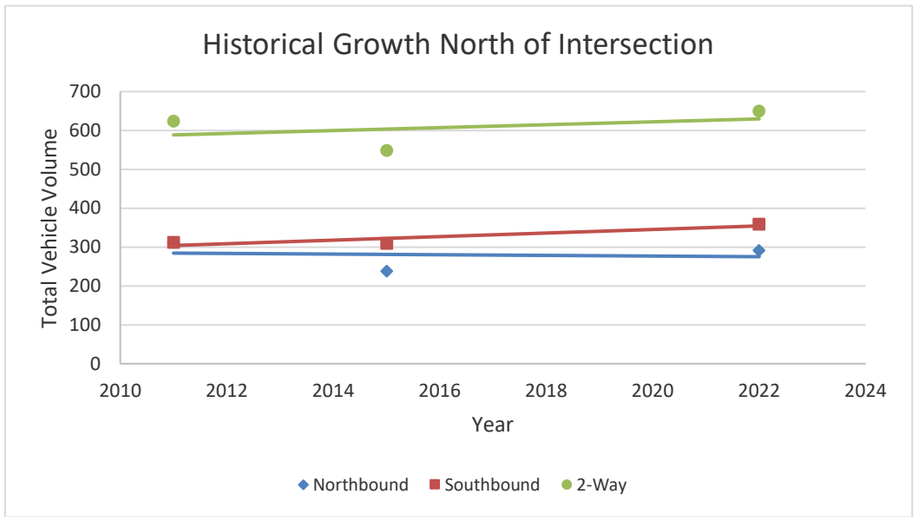


APPENDIX D:
Growth Analysis

Project:	Delhi Golf Course
Project ID:	6860-41
Intersection	James Street (Hwy3) / Pine Grove Rd
Peak Hour	AM Peak

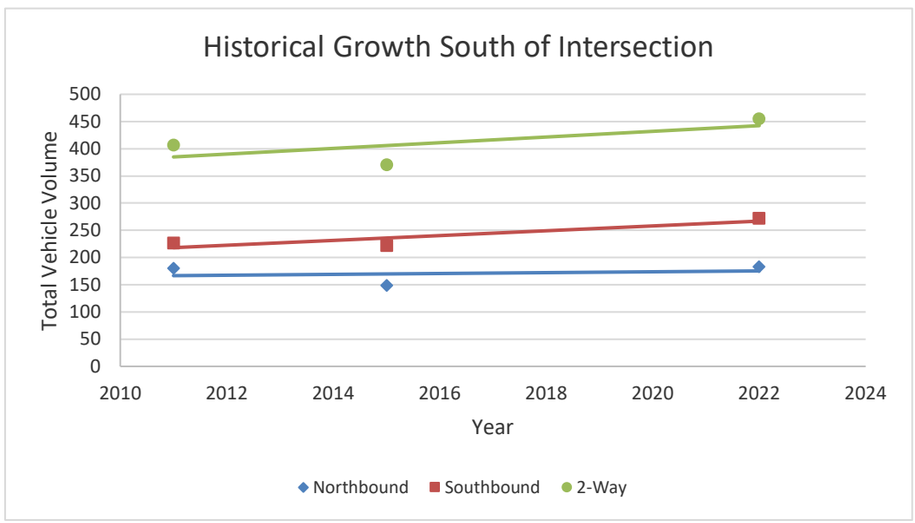
North of Intersection				
Date	**Year**	**Northbound**	**Southbound**	**2-Way**
Wed, June 22	2011	312	312	624
Tue, Aug 18	2015	238	310	548
Wed, May 25	2022	291	359	650
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0

Trend Point at start		284.5	304.1	588.6
Trend Point at end		275.3	354.5	629.8
Slope		-0.8	4.6	3.7
Annual Growth		**-0.3%**	**1.4%**	**0.6%**



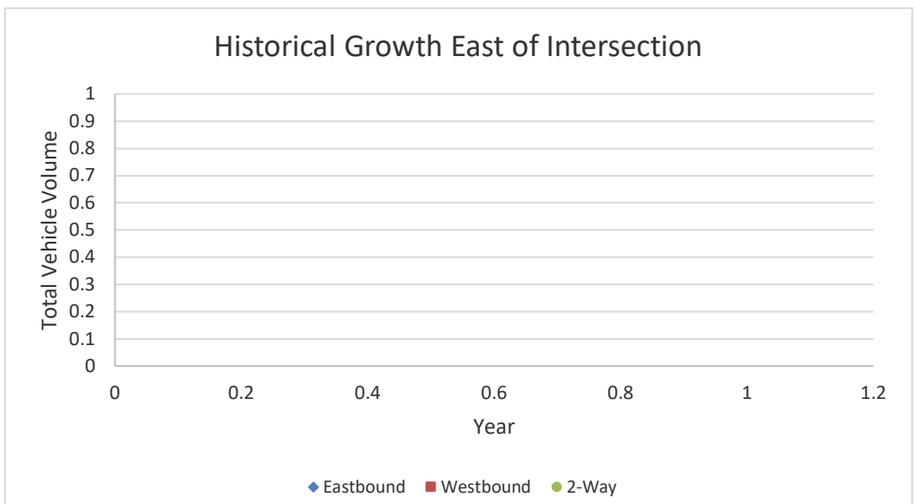
South of Intersection				
Date	**Year**	**Northbound**	**Southbound**	**2-Way**
Wed, June 22	2011	180	227	407
Tue, Aug 18	2015	149	222	371
Wed, May 25	2022	183	272	455
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0

Trend Point at start		166.7	218.2	384.9
Trend Point at end		175.4	266.9	442.4
Slope		0.8	4.4	5.2
Annual Growth		**0.5%**	**1.9%**	**1.3%**



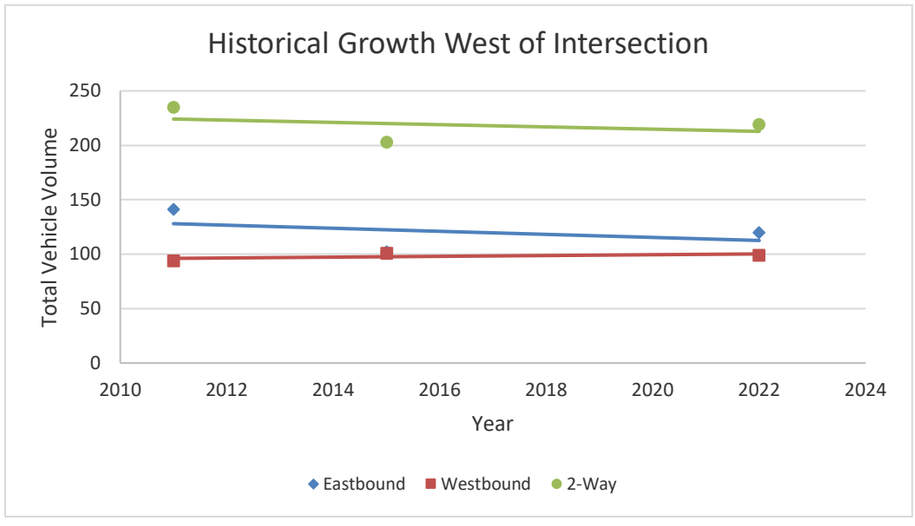
East of Intersection				
Date	**Year**	**Eastbound**	**Westbound**	**2-Way**
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0

Trend Point at start		#VALUE!	#VALUE!	#VALUE!
Trend Point at end		#VALUE!	#VALUE!	#VALUE!
Slope		#DIV/0!	#DIV/0!	#DIV/0!
Annual Growth		**#VALUE!**	**#VALUE!**	**#VALUE!**



West of Intersection				
Date	**Year**	**Eastbound**	**Westbound**	**2-Way**
Wed, June 22	2011	141	94	235
Tue, Aug 18	2015	102	101	203
Wed, May 25	2022	120	99	219
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0

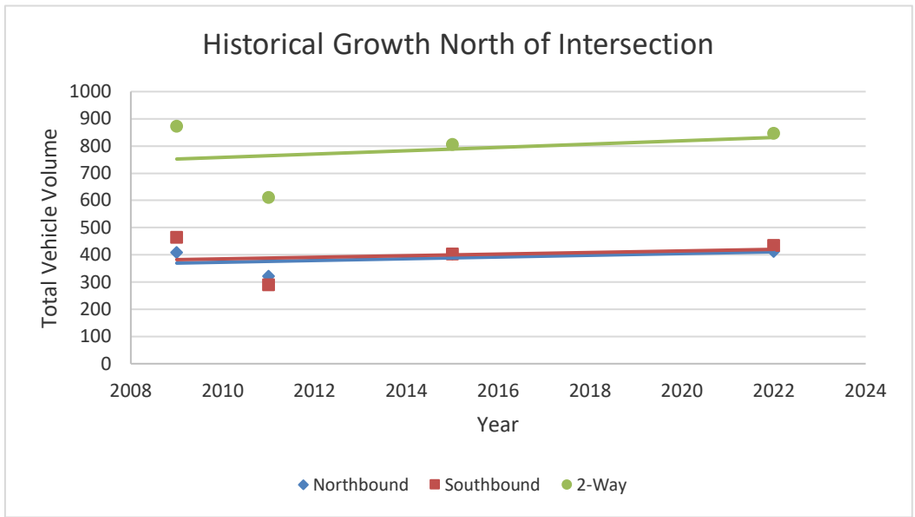
Trend Point at start		128.0	96.1	224.2
Trend Point at end		112.6	100.2	212.8
Slope		-1.4	0.4	-1.0
Annual Growth		**-1.2%**	**0.4%**	**-0.5%**



Project: Delhi Golf Course
Project ID: 6860-41
Intersection James Street (Hwy3) / Pine Grove Rd
Peak Hour PM Peak

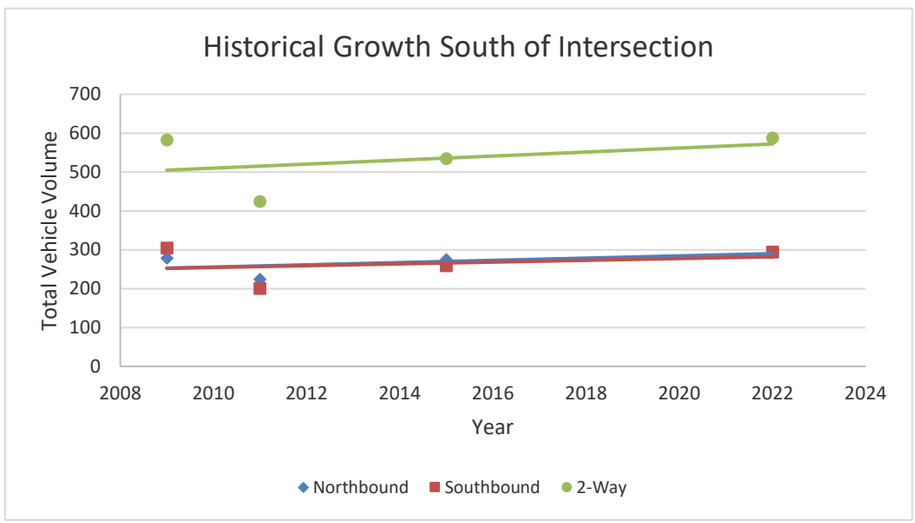
North of Intersection				
Date	Year	Northbound	Southbound	2-Way
Wed, Aug 12	2009	408	464	872
Wed, June 22	2011	322	290	612
Tue, Aug 18	2015	403	403	806
Wed, May 25	2022	413	434	847
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0

Trend Point at start		369.8	382.5	752.3
Trend Point at end		411.2	420.3	831.5
Slope		3.2	2.9	6.1
Annual Growth		**0.8%**	**0.7%**	**0.8%**



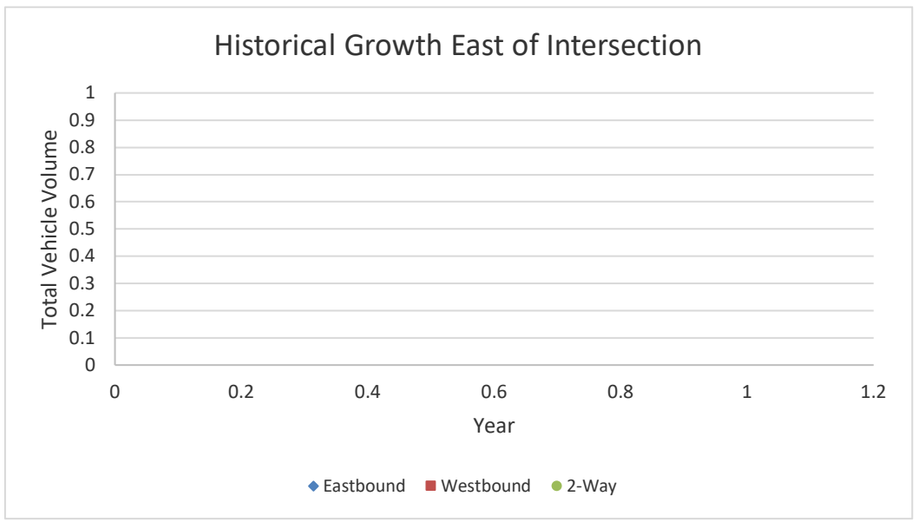
South of Intersection				
Date	Year	Northbound	Southbound	2-Way
Wed, Aug 12	2009	279	304	583
Wed, June 22	2011	224	200	424
Tue, Aug 18	2015	275	259	534
Wed, May 25	2022	293	294	587
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0

Trend Point at start		252.6	252.2	504.8
Trend Point at end		290.1	282.0	572.1
Slope		2.9	2.3	5.2
Annual Growth		**1.1%**	**0.9%**	**1.0%**



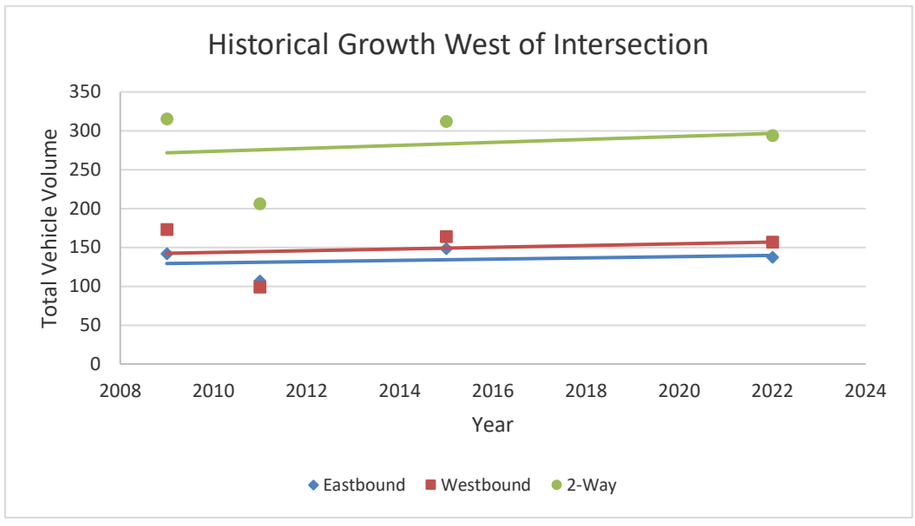
East of Intersection				
Date	Year	Eastbound	Westbound	2-Way
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0

Trend Point at start		#VALUE!	#VALUE!	#VALUE!
Trend Point at end		#VALUE!	#VALUE!	#VALUE!
Slope		#DIV/0!	#DIV/0!	#DIV/0!
Annual Growth		**#VALUE!**	**#VALUE!**	**#VALUE!**



West of Intersection				
Date	Year	Eastbound	Westbound	2-Way
Wed, Aug 12	2009	142	173	315
Wed, June 22	2011	107	99	206
Tue, Aug 18	2015	148	164	312
Wed, May 25	2022	137	157	294
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0

Trend Point at start		129.3	142.4	271.7
Trend Point at end		139.7	156.9	296.6
Slope		0.8	1.1	1.9
Annual Growth		**0.6%**	**0.7%**	**0.7%**



APPENDIX E:
Synchro Summary Tables and Outputs

Intersection Operations - Signalized Intersections

General Notes:

- xx (xx) – AM Peak (PM Peak)

James St / Pine Grove Rd																				
Movement	Existing			Future Background									Future Total							
				2028			2033			2038			2028			2033			2038		
	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay
EBLR	0.53 (0.57)	D (D)	35.5 (36.0)	0.53 (0.57)	D (D)	35.5 (36.0)	0.53 (0.57)	D (D)	35.5 (36.0)	0.53 (0.57)	D (D)	35.5 (36.0)	0.58 (0.64)	D (D)	36.0 (36.7)	0.58 (0.64)	D (D)	36.0 (36.7)	0.58 (0.64)	D (D)	36.0 (36.7)
NBL	0.01 (0.01)	A (A)	4.1 (4.4)	0.01 (0.01)	A (A)	4.1 (4.4)	0.01 (0.01)	A (A)	4.1 (4.4)	0.01 (0.01)	A (A)	4.1 (4.4)	0.01 (0.01)	A (A)	4.4 (5.0)	0.01 (0.01)	A (A)	4.4 (5.0)	0.01 (0.01)	A (A)	4.4 (5.0)
NBT	0.16 (0.28)	A (A)	4.8 (5.9)	0.18 (0.31)	A (A)	4.9 (6.1)	0.19 (0.34)	A (A)	5.0 (6.3)	0.22 (0.37)	A (A)	5.2 (6.6)	0.21 (0.38)	A (A)	5.4 (7.5)	0.22 (0.41)	A (A)	5.5 (7.8)	0.24 (0.45)	A (A)	5.7 (8.2)
SBT	0.22 (0.26)	A (A)	5.2 (5.8)	0.25 (0.29)	A (A)	5.4 (6.0)	0.28 (0.32)	A (A)	5.6 (6.2)	0.30 (0.36)	A (A)	5.8 (6.5)	0.31 (0.34)	A (A)	6.2 (7.1)	0.34 (0.37)	A (A)	6.4 (7.4)	0.36 (0.41)	A (A)	6.6 (7.8)
SBR	0.07 (0.11)	A (A)	4.4 (4.9)	0.07 (0.11)	A (A)	4.4 (4.9)	0.07 (0.11)	A (A)	4.4 (4.9)	0.07 (0.11)	A (A)	4.4 (4.9)	0.10 (0.13)	A (A)	4.8 (5.7)	0.10 (0.13)	A (A)	4.8 (5.7)	0.10 (0.13)	A (A)	4.8 (5.7)
Overall	**0.28 (0.33)**	**B (B)**	**10.7 (10.4)**	**0.30 (0.36)**	**B (B)**	**10.4 (10.3)**	**0.32 (0.38)**	**B (B)**	**10.2 (10.2)**	**0.34 (0.41)**	**A (B)**	**10.0 (10.1)**	**0.36 (0.44)**	**B (B)**	**10.7 (11.7)**	**0.38 (0.46)**	**B (B)**	**10.6 (11.7)**	**0.40 (0.49)**	**B (B)**	**10.5 (11.7)**

Proposed Signalized James St / Tisdale Drive Intersection																				
Movement	Existing			Future Background									Future Total							
				2028			2033			2038			2028			2033			2038		
	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay
WBLR	Does not exist												0.61 (0.46)	D (C)	36.4 (34.9)	0.61 (0.46)	D (C)	36.4 (34.9)	0.61 (0.46)	D (C)	36.4 (34.9)
NBT													0.31 (0.43)	A (A)	4.0 (5.4)	0.33 (0.46)	A (A)	4.2 (5.5)	0.35 (0.49)	A (A)	4.4 (5.8)
NBR													0.03 (0.07)	A (A)	1.8 (3.9)	0.03 (0.08)	A (A)	2.0 (3.8)	0.03 (0.08)	A (A)	2.2 (3.8)
SBL													0.10 (0.28)	A (A)	5.2 (6.1)	0.10 (0.29)	A (A)	5.3 (6.3)	0.11 (0.31)	A (A)	5.3 (6.7)
SBT													0.37 (0.43)	A (A)	6.9 (6.6)	0.39 (0.46)	A (A)	7.2 (6.9)	0.42 (0.49)	A (A)	7.4 (7.2)
Overall													**0.41 (0.43)**	**B (A)**	**12.0 (9.4)**	**0.43 (0.46)**	**B (A)**	**11.9 (9.4)**	**0.46 (0.49)**	**B (A)**	**11.8 (9.5)**

Intersection Queue Lengths - Signalized Intersections

General Notes:

- xx (xx) – AM Peak (PM Peak)

James St / Pine Grove Rd

Movement	Approx. Storage Length (m)	Existing		Future Background						Future Total					
				2028		2033		2038		2028		2033		2038	
		50%ile (m)	95%ile (m)	50%ile (m)	95%ile (m)	50%ile (m)	95%ile (m)	50%ile (m)	95%ile (m)	50%ile (m)	95%ile (m)	50%ile (m)	95%ile (m)	50%ile (m)	95%ile (m)
EBLR	200	22.5 (25.5)	38.2 (42.2)	22.5 (25.5)	38.2 (42.2)	22.5 (25.5)	38.2 (42.2)	22.5 (25.5)	38.2 (42.2)	26.0 (32.6)	42.7 (50.8)	26.0 (32.6)	42.7 (50.8)	26.0 (32.6)	42.7 (50.8)
NBL	125	0.2 (0.3)	1.5 (1.6)	0.2 (0.3)	1.5 (1.6)	0.2 (0.3)	1.5 (1.6)	0.2 (0.3)	1.5 (1.6)	0.3 (0.3)	1.6 (1.7)	0.3 (0.3)	1.6 (1.7)	0.3 (0.3)	1.6 (1.7)
NBT	>1km	10.2 (20.1)	21.4 (39.2)	11.4 (22.7)	23.5 (44.2)	12.6 (25.6)	25.8 (49.3)	14.3 (29.2)	28.7 (55.5)	14.0 (31.6)	28.5 (60.2)	15.4 (35.2)	30.9 (66.7)	17.2 (39.5)	33.9 (74.7)
SBT	200	14.9 (18.6)	29.9 (36.6)	17.3 (21.3)	34.0 (41.3)	19.5 (24.1)	37.8 (46.3)	21.7 (27.4)	41.8 (52.3)	23.3 (27.4)	44.9 (52.7)	25.8 (30.7)	49.3 (58.8)	28.4 (34.6)	53.9 (65.8)
SBR	100	0.0 (0.0)	5.1 (6.8)	0.0 (0.0)	5.1 (6.8)	0.0 (0.0)	5.1 (6.8)	0.0 (0.0)	5.1 (6.8)	0.0 (0.0)	6.4 (8.1)	0.0 (0.0)	6.4 (8.1)	0.0 (0.0)	6.4 (8.1)

Proposed Signalized James St / Tisdale Drive Intersection

Movement	Approx. Storage Length (m)	Existing		Future Background						Future Total					
				2028		2033		2038		2028		2033		2038	
		50%ile (m)	95%ile (m)	50%ile (m)	95%ile (m)	50%ile (m)	95%ile (m)	50%ile (m)	95%ile (m)	50%ile (m)	95%ile (m)	50%ile (m)	95%ile (m)	50%ile (m)	95%ile (m)
WBLR	200	Does not exist								24.6 (15.2)	45.3 (33.7)	24.6 (15.2)	45.3 (33.7)	24.6 (15.2)	45.3 (33.7)
NBT	150									13.5 (20.4)	26.4 (57.9)	14.8 (22.8)	29.2 (54.4)	16.6 (25.7)	32.2 (54.5)
NBR	65									0.0 (0.8)	2.1 (8.1)	0.0 (0.9)	2.3 (7.5)	0.0 (1.2)	2.6 (7.7)
SBL	115									3.3 (7.6)	10.0 (20.5)	3.3 (7.7)	10.1 (21.1)	3.3 (7.8)	10.1 (21.9)
SBT	700									28.7 (31.6)	58.5 (64.2)	31.5 (34.7)	63.8 (70.5)	34.4 (38.7)	69.4 (78.3)

Intersection Operations - Unsignalized Intersections

General Notes:

- xx (xx) – AM Peak (PM Peak)

James St / Alpha St

Movement	Existing			Future Background									Future Total								
				2028			2033			2038			2028			2033			2038		
	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay
EBLR	0.04 (0.03)	B (C)	13.4 (15.5)	0.04 (0.03)	B (C)	14.1 (16.6)	0.04 (0.03)	B (C)	14.7 (17.8)	0.04 (0.04)	C (C)	15.5 (19.6)	0.05 (0.04)	C (C)	16.4 (20.3)	0.05 (0.05)	C (C)	17.3 (22.3)	0.06 (0.05)	C (D)	18.3 (25.1)
NBTL	0.00 (0.01)	A (A)	0.0 (0.3)	0.00 (0.01)	A (A)	0.0 (0.3)	0.00 (0.01)	A (A)	0.0 (0.3)	0.00 (0.01)	A (A)	0.0 (0.3)	0.00 (0.01)	A (A)	0.0 (0.3)	0.00 (0.01)	A (A)	0.0 (0.3)	0.00 (0.01)	A (A)	0.0 (0.3)
SBTR	0.23 (0.30)	A (A)	0.0 (0.0)	0.26 (0.32)	A (A)	0.0 (0.0)	0.28 (0.35)	A (A)	0.0 (0.0)	0.29 (0.37)	A (A)	0.0 (0.0)	0.33 (0.37)	A (A)	0.0 (0.0)	0.35 (0.39)	A (A)	0.0 (0.0)	0.36 (0.42)	A (A)	0.0 (0.0)

James St / Tisdale Rd

Movement	Existing			Future Background									Future Total								
				2028			2033			2038			2028			2033			2038		
	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay
WBLR	0.01 (0.00)	B (A)	10.2 (0.0)	0.01 (0.00)	B (A)	10.4 (0.0)	0.01 (0.00)	B (A)	10.5 (0.0)	0.01 (0.00)	B (A)	10.7 (0.0)	0.61 (0.82)	D (F)	26.1 (65.5)	0.65 (0.90)	D (F)	29.3 (86.1)	0.69 (1.01)	D (F)	33.8 (119.3)
NBT	0.20 (0.29)	A (A)	0.0 (0.0)	0.22 (0.32)	A (A)	0.0 (0.0)	0.23 (0.34)	A (A)	0.0 (0.0)	0.25 (0.36)	A (A)	0.0 (0.0)	0.23 (0.33)	A (A)	0.0 (0.0)	0.24 (0.35)	A (A)	0.0 (0.0)	0.26 (0.38)	A (A)	0.0 (0.0)
NBR													0.03 (0.06)	A (A)	0.0 (0.0)	0.03 (0.06)	A (A)	0.0 (0.0)	0.03 (0.06)	A (A)	0.0 (0.0)
SBL	0.0 (0.0	A (A)	0.0 (0.0)	0.00 (0.00)	A (A)	0.0 (0.0)	0.00 (0.00)	A (A)	0.0 (0.0)	0.00 (0.00)	A (A)	0.0 (0.0)	0.06 (0.16)	A (A)	8.4 (9.6)	0.06 (0.17)	A (A)	8.4 (9.8)	0.06 (0.18)	A (B)	8.5 (10.0)
SBT													0.27 (0.33)	A (A)	0.0 (0.0)	0.29 (0.35)	A (A)	0.0 (0.0)	0.31 (0.37)	A (A)	0.0 (0.0)

James St / Wilson Ave

Movement	Existing			Future Background									Future Total								
				2028			2033			2038			2028			2033			2038		
	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay
WBLR	0.09 (0.13)	B (B)	11.0 (13.5)	0.09 (0.14)	B (B)	11.3 (14.3)	0.10 (0.15)	B (C)	11.5 (15.0)	0.10 (0.17)	B (C)	11.9 (15.9)	0.30 (0.59)	C (E)	17.0 (36.6)	0.32 (0.64)	C (E)	17.8 (42.8)	0.33 (0.71)	C (F)	18.8 (52.3)
NBT	0.13 (0.19)	A (A)	0.0 (0.0)	0.14 (0.20)	A (A)	0.0 (0.0)	0.15 (0.22)	A (A)	0.0 (0.0)	0.16 (0.23)	A (A)	0.0 (0.0)	0.17 (0.23)	A (A)	0.0 (0.0)	0.18 (0.24)	A (A)	0.0 (0.0)	0.19 (0.26)	A (A)	0.0 (0.0)
NBTR	0.08 (0.11)	A (A)	0.0 (0.0)	0.08 (0.12)	A (A)	0.0 (0.0)	0.08 (0.12)	A (A)	0.0 (0.0)	0.09 (0.13)	A (A)	0.0 (0.0)	0.15 (0.17)	A (A)	0.0 (0.0)	0.15 (0.18)	A (A)	0.0 (0.0)	0.15 (0.19)	A (A)	0.0 (0.0)
SBTL	0.03 (0.05)	A (A)	1.8 (2.5)	0.03 (0.06)	A (A)	2.0 (2.6)	0.03 (0.06)	A (A)	1.9 (2.6)	0.03 (0.06)	A (A)	1.8 (2.6)	0.04 (0.08)	A (A)	2.2 (3.2)	0.04 (0.09)	A (A)	2.2 (3.2)	0.04 (0.09)	A (A)	2.1 (3.1)
SBT	0.15 (0.19)	A (A)	0.0 (0.0)	0.17 (0.21)	A (A)	0.0 (0.0)	0.18 (0.22)	A (A)	0.0 (0.0)	0.19 (0.24)	A (A)	0.0 (0.0)	0.18 (0.24)	A (A)	0.0 (0.0)	0.19 (0.25)	A (A)	0.0 (0.0)	0.20 (0.27)	A (A)	0.0 (0.0)

St Michael's St / Wilson Ave

Movement	Existing			Future Background									Future Total								
				2028			2033			2038			2028			2033			2038		
	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay
EBTR	0.03 (0.05)	A (A)	0.0 (0.0)	0.03 (0.05)	A (A)	0.0 (0.0)	0.03 (0.05)	A (A)	0.0 (0.0)	0.03 (0.05)	A (A)	0.0 (0.0)	0.08 (0.10)	A (A)	0.0 (0.0)	0.08 (0.10)	A (A)	0.0 (0.0)	0.08 (0.10)	A (A)	0.0 (0.0)
WBTL	0.00 (0.00)	A (A)	0.0 (0.0)	0.00 (0.00)	A (A)	0.0 (0.0)	0.00 (0.00)	A (A)	0.0 (0.0)	0.00 (0.00)	A (A)	0.0 (0.0)	0.00 (0.00)	A (A)	0.0 (0.0)	0.00 (0.00)	A (A)	0.0 (0.0)	0.00 (0.00)	A (A)	0.0 (0.0)
NBLR	0.01 (0.01)	A (A)	8.8 (9.2)	0.01 (0.01)	A (A)	8.8 (9.3)	0.01 (0.01)	A (A)	8.8 (9.3)	0.01 (0.01)	A (A)	8.8 (9.3)	0.01 (0.01)	A (B)	9.5 (10.4)	0.01 (0.01)	A (B)	9.5 (10.4)	0.01 (0.01)	A (B)	9.5 (10.4)

Notes:

Viola Ct / Wilson Ave

Movement	Existing			Future Background									Future Total								
				2028			2033			2038			2028			2033			2038		
	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay
EBTR	0.03 (0.04)	A (A)	0.0 (0.0)	0.03 (0.04)	A (A)	0.0 (0.0)	0.03 (0.04)	A (A)	0.0 (0.0)	0.03 (0.04)	A (A)	0.0 (0.0)	0.08 (0.09)	A (A)	0.0 (0.0)	0.08 (0.09)	A (A)	0.0 (0.0)	0.08 (0.09)	A (A)	0.0 (0.0)
WBTL	0.00 (0.00)	A (A)	0.0 (0.6)	0.00 (0.00)	A (A)	0.0 (0.6)	0.00 (0.00)	A (A)	0.0 (0.6)	0.00 (0.00)	A (A)	0.0 (0.6)	0.00 (0.01)	A (A)	0.0 (0.6)	0.00 (0.01)	A (A)	0.0 (0.6)	0.00 (0.01)	A (A)	0.0 (0.6)
NBLR	0.02 (0.02)	A (A)	8.9 (9.0)	0.02 (0.02)	A (A)	8.9 (9.1)	0.02 (0.02)	A (A)	8.9 (9.1)	0.02 (0.02)	A (A)	8.9 (9.1)	0.03 (0.03)	A (B)	9.8 (10.2)	0.03 (0.03)	A (B)	9.8 (10.2)	0.03 (0.03)	A (B)	9.8 (10.2)

Viola Ct / St Michael's St

Movement	Existing			Future Background									Future Total								
				2028			2033			2038			2028			2033			2038		
	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay
EBTLR	0.01 (0.01)	A (A)	9.2 (9.3)	0.01 (0.01)	A (A)	9.2 (9.3)	0.01 (0.01)	A (A)	9.2 (9.3)	0.01 (0.01)	A (A)	9.2 (9.3)	0.01 (0.02)	A (A)	9.2 (9.5)	0.01 (0.02)	A (A)	9.2 (9.5)	0.01 (0.02)	A (A)	9.2 (9.5)
WBTLR	0.02 (0.01)	A (A)	8.8 (8.4)	0.02 (0.01)	A (A)	8.8 (8.4)	0.02 (0.01)	A (A)	8.8 (8.4)	0.02 (0.01)	A (A)	8.8 (8.4)	0.03 (0.01)	A (A)	8.8 (8.4)	0.03 (0.01)	A (A)	8.8 (8.4)	0.03 (0.01)	A (A)	8.8 (8.4)
NBTLR	0.00 (0.00)	A (A)	0.0 (0.0)	0.00 (0.00)	A (A)	0.0 (0.0)	0.00 (0.00)	A (A)	0.0 (0.0)	0.00 (0.00)	A (A)	0.0 (0.0)	0.00 (0.00)	A (A)	0.0 (0.0)	0.00 (0.00)	A (A)	0.0 (0.0)	0.00 (0.00)	A (A)	0.0 (0.0)
SBTLR	0.00 (0.01)	A (A)	7.2 (4.5)	0.00 (0.01)	A (A)	7.2 (4.5)	0.00 (0.01)	A (A)	7.2 (4.5)	0.00 (0.01)	A (A)	7.2 (4.5)	0.00 (0.01)	A (A)	7.2 (5.0)	0.00 (0.01)	A (A)	7.2 (5.0)	0.00 (0.01)	A (A)	7.2 (5.0)

Area B Driveway / St Michael's St

Movement	Existing			Future Background									Future Total								
				2028			2033			2038			2028			2033			2038		
	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay
EBTR	Does not exist												0.01 (0.02)	A (A)	0.0 (0.0)	0.01 (0.02)	A (A)	0.0 (0.0)	0.01 (0.02)	A (A)	0.0 (0.0)
WBTL													0.00 (0.00)	A (A)	0.0 (0.0)	0.00 (0.00)	A (A)	0.0 (0.0)	0.00 (0.00)	A (A)	0.0 (0.0)
NBLR													0.01 (0.01)	A (A)	8.7 (8.7)	0.01 (0.01)	A (A)	8.7 (8.7)	0.01 (0.01)	A (A)	8.7 (8.7)

Area C Driveway / Wilson Ave

Movement	Existing			Future Background									Future Total								
				2028			2033			2038			2028			2033			2038		
	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay
EBTR	Does not exist												0.08 (0.08)	A (A)	0.0 (0.0)	0.08 (0.08)	A (A)	0.0 (0.0)	0.08 (0.08)	A (A)	0.0 (0.0)
WBTL													0.00 (0.01)	A (A)	0.6 (0.6)	0.00 (0.01)	A (A)	0.6 (0.6)	0.00 (0.01)	A (A)	0.6 (0.6)
NBLR													0.06 (0.04)	A (A)	9.7 (9.9)	0.06 (0.04)	A (A)	9.7 (9.9)	0.06 (0.04)	A (A)	9.7 (9.9)

Intersection Queue Lengths - Unsignalized Intersections

General Notes:

- xx (xx) – AM Peak (PM Peak)

James St / Alpha St								
Movement	Approx. Storage Length (m)	Existing	Future Background			Future Total		
			2028	2033	2038	2028	2033	2038
		95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)
EBLR	350	0.9 (0.7)	1.0 (0.8)	1.0 (0.9)	1.1 (1.0)	1.2 (1.0)	1.3 (1.1)	1.4 (1.3)
NBTL	300	0.0 (0.3)	0.0 (0.3)	0.0 (0.3)	0.0 (0.3)	0.0 (0.3)	0.0 (0.3)	0.0 (0.3)

James St / Tisdale Rd								
Movement	Approx. Storage Length (m)	Existing	Future Background			Future Total		
			2028	2033	2038	2028	2033	2038
		95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)
WBLR	100	0.2 (0.0)	0.2 (0.0)	0.2 (0.0)	0.2 (0.0)	31.5 (49.7)	35.1 (58.0)	39.8 (68.4)

James St / Wilson Ave								
Movement	Approx. Storage Length (m)	Existing	Future Background			Future Total		
			2028	2033	2038	2028	2033	2038
		95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)
WBLR	150	2.4 (3.7)	2.5 (4.0)	2.6 (4.3)	2.7 (4.7)	10.1 (28.0)	10.7 (31.8)	11.5 (36.9)
SBTL	175	0.7 (1.3)	0.8 (1.5)	0.8 (1.5)	0.8 (1.6)	1.1 (2.2)	1.1 (2.3)	1.1 (2.3)

St Michael's St / Wilson Ave								
Movement	Approx. Storage Length (m)	Existing	Future Background			Future Total		
			2028	2033	2038	2028	2033	2038
		95%ile (veh)	95%ile (veh)	95%ile (veh)	95%ile (veh)	95%ile (veh)	95%ile (veh)	95%ile (veh)
NBLR	300	0.3 (0.1)	0.3 (0.1)	0.3 (0.1)	0.3 (0.1)	0.3 (0.2)	0.3 (0.2)	0.3 (0.2)

Viola Ct / Wilson Ave								
Movement	Approx. Storage Length (m)	Existing	Future Background			Future Total		
			2028	2033	2038	2028	2033	2038
		95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)
WBTL	>1km	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)	0.0 (0.2)	0.0 (0.2)	0.0 (0.2)
NBLR	300	0.5 (0.4)	0.6 (0.4)	0.6 (0.4)	0.6 (0.4)	0.9 (0.7)	0.9 (0.7)	0.9 (0.7)

Viola Ct / St Michael's St								
Movement	Approx. Storage Length (m)	Existing	Future Background			Future Total		
			2028	2033	2038	2028	2033	2038
		95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)
EBTLR	300	0.1 (0.3)	0.1 (0.3)	0.1 (0.3)	0.1 (0.3)	0.3 (0.5)	0.3 (0.5)	0.3 (0.5)
WBTLR	200	0.6 (0.2)	0.6 (0.2)	0.6 (0.2)	0.6 (0.2)	0.7 (0.4)	0.7 (0.4)	0.7 (0.4)
SBTLR	250	0.1 (0.2)	0.1 (0.2)	0.1 (0.2)	0.1 (0.2)	0.1 (0.3)	0.1 (0.3)	0.1 (0.3)

Area B Driveway / St Michael's St								
Movement	Approx. Storage Length (m)	Existing	Future Background			Future Total		
			2028	2033	2038	2028	2033	2038
		95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)
NBLR	-	Does not exist				0.1 (0.1)	0.1 (0.1)	0.1 (0.1)

Area C Driveway / Wilsone Ave								
Movement	Approx. Storage Length (m)	Existing	Future Background			Future Total		
			2028	2033	2038	2028	2033	2038
		95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)	95%ile (m)
WBTL	>1km	Does not exist				0.1 (0.2)	0.1 (0.2)	0.1 (0.2)
NBLR	-					1.5 (1.1)	1.5 (1.1)	1.5 (1.1)

Lane Group	EBL	NBL	NBT	SBT	SBR
Lane Configurations					
Traffic Volume (vph)	125	5	190	265	95
Future Volume (vph)	125	5	190	265	95
Lane Group Flow (vph)	141	5	207	288	103
Turn Type	Prot	Perm	NA	NA	Perm
Protected Phases	8		2	6	
Permitted Phases		2			6
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	25.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.54	0.01	0.16	0.22	0.09
Control Delay	40.3	5.0	5.4	5.7	1.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	40.3	5.0	5.4	5.7	1.4
Queue Length 50th (m)	22.5	0.2	10.2	14.9	0.0
Queue Length 95th (m)	38.2	1.5	21.4	29.9	5.1
Internal Link Dist (m)	15.2		262.9	161.5	
Turn Bay Length (m)		125.0			100.0
Base Capacity (vph)	598	750	1287	1287	1125
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.24	0.01	0.16	0.22	0.09

Intersection Summary
Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green
Natural Cycle: 55
Control Type: Actuated-Coordinated

Splits and Phases: 1: James St & Pine Grove Rd

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	125	5	5	190	265	95
Future Volume (vph)	125	5	5	190	265	95
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	1.00		1.00	1.00	1.00	0.85
Flt Protected	0.95		0.95	1.00	1.00	1.00
Satd. Flow (prot)	1769		1770	1863	1863	1583
Flt Permitted	0.95		0.58	1.00	1.00	1.00
Satd. Flow (perm)	1769		1087	1863	1863	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	136	5	5	207	288	103
RTOR Reduction (vph)	2	0	0	0	0	32
Lane Group Flow (vph)	139	0	5	207	288	71
Turn Type	Prot		Perm	NA	NA	Perm
Protected Phases	8			2	6	
Permitted Phases			2			6
Actuated Green, G (s)	12.6		58.7	58.7	58.7	58.7
Effective Green, g (s)	12.6		58.7	58.7	58.7	58.7
Actuated g/C Ratio	0.15		0.69	0.69	0.69	0.69
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	262		750	1286	1286	1093
v/s Ratio Prot	c0.08			0.11	c0.15	
v/s Ratio Perm			0.00			0.04
v/c Ratio	0.53		0.01	0.16	0.22	0.07
Uniform Delay, d1	33.5		4.1	4.6	4.8	4.3
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	2.1		0.0	0.3	0.4	0.1
Delay (s)	35.5		4.1	4.8	5.2	4.4
Level of Service	D		A	A	A	A
Approach Delay (s)	35.5			4.8	5.0	
Approach LOS	D			A	A	

Intersection Summary			
HCM 2000 Control Delay	10.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.28		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	10	5	0	315	355	10
Future Volume (Veh/h)	10	5	0	315	355	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	5	0	342	386	11
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)				323		
pX, platoon unblocked						
vC, conflicting volume	734	392	397			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	734	392	397			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	100			
cM capacity (veh/h)	388	657	1162			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	16	342	397
Volume Left	11	0	0
Volume Right	5	0	11
cSH	445	1162	1700
Volume to Capacity	0.04	0.00	0.23
Queue Length 95th (m)	0.9	0.0	0.0
Control Delay (s)	13.4	0.0	0.0
Lane LOS	B		
Approach Delay (s)	13.4	0.0	0.0
Approach LOS	B		

Intersection Summary				
Average Delay		0.3		
Intersection Capacity Utilization		29.3%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	0	320	5	5	365
Future Volume (Veh/h)	0	0	320	5	5	365
Sign Control	Yield		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	348	5	5	397
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	758	350			353	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	758	350			353	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	374	693			1206	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	0	353	402
Volume Left	0	0	5
Volume Right	0	5	0
cSH	1700	1700	1206
Volume to Capacity	0.02	0.21	0.00
Queue Length 95th (m)	0.0	0.0	0.1
Control Delay (s)	0.0	0.0	0.1
Lane LOS	A		A
Approach Delay (s)	0.0	0.0	0.1
Approach LOS	A		

Intersection Summary				
Average Delay		0.1		
Intersection Capacity Utilization		26.5%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	5	320	0	0	370
Future Volume (Veh/h)	0	5	320	0	0	370
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	5	348	0	0	402
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	750	348			348	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	750	348			348	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	379	695			1211	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	5	348	402
Volume Left	0	0	0
Volume Right	5	0	0
cSH	695	1700	1211
Volume to Capacity	0.01	0.20	0.00
Queue Length 95th (m)	0.2	0.0	0.0
Control Delay (s)	10.2	0.0	0.0
Lane LOS	B		
Approach Delay (s)	10.2	0.0	0.0
Approach LOS	B		

Intersection Summary				
Average Delay		0.1		
Intersection Capacity Utilization		29.5%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	15	40	310	15	30	355
Future Volume (Veh/h)	15	40	310	15	30	355
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	16	43	337	16	33	386
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	604	176			353	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	604	176			353	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	96	95			97	
cM capacity (veh/h)	418	836			1202	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	59	225	128	162	257
Volume Left	16	0	0	33	0
Volume Right	43	0	16	0	0
cSH	658	1700	1700	1202	1700
Volume to Capacity	0.09	0.13	0.08	0.03	0.15
Queue Length 95th (m)	2.4	0.0	0.0	0.7	0.0
Control Delay (s)	11.0	0.0	0.0	1.8	0.0
Lane LOS	B			A	
Approach Delay (s)	11.0	0.0		0.7	
Approach LOS	B				

Intersection Summary				
Average Delay		1.1		
Intersection Capacity Utilization		33.1%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	35	5	0	45	5	5
Future Volume (Veh/h)	35	5	0	45	5	5
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)	38	5	0	49	5	5
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			43		90	40
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			43		90	40
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		99	100
cM capacity (veh/h)			1566		911	1031

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	43	49	10
Volume Left	0	0	5
Volume Right	5	0	5
cSH	1700	1566	967
Volume to Capacity	0.03	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.3
Control Delay (s)	0.0	0.0	8.8
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.8
Approach LOS			A

Intersection Summary				
Average Delay		0.9		
Intersection Capacity Utilization		13.3%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	40	5	0	35	15	5
Future Volume (Veh/h)	40	5	0	35	15	5
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)	43	5	0	38	16	5
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			48		84	46
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			48		84	46
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		98	100
cM capacity (veh/h)			1559		918	1024

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	48	38	21
Volume Left	0	0	16
Volume Right	5	0	5
cSH	1700	1559	941
Volume to Capacity	0.03	0.00	0.02
Queue Length 95th (m)	0.0	0.0	0.5
Control Delay (s)	0.0	0.0	8.9
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.9
Approach LOS			A

Intersection Summary				
Average Delay		1.7		
Intersection Capacity Utilization		13.3%	ICU Level of Service	A
Analysis Period (min)		15		

HCM Unsignalized Intersection Capacity Analysis
8: Viola Ct & St Michael's St

Existing AM
Delhi Golf Course

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	5	0	0	10	10	0	10	0	5	0	0
Future Volume (Veh/h)	0	5	0	0	10	10	0	10	0	5	0	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	5	0	0	11	11	0	11	0	5	0	0
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	38	21	0	24	21	11	0			11		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	38	21	0	24	21	11	0			11		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	99	100	100	99	99	100			100		
cM capacity (veh/h)	946	870	1085	981	870	1070	1623			1608		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	5	22	11	5
Volume Left	0	0	0	5
Volume Right	0	11	0	0
cSH	870	960	1623	1608
Volume to Capacity	0.01	0.02	0.00	0.00
Queue Length 95th (m)	0.1	0.6	0.0	0.1
Control Delay (s)	9.2	8.8	0.0	7.2
Lane LOS	A	A		A
Approach Delay (s)	9.2	8.8	0.0	7.2
Approach LOS	A	A		

Intersection Summary				
Average Delay	6.4			
Intersection Capacity Utilization	14.2%	ICU Level of Service	A	
Analysis Period (min)	15			

Queues
1: James St & Pine Grove Rd

Existing PM
Delhi Golf Course

Lane Group	EBL	NBL	NBT	SBT	SBR
Lane Configurations					
Traffic Volume (vph)	140	5	325	305	160
Future Volume (vph)	140	5	325	305	160
Lane Group Flow (vph)	163	5	353	332	174
Turn Type	Prot	Perm	NA	NA	Perm
Protected Phases	8		2	6	
Permitted Phases		2			6
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	25.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.58	0.01	0.28	0.26	0.15
Control Delay	39.9	5.6	6.5	6.4	1.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	39.9	5.6	6.5	6.4	1.4
Queue Length 50th (m)	25.5	0.3	20.1	18.6	0.0
Queue Length 95th (m)	42.2	1.6	39.2	36.6	6.8
Internal Link Dist (m)	15.2		262.9	161.5	
Turn Bay Length (m)		125.0			100.0
Base Capacity (vph)	598	710	1268	1268	1133
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.27	0.01	0.28	0.26	0.15

Intersection Summary
Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green
Natural Cycle: 55
Control Type: Actuated-Coordinated

Splits and Phases: 1: James St & Pine Grove Rd

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	140	10	5	325	305	160
Future Volume (vph)	140	10	5	325	305	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	0.99		1.00	1.00	1.00	0.85
Flt Protected	0.96		0.95	1.00	1.00	1.00
Satd. Flow (prot)	1764		1770	1863	1863	1583
Flt Permitted	0.96		0.56	1.00	1.00	1.00
Satd. Flow (perm)	1764		1044	1863	1863	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	152	11	5	353	332	174
RTOR Reduction (vph)	4	0	0	0	0	55
Lane Group Flow (vph)	159	0	5	353	332	119
Turn Type	Prot		Perm	NA	NA	Perm
Protected Phases	8			2	6	
Permitted Phases			2			6
Actuated Green, G (s)	13.4		57.9	57.9	57.9	57.9
Effective Green, g (s)	13.4		57.9	57.9	57.9	57.9
Actuated g/C Ratio	0.16		0.68	0.68	0.68	0.68
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	278		711	1269	1269	1078
v/s Ratio Prot	c0.09			c0.19	0.18	
v/s Ratio Perm			0.00			0.07
v/c Ratio	0.57		0.01	0.28	0.26	0.11
Uniform Delay, d1	33.1		4.3	5.3	5.3	4.7
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	2.8		0.0	0.5	0.5	0.2
Delay (s)	36.0		4.4	5.9	5.8	4.9
Level of Service	D		A	A	A	A
Approach Delay (s)	36.0			5.9	5.5	
Approach LOS	D			A	A	

Intersection Summary				
HCM 2000 Control Delay	10.4	HCM 2000 Level of Service	B	
HCM 2000 Volume to Capacity ratio	0.33			
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7	
Intersection Capacity Utilization	45.7%	ICU Level of Service	A	
Analysis Period (min)	15			

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	5	5	10	455	460	10
Future Volume (Veh/h)	5	5	10	455	460	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	11	495	500	11
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)				323		
pX, platoon unblocked	0.98					
vC, conflicting volume	1022	506	511			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1012	506	511			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	99	99			
cM capacity (veh/h)	257	567	1054			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	10	506	511
Volume Left	5	11	0
Volume Right	5	0	11
cSH	353	1054	1700
Volume to Capacity	0.03	0.01	0.30
Queue Length 95th (m)	0.7	0.3	0.0
Control Delay (s)	15.5	0.3	0.0
Lane LOS	C	A	
Approach Delay (s)	15.5	0.3	0.0
Approach LOS	C		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	42.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	5	0	460	0	5	465
Future Volume (Veh/h)	5	0	460	0	5	465
Sign Control	Yield		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	0	500	0	5	505
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	1015	500			500	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1015	500			500	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	98	100			100	
cM capacity (veh/h)	263	571			1064	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	5	500	510
Volume Left	5	0	5
Volume Right	0	0	0
cSH	263	1700	1064
Volume to Capacity	0.02	0.29	0.00
Queue Length 95th (m)	0.5	0.0	0.1
Control Delay (s)	19.0	0.0	0.1
Lane LOS	C		A
Approach Delay (s)	19.0	0.0	0.1
Approach LOS	C		

Intersection Summary				
Average Delay		0.2		
Intersection Capacity Utilization		38.5%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	0	460	0	0	470
Future Volume (Veh/h)	0	0	460	0	0	470
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	500	0	0	511
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	1011	500			500	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1011	500			500	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	265	571			1064	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	0	500	511
Volume Left	0	0	0
Volume Right	0	0	0
cSH	1700	1700	1064
Volume to Capacity	0.01	0.29	0.00
Queue Length 95th (m)	0.0	0.0	0.0
Control Delay (s)	0.0	0.0	0.0
Lane LOS	A		
Approach Delay (s)	0.0	0.0	0.0
Approach LOS	A		

Intersection Summary				
Average Delay		0.0		
Intersection Capacity Utilization		28.1%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	20	40	435	25	50	450
Future Volume (Veh/h)	20	40	435	25	50	450
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	22	43	473	27	54	489
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	839	250			500	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	839	250			500	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	92	94			95	
cM capacity (veh/h)	289	750			1060	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	65	315	185	217	326
Volume Left	22	0	0	54	0
Volume Right	43	0	27	0	0
cSH	487	1700	1700	1060	1700
Volume to Capacity	0.13	0.19	0.11	0.05	0.19
Queue Length 95th (m)	3.7	0.0	0.0	1.3	0.0
Control Delay (s)	13.5	0.0	0.0	2.5	0.0
Lane LOS	B			A	
Approach Delay (s)	13.5	0.0		1.0	
Approach LOS	B				

Intersection Summary				
Average Delay	1.3			
Intersection Capacity Utilization	40.3%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	65	10	0	55	5	0
Future Volume (Veh/h)	65	10	0	55	5	0
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)	71	11	0	60	5	0
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			82		136	76
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			82		136	76
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		99	100
cM capacity (veh/h)			1515		857	985

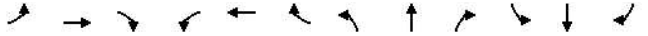
Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	82	60	5
Volume Left	0	0	5
Volume Right	11	0	0
cSH	1700	1515	857
Volume to Capacity	0.05	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.1
Control Delay (s)	0.0	0.0	9.2
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.2
Approach LOS			A

Intersection Summary				
Average Delay	0.3			
Intersection Capacity Utilization	14.0%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	45	20	5	50	10	5
Future Volume (Veh/h)	45	20	5	50	10	5
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)	49	22	5	54	11	5
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			71		124	60
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			71		124	60
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		99	100
cM capacity (veh/h)			1529		868	1005

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	71	59	16
Volume Left	0	5	11
Volume Right	22	0	5
cSH	1700	1529	907
Volume to Capacity	0.04	0.00	0.02
Queue Length 95th (m)	0.0	0.1	0.4
Control Delay (s)	0.0	0.6	9.0
Lane LOS		A	A
Approach Delay (s)	0.0	0.6	9.0
Approach LOS			A

Intersection Summary				
Average Delay			1.3	
Intersection Capacity Utilization			16.8%	ICU Level of Service A
Analysis Period (min)			15	



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	10	0	0	0	10	0	5	0	15	5	5
Future Volume (Veh/h)	0	10	0	0	0	10	0	5	0	15	5	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	11	0	0	0	11	0	5	0	16	5	5
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	56	44	8	50	47	5	10			5		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	56	44	8	50	47	5	10			5		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	99	100	100	100	99	100			99		
cM capacity (veh/h)	925	839	1075	933	836	1078	1610			1616		

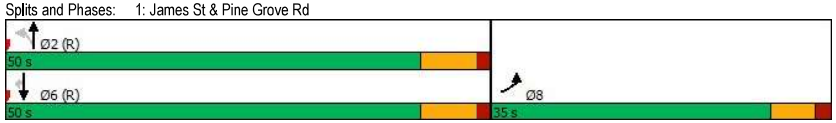
Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	11	11	5	26
Volume Left	0	0	0	16
Volume Right	0	11	0	5
cSH	839	1078	1610	1616
Volume to Capacity	0.01	0.01	0.00	0.01
Queue Length 95th (m)	0.3	0.2	0.0	0.2
Control Delay (s)	9.3	8.4	0.0	4.5
Lane LOS	A	A		A
Approach Delay (s)	9.3	8.4	0.0	4.5
Approach LOS	A	A		

Intersection Summary				
Average Delay			5.9	
Intersection Capacity Utilization			18.1%	ICU Level of Service A
Analysis Period (min)			15	

Lane Group	EBL	NBL	NBT	SBT	SBR
Lane Configurations					
Traffic Volume (vph)	125	5	210	300	95
Future Volume (vph)	125	5	210	300	95
Lane Group Flow (vph)	141	5	228	326	103
Turn Type	Prot	Perm	NA	NA	Perm
Protected Phases	8		2	6	
Permitted Phases		2			6
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	25.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.54	0.01	0.18	0.25	0.09
Control Delay	40.3	5.0	5.5	5.9	1.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	40.3	5.0	5.5	5.9	1.4
Queue Length 50th (m)	22.5	0.2	11.4	17.3	0.0
Queue Length 95th (m)	38.2	1.5	23.5	34.0	5.1
Internal Link Dist (m)	15.2		262.9	161.5	
Turn Bay Length (m)		125.0			100.0
Base Capacity (vph)	598	724	1287	1287	1125
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.24	0.01	0.18	0.25	0.09

Intersection Summary
Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green
Natural Cycle: 55
Control Type: Actuated-Coordinated

Splits and Phases: 1: James St & Pine Grove Rd



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	125	5	5	210	300	95
Future Volume (vph)	125	5	5	210	300	95
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	1.00		1.00	1.00	1.00	0.85
Flt Protected	0.95		0.95	1.00	1.00	1.00
Satd. Flow (prot)	1769		1770	1863	1863	1583
Flt Permitted	0.95		0.56	1.00	1.00	1.00
Satd. Flow (perm)	1769		1050	1863	1863	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	136	5	5	228	326	103
RTOR Reduction (vph)	2	0	0	0	0	32
Lane Group Flow (vph)	139	0	5	228	326	71
Turn Type	Prot		Perm	NA	NA	Perm
Protected Phases	8			2	6	
Permitted Phases			2			6
Actuated Green, G (s)	12.6		58.7	58.7	58.7	58.7
Effective Green, g (s)	12.6		58.7	58.7	58.7	58.7
Actuated g/C Ratio	0.15		0.69	0.69	0.69	0.69
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	262		725	1286	1286	1093
v/s Ratio Prot	c0.08			0.12	c0.18	
v/s Ratio Perm			0.00			0.04
v/c Ratio	0.53		0.01	0.18	0.25	0.07
Uniform Delay, d1	33.5		4.1	4.6	4.9	4.3
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	2.1		0.0	0.3	0.5	0.1
Delay (s)	35.5		4.1	4.9	5.4	4.4
Level of Service	D		A	A	A	A
Approach Delay (s)	35.5			4.9	5.2	
Approach LOS	D			A	A	

Intersection Summary			
HCM 2000 Control Delay	10.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.30		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	10	5	0	335	390	10
Future Volume (Veh/h)	10	5	0	335	390	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	5	0	364	424	11
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)				323		
pX, platoon unblocked						
vC, conflicting volume	794	430	435			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	794	430	435			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	100			
cM capacity (veh/h)	357	626	1125			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	16	364	435
Volume Left	11	0	0
Volume Right	5	0	11
cSH	413	1125	1700
Volume to Capacity	0.04	0.00	0.26
Queue Length 95th (m)	1.0	0.0	0.0
Control Delay (s)	14.1	0.0	0.0
Lane LOS	B		
Approach Delay (s)	14.1	0.0	0.0
Approach LOS	B		

Intersection Summary				
Average Delay		0.3		
Intersection Capacity Utilization		31.1%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	5	340	0	0	405
Future Volume (Veh/h)	0	5	340	0	0	405
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	5	370	0	0	440
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	810	370			370	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	810	370			370	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	349	676			1189	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	5	370	440
Volume Left	0	0	0
Volume Right	5	0	0
cSH	676	1700	1189
Volume to Capacity	0.01	0.22	0.00
Queue Length 95th (m)	0.2	0.0	0.0
Control Delay (s)	10.4	0.0	0.0
Lane LOS	B		
Approach Delay (s)	10.4	0.0	0.0
Approach LOS	B		

Intersection Summary				
Average Delay		0.1		
Intersection Capacity Utilization		31.3%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	15	40	330	15	35	390
Future Volume (Veh/h)	15	40	330	15	35	390
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	16	43	359	16	38	424
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	655	188			375	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	655	188			375	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	96	95			97	
cM capacity (veh/h)	386	823			1180	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	59	239	136	179	283
Volume Left	16	0	0	38	0
Volume Right	43	0	16	0	0
cSH	630	1700	1700	1180	1700
Volume to Capacity	0.09	0.14	0.08	0.03	0.17
Queue Length 95th (m)	2.5	0.0	0.0	0.8	0.0
Control Delay (s)	11.3	0.0	0.0	2.0	0.0
Lane LOS	B			A	
Approach Delay (s)	11.3	0.0		0.8	
Approach LOS	B				

Intersection Summary				
Average Delay	1.1			
Intersection Capacity Utilization	34.7%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	40	5	0	45	5	5
Future Volume (Veh/h)	40	5	0	45	5	5
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)	43	5	0	49	5	5
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			48		94	46
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			48		94	46
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		99	100
cM capacity (veh/h)			1559		905	1024

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	48	49	10
Volume Left	0	0	5
Volume Right	5	0	5
cSH	1700	1559	961
Volume to Capacity	0.03	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.3
Control Delay (s)	0.0	0.0	8.8
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.8
Approach LOS			A

Intersection Summary				
Average Delay	0.8			
Intersection Capacity Utilization	13.3%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	45	5	0	35	15	5
Future Volume (Veh/h)	45	5	0	35	15	5
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)	49	5	0	38	16	5
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			54		90	52
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			54		90	52
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		98	100
cM capacity (veh/h)			1551		911	1016

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	54	38	21
Volume Left	0	0	16
Volume Right	5	0	5
cSH	1700	1551	934
Volume to Capacity	0.03	0.00	0.02
Queue Length 95th (m)	0.0	0.0	0.6
Control Delay (s)	0.0	0.0	8.9
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.9
Approach LOS			A

Intersection Summary				
Average Delay			1.7	
Intersection Capacity Utilization			13.3%	ICU Level of Service A
Analysis Period (min)			15	

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	5	0	0	10	10	0	10	0	5	0	0
Future Volume (Veh/h)	0	5	0	0	10	10	0	10	0	5	0	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	5	0	0	11	11	0	11	0	5	0	0
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	38	21	0	24	21	11	0			11		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	38	21	0	24	21	11	0			11		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	99	100	100	99	99	100			100		
cM capacity (veh/h)	946	870	1085	981	870	1070	1623			1608		

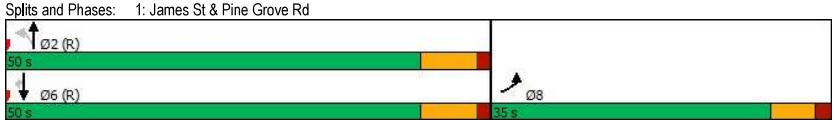
Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	5	22	11	5
Volume Left	0	0	0	5
Volume Right	0	11	0	0
cSH	870	960	1623	1608
Volume to Capacity	0.01	0.02	0.00	0.00
Queue Length 95th (m)	0.1	0.6	0.0	0.1
Control Delay (s)	9.2	8.8	0.0	7.2
Lane LOS	A	A		A
Approach Delay (s)	9.2	8.8	0.0	7.2
Approach LOS	A	A		

Intersection Summary				
Average Delay			6.4	
Intersection Capacity Utilization			14.2%	ICU Level of Service A
Analysis Period (min)			15	

Lane Group	EBL	NBL	NBT	SBT	SBR
Lane Configurations					
Traffic Volume (vph)	140	5	360	340	160
Future Volume (vph)	140	5	360	340	160
Lane Group Flow (vph)	163	5	391	370	174
Turn Type	Prot	Perm	NA	NA	Perm
Protected Phases	8		2	6	
Permitted Phases		2			6
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	25.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.58	0.01	0.31	0.29	0.15
Control Delay	39.9	5.6	6.8	6.6	1.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	39.9	5.6	6.8	6.6	1.4
Queue Length 50th (m)	25.5	0.3	22.7	21.3	0.0
Queue Length 95th (m)	42.2	1.6	44.2	41.3	6.8
Internal Link Dist (m)	15.2		262.9	161.5	
Turn Bay Length (m)		125.0			100.0
Base Capacity (vph)	598	686	1268	1268	1133
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.27	0.01	0.31	0.29	0.15

Intersection Summary
Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green
Natural Cycle: 55
Control Type: Actuated-Coordinated

Splits and Phases: 1: James St & Pine Grove Rd



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	140	10	5	360	340	160
Future Volume (vph)	140	10	5	360	340	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	0.99		1.00	1.00	1.00	0.85
Flt Protected	0.96		0.95	1.00	1.00	1.00
Satd. Flow (prot)	1764		1770	1863	1863	1583
Flt Permitted	0.96		0.54	1.00	1.00	1.00
Satd. Flow (perm)	1764		1008	1863	1863	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	152	11	5	391	370	174
RTOR Reduction (vph)	4	0	0	0	0	55
Lane Group Flow (vph)	159	0	5	391	370	119
Turn Type	Prot		Perm	NA	NA	Perm
Protected Phases	8			2	6	
Permitted Phases			2			6
Actuated Green, G (s)	13.4		57.9	57.9	57.9	57.9
Effective Green, g (s)	13.4		57.9	57.9	57.9	57.9
Actuated g/C Ratio	0.16		0.68	0.68	0.68	0.68
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	278		686	1269	1269	1078
v/s Ratio Prot	c0.09			c0.21	0.20	
v/s Ratio Perm			0.00			0.07
v/c Ratio	0.57		0.01	0.31	0.29	0.11
Uniform Delay, d1	33.1		4.3	5.5	5.4	4.7
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	2.8		0.0	0.6	0.6	0.2
Delay (s)	36.0		4.4	6.1	6.0	4.9
Level of Service	D		A	A	A	A
Approach Delay (s)	36.0			6.1	5.6	
Approach LOS	D			A	A	

Intersection Summary			
HCM 2000 Control Delay	10.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	5	5	10	490	495	10
Future Volume (Veh/h)	5	5	10	490	495	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	11	533	538	11
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)				323		
pX, platoon unblocked	0.96					
vC, conflicting volume	1098	544	549			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1081	544	549			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	99	99			
cM capacity (veh/h)	228	539	1021			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	10	544	549
Volume Left	5	11	0
Volume Right	5	0	11
cSH	321	1021	1700
Volume to Capacity	0.03	0.01	0.32
Queue Length 95th (m)	0.8	0.3	0.0
Control Delay (s)	16.6	0.3	0.0
Lane LOS	C	A	
Approach Delay (s)	16.6	0.3	0.0
Approach LOS	C		

Intersection Summary				
Average Delay		0.3		
Intersection Capacity Utilization		43.8%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	0	495	0	0	505
Future Volume (Veh/h)	0	0	495	0	0	505
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	538	0	0	549
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	1087	538			538	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1087	538			538	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	239	543			1030	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	0	538	549
Volume Left	0	0	0
Volume Right	0	0	0
cSH	1700	1700	1030
Volume to Capacity	0.01	0.32	0.00
Queue Length 95th (m)	0.0	0.0	0.0
Control Delay (s)	0.0	0.0	0.0
Lane LOS	A		
Approach Delay (s)	0.0	0.0	0.0
Approach LOS	A		

Intersection Summary				
Average Delay		0.0		
Intersection Capacity Utilization		29.9%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	20	40	470	25	55	485
Future Volume (Veh/h)	20	40	470	25	55	485
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	22	43	511	27	60	527
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	908	269			538	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	908	269			538	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	91	94			94	
cM capacity (veh/h)	259	729			1026	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	65	341	197	236	351
Volume Left	22	0	0	60	0
Volume Right	43	0	27	0	0
cSH	451	1700	1700	1026	1700
Volume to Capacity	0.14	0.20	0.12	0.06	0.21
Queue Length 95th (m)	4.0	0.0	0.0	1.5	0.0
Control Delay (s)	14.3	0.0	0.0	2.6	0.0
Lane LOS	B			A	
Approach Delay (s)	14.3	0.0		1.1	
Approach LOS	B				

Intersection Summary				
Average Delay	1.3			
Intersection Capacity Utilization	42.4%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	70	10	0	55	5	0
Future Volume (Veh/h)	70	10	0	55	5	0
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)	76	11	0	60	5	0
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			87		142	82
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			87		142	82
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		99	100
cM capacity (veh/h)			1509		851	978

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	87	60	5
Volume Left	0	0	5
Volume Right	11	0	0
cSH	1700	1509	851
Volume to Capacity	0.05	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.1
Control Delay (s)	0.0	0.0	9.3
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.3
Approach LOS			A

Intersection Summary				
Average Delay	0.3			
Intersection Capacity Utilization	14.3%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	50	20	5	50	10	5
Future Volume (Veh/h)	50	20	5	50	10	5
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)	54	22	5	54	11	5
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			76		129	65
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			76		129	65
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		99	99
cM capacity (veh/h)			1523		862	999

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	76	59	16
Volume Left	0	5	11
Volume Right	22	0	5
cSH	1700	1523	901
Volume to Capacity	0.04	0.00	0.02
Queue Length 95th (m)	0.0	0.1	0.4
Control Delay (s)	0.0	0.6	9.1
Lane LOS		A	A
Approach Delay (s)	0.0	0.6	9.1
Approach LOS			A

Intersection Summary				
Average Delay	1.2			
Intersection Capacity Utilization	16.8%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	10	0	0	0	10	0	5	0	15	5	5
Future Volume (Veh/h)	0	10	0	0	0	10	0	5	0	15	5	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	11	0	0	0	11	0	5	0	16	5	5
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	56	44	8	50	47	5	10			5		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	56	44	8	50	47	5	10			5		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	99	100	100	100	99	100			99		
cM capacity (veh/h)	925	839	1075	933	836	1078	1610			1616		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	11	11	5	26
Volume Left	0	0	0	16
Volume Right	0	11	0	5
cSH	839	1078	1610	1616
Volume to Capacity	0.01	0.01	0.00	0.01
Queue Length 95th (m)	0.3	0.2	0.0	0.2
Control Delay (s)	9.3	8.4	0.0	4.5
Lane LOS	A	A		A
Approach Delay (s)	9.3	8.4	0.0	4.5
Approach LOS	A	A		

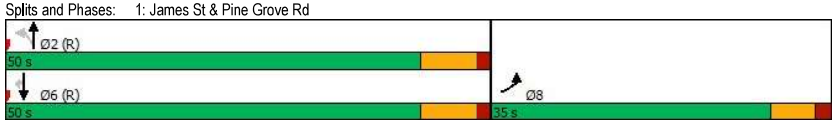
Intersection Summary				
Average Delay	5.9			
Intersection Capacity Utilization	18.1%	ICU Level of Service		A
Analysis Period (min)	15			

Lane Group	EBL	NBL	NBT	SBT	SBR
Lane Configurations					
Traffic Volume (vph)	125	5	230	330	95
Future Volume (vph)	125	5	230	330	95
Lane Group Flow (vph)	141	5	250	359	103
Turn Type	Prot	Perm	NA	NA	Perm
Protected Phases	8		2	6	
Permitted Phases		2			6
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	25.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.54	0.01	0.19	0.28	0.09
Control Delay	40.3	5.0	5.6	6.1	1.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	40.3	5.0	5.6	6.1	1.4
Queue Length 50th (m)	22.5	0.2	12.6	19.5	0.0
Queue Length 95th (m)	38.2	1.5	25.8	37.8	5.1
Internal Link Dist (m)	15.2		262.9	161.5	
Turn Bay Length (m)		125.0			100.0
Base Capacity (vph)	598	703	1287	1287	1125
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.24	0.01	0.19	0.28	0.09

Intersection Summary

Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green
Natural Cycle: 55
Control Type: Actuated-Coordinated

Splits and Phases: 1: James St & Pine Grove Rd



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	125	5	5	230	330	95
Future Volume (vph)	125	5	5	230	330	95
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	1.00		1.00	1.00	1.00	0.85
Flt Protected	0.95		0.95	1.00	1.00	1.00
Satd. Flow (prot)	1769		1770	1863	1863	1583
Flt Permitted	0.95		0.55	1.00	1.00	1.00
Satd. Flow (perm)	1769		1018	1863	1863	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	136	5	5	250	359	103
RTOR Reduction (vph)	2	0	0	0	0	32
Lane Group Flow (vph)	139	0	5	250	359	71
Turn Type	Prot		Perm	NA	NA	Perm
Protected Phases	8			2	6	
Permitted Phases			2			6
Actuated Green, G (s)	12.6		58.7	58.7	58.7	58.7
Effective Green, g (s)	12.6		58.7	58.7	58.7	58.7
Actuated g/C Ratio	0.15		0.69	0.69	0.69	0.69
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	262		703	1286	1286	1093
v/s Ratio Prot	c0.08			0.13	c0.19	
v/s Ratio Perm			0.00			0.04
v/c Ratio	0.53		0.01	0.19	0.28	0.07
Uniform Delay, d1	33.5		4.1	4.7	5.0	4.3
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	2.1		0.0	0.3	0.5	0.1
Delay (s)	35.5		4.1	5.0	5.6	4.4
Level of Service	D		A	A	A	A
Approach Delay (s)	35.5			5.0	5.3	
Approach LOS	D			A	A	

Intersection Summary

HCM 2000 Control Delay	10.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.32		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	10	5	0	355	420	10
Future Volume (Veh/h)	10	5	0	355	420	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	5	0	386	457	11
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)				323		
pX, platoon unblocked						
vC, conflicting volume	848	462	468			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	848	462	468			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	100			
cM capacity (veh/h)	332	599	1094			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	16	386	468
Volume Left	11	0	0
Volume Right	5	0	11
cSH	385	1094	1700
Volume to Capacity	0.04	0.00	0.28
Queue Length 95th (m)	1.0	0.0	0.0
Control Delay (s)	14.7	0.0	0.0
Lane LOS	B		
Approach Delay (s)	14.7	0.0	0.0
Approach LOS	B		

Intersection Summary				
Average Delay		0.3		
Intersection Capacity Utilization		32.7%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	5	360	0	0	435
Future Volume (Veh/h)	0	5	360	0	0	435
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	5	391	0	0	473
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	864	391			391	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	864	391			391	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	325	658			1168	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	5	391	473
Volume Left	0	0	0
Volume Right	5	0	0
cSH	658	1700	1168
Volume to Capacity	0.01	0.23	0.00
Queue Length 95th (m)	0.2	0.0	0.0
Control Delay (s)	10.5	0.0	0.0
Lane LOS	B		
Approach Delay (s)	10.5	0.0	0.0
Approach LOS	B		

Intersection Summary				
Average Delay		0.1		
Intersection Capacity Utilization		32.9%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	15	40	350	15	35	420
Future Volume (Veh/h)	15	40	350	15	35	420
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	16	43	380	16	38	457
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	692	198			396	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	692	198			396	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	96	95			97	
cM capacity (veh/h)	365	810			1159	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	59	253	143	190	305
Volume Left	16	0	0	38	0
Volume Right	43	0	16	0	0
cSH	609	1700	1700	1159	1700
Volume to Capacity	0.10	0.15	0.08	0.03	0.18
Queue Length 95th (m)	2.6	0.0	0.0	0.8	0.0
Control Delay (s)	11.5	0.0	0.0	1.9	0.0
Lane LOS	B			A	
Approach Delay (s)	11.5	0.0		0.7	
Approach LOS	B				

Intersection Summary				
Average Delay	1.1			
Intersection Capacity Utilization	36.1%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	40	5	0	45	5	5
Future Volume (Veh/h)	40	5	0	45	5	5
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)	43	5	0	49	5	5
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			48		94	46
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			48		94	46
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		99	100
cM capacity (veh/h)			1559		905	1024

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	48	49	10
Volume Left	0	0	5
Volume Right	5	0	5
cSH	1700	1559	961
Volume to Capacity	0.03	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.3
Control Delay (s)	0.0	0.0	8.8
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.8
Approach LOS			A

Intersection Summary				
Average Delay	0.8			
Intersection Capacity Utilization	13.3%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	45	5	0	35	15	5
Future Volume (Veh/h)	45	5	0	35	15	5
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)	49	5	0	38	16	5
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			54		90	52
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			54		90	52
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		98	100
cM capacity (veh/h)			1551		911	1016

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	54	38	21
Volume Left	0	0	16
Volume Right	5	0	5
cSH	1700	1551	934
Volume to Capacity	0.03	0.00	0.02
Queue Length 95th (m)	0.0	0.0	0.6
Control Delay (s)	0.0	0.0	8.9
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.9
Approach LOS			A

Intersection Summary				
Average Delay			1.7	
Intersection Capacity Utilization			13.3%	ICU Level of Service A
Analysis Period (min)			15	

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	5	0	0	10	10	0	10	0	5	0	0
Future Volume (Veh/h)	0	5	0	0	10	10	0	10	0	5	0	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	5	0	0	11	11	0	11	0	5	0	0
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	38	21	0	24	21	11	0			11		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	38	21	0	24	21	11	0			11		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	99	100	100	99	99	100			100		
cM capacity (veh/h)	946	870	1085	981	870	1070	1623			1608		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	5	22	11	5
Volume Left	0	0	0	5
Volume Right	0	11	0	0
cSH	870	960	1623	1608
Volume to Capacity	0.01	0.02	0.00	0.00
Queue Length 95th (m)	0.1	0.6	0.0	0.1
Control Delay (s)	9.2	8.8	0.0	7.2
Lane LOS	A	A		A
Approach Delay (s)	9.2	8.8	0.0	7.2
Approach LOS	A	A		

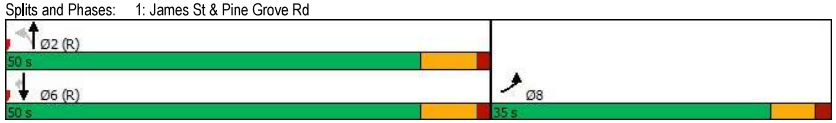
Intersection Summary				
Average Delay			6.4	
Intersection Capacity Utilization			14.2%	ICU Level of Service A
Analysis Period (min)			15	

Lane Group	EBL	NBL	NBT	SBT	SBR
Lane Configurations					
Traffic Volume (vph)	140	5	395	375	160
Future Volume (vph)	140	5	395	375	160
Lane Group Flow (vph)	163	5	429	408	174
Turn Type	Prot	Perm	NA	NA	Perm
Protected Phases	8		2	6	
Permitted Phases		2			6
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	25.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.58	0.01	0.34	0.32	0.15
Control Delay	39.9	5.6	7.0	6.9	1.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	39.9	5.6	7.0	6.9	1.4
Queue Length 50th (m)	25.5	0.3	25.6	24.1	0.0
Queue Length 95th (m)	42.2	1.6	49.3	46.3	6.8
Internal Link Dist (m)	15.2		262.9	161.5	
Turn Bay Length (m)		125.0			100.0
Base Capacity (vph)	598	656	1268	1268	1133
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.27	0.01	0.34	0.32	0.15

Intersection Summary

Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green
Natural Cycle: 55
Control Type: Actuated-Coordinated

Splits and Phases: 1: James St & Pine Grove Rd



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	140	10	5	395	375	160
Future Volume (vph)	140	10	5	395	375	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	0.99		1.00	1.00	1.00	0.85
Flt Protected	0.96		0.95	1.00	1.00	1.00
Satd. Flow (prot)	1764		1770	1863	1863	1583
Flt Permitted	0.96		0.52	1.00	1.00	1.00
Satd. Flow (perm)	1764		964	1863	1863	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	152	11	5	429	408	174
RTOR Reduction (vph)	4	0	0	0	0	55
Lane Group Flow (vph)	159	0	5	429	408	119
Turn Type	Prot		Perm	NA	NA	Perm
Protected Phases	8			2	6	
Permitted Phases			2			6
Actuated Green, G (s)	13.4		57.9	57.9	57.9	57.9
Effective Green, g (s)	13.4		57.9	57.9	57.9	57.9
Actuated g/C Ratio	0.16		0.68	0.68	0.68	0.68
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	278		656	1269	1269	1078
v/s Ratio Prot	c0.09			c0.23	0.22	
v/s Ratio Perm			0.01			0.07
v/c Ratio	0.57		0.01	0.34	0.32	0.11
Uniform Delay, d1	33.1		4.3	5.6	5.5	4.7
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	2.8		0.0	0.7	0.7	0.2
Delay (s)	36.0		4.4	6.3	6.2	4.9
Level of Service	D		A	A	A	A
Approach Delay (s)	36.0			6.3	5.8	
Approach LOS	D			A	A	

Intersection Summary

HCM 2000 Control Delay	10.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	5	5	10	525	530	10
Future Volume (Veh/h)	5	5	10	525	530	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	11	571	576	11
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)				323		
pX, platoon unblocked	0.94					
vC, conflicting volume	1174	582	587			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1153	582	587			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	99	99			
cM capacity (veh/h)	202	513	988			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	10	582	587
Volume Left	5	11	0
Volume Right	5	0	11
cSH	290	988	1700
Volume to Capacity	0.03	0.01	0.35
Queue Length 95th (m)	0.9	0.3	0.0
Control Delay (s)	17.8	0.3	0.0
Lane LOS	C	A	
Approach Delay (s)	17.8	0.3	0.0
Approach LOS	C		

Intersection Summary				
Average Delay		0.3		
Intersection Capacity Utilization		45.6%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	0	530	0	0	540
Future Volume (Veh/h)	0	0	530	0	0	540
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	576	0	0	587
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	1163	576			576	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1163	576			576	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	215	517			997	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	0	576	587
Volume Left	0	0	0
Volume Right	0	0	0
cSH	1700	1700	997
Volume to Capacity	0.01	0.34	0.00
Queue Length 95th (m)	0.0	0.0	0.0
Control Delay (s)	0.0	0.0	0.0
Lane LOS	A		
Approach Delay (s)	0.0	0.0	0.0
Approach LOS	A		

Intersection Summary				
Average Delay		0.0		
Intersection Capacity Utilization		31.8%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	20	40	505	25	55	520
Future Volume (Veh/h)	20	40	505	25	55	520
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	22	43	549	27	60	565
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	965	288			576	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	965	288			576	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	91	94			94	
cM capacity (veh/h)	237	709			993	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	65	366	210	248	377
Volume Left	22	0	0	60	0
Volume Right	43	0	27	0	0
cSH	424	1700	1700	993	1700
Volume to Capacity	0.15	0.22	0.12	0.06	0.22
Queue Length 95th (m)	4.3	0.0	0.0	1.5	0.0
Control Delay (s)	15.0	0.0	0.0	2.6	0.0
Lane LOS	C			A	
Approach Delay (s)	15.0	0.0		1.0	
Approach LOS	C				

Intersection Summary				
Average Delay	1.3			
Intersection Capacity Utilization	44.3%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	70	10	0	55	5	0
Future Volume (Veh/h)	70	10	0	55	5	0
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)	76	11	0	60	5	0
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			87		142	82
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			87		142	82
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		99	100
cM capacity (veh/h)			1509		851	978

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	87	60	5
Volume Left	0	0	5
Volume Right	11	0	0
cSH	1700	1509	851
Volume to Capacity	0.05	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.1
Control Delay (s)	0.0	0.0	9.3
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.3
Approach LOS			A

Intersection Summary				
Average Delay	0.3			
Intersection Capacity Utilization	14.3%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	50	20	5	50	10	5
Future Volume (Veh/h)	50	20	5	50	10	5
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)	54	22	5	54	11	5
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			76		129	65
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			76		129	65
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		99	99
cM capacity (veh/h)			1523		862	999

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	76	59	16
Volume Left	0	5	11
Volume Right	22	0	5
cSH	1700	1523	901
Volume to Capacity	0.04	0.00	0.02
Queue Length 95th (m)	0.0	0.1	0.4
Control Delay (s)	0.0	0.6	9.1
Lane LOS		A	A
Approach Delay (s)	0.0	0.6	9.1
Approach LOS			A

Intersection Summary				
Average Delay	1.2			
Intersection Capacity Utilization	16.8%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	10	0	0	0	10	0	5	0	15	5	5
Future Volume (Veh/h)	0	10	0	0	0	10	0	5	0	15	5	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	11	0	0	0	11	0	5	0	16	5	5
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	56	44	8	50	47	5	10			5		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	56	44	8	50	47	5	10			5		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	99	100	100	100	99	100			99		
cM capacity (veh/h)	925	839	1075	933	836	1078	1610			1616		

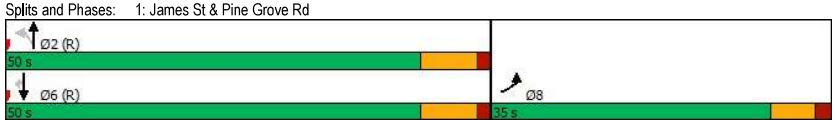
Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	11	11	5	26
Volume Left	0	0	0	16
Volume Right	0	11	0	5
cSH	839	1078	1610	1616
Volume to Capacity	0.01	0.01	0.00	0.01
Queue Length 95th (m)	0.3	0.2	0.0	0.2
Control Delay (s)	9.3	8.4	0.0	4.5
Lane LOS	A	A		A
Approach Delay (s)	9.3	8.4	0.0	4.5
Approach LOS	A	A		

Intersection Summary				
Average Delay	5.9			
Intersection Capacity Utilization	18.1%	ICU Level of Service		A
Analysis Period (min)	15			

Lane Group	EBL	NBL	NBT	SBT	SBR
Lane Configurations					
Traffic Volume (vph)	125	5	255	360	95
Future Volume (vph)	125	5	255	360	95
Lane Group Flow (vph)	141	5	277	391	103
Turn Type	Prot	Perm	NA	NA	Perm
Protected Phases	8		2	6	
Permitted Phases		2			6
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	25.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.54	0.01	0.22	0.30	0.09
Control Delay	40.3	5.0	5.7	6.3	1.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	40.3	5.0	5.7	6.3	1.4
Queue Length 50th (m)	22.5	0.2	14.3	21.7	0.0
Queue Length 95th (m)	38.2	1.5	28.7	41.8	5.1
Internal Link Dist (m)	15.2		262.9	161.5	
Turn Bay Length (m)		125.0			100.0
Base Capacity (vph)	598	683	1287	1287	1125
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.24	0.01	0.22	0.30	0.09

Intersection Summary
Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green
Natural Cycle: 55
Control Type: Actuated-Coordinated

Splits and Phases: 1: James St & Pine Grove Rd



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	125	5	5	255	360	95
Future Volume (vph)	125	5	5	255	360	95
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	1.00		1.00	1.00	1.00	0.85
Flt Protected	0.95		0.95	1.00	1.00	1.00
Satd. Flow (prot)	1769		1770	1863	1863	1583
Flt Permitted	0.95		0.53	1.00	1.00	1.00
Satd. Flow (perm)	1769		989	1863	1863	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	136	5	5	277	391	103
RTOR Reduction (vph)	2	0	0	0	0	32
Lane Group Flow (vph)	139	0	5	277	391	71
Turn Type	Prot		Perm	NA	NA	Perm
Protected Phases	8			2	6	
Permitted Phases			2			6
Actuated Green, G (s)	12.6		58.7	58.7	58.7	58.7
Effective Green, g (s)	12.6		58.7	58.7	58.7	58.7
Actuated g/C Ratio	0.15		0.69	0.69	0.69	0.69
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	262		682	1286	1286	1093
v/s Ratio Prot	c0.08			0.15	c0.21	
v/s Ratio Perm			0.01			0.04
v/c Ratio	0.53		0.01	0.22	0.30	0.07
Uniform Delay, d1	33.5		4.1	4.8	5.2	4.3
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	2.1		0.0	0.4	0.6	0.1
Delay (s)	35.5		4.1	5.2	5.8	4.4
Level of Service	D		A	A	A	A
Approach Delay (s)	35.5			5.1	5.5	
Approach LOS	D			A	A	

Intersection Summary			
HCM 2000 Control Delay	10.0	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.34		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	10	5	0	380	450	10
Future Volume (Veh/h)	10	5	0	380	450	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	5	0	413	489	11
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)				323		
pX, platoon unblocked						
vC, conflicting volume	908	494	500			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	908	494	500			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	96	99	100			
cM capacity (veh/h)	306	575	1064			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	16	413	500
Volume Left	11	0	0
Volume Right	5	0	11
cSH	358	1064	1700
Volume to Capacity	0.04	0.00	0.29
Queue Length 95th (m)	1.1	0.0	0.0
Control Delay (s)	15.5	0.0	0.0
Lane LOS	C		
Approach Delay (s)	15.5	0.0	0.0
Approach LOS	C		

Intersection Summary				
Average Delay		0.3		
Intersection Capacity Utilization		34.3%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	5	385	0	0	465
Future Volume (Veh/h)	0	5	385	0	0	465
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	5	418	0	0	505
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	923	418			418	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	923	418			418	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	299	635			1141	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	5	418	505
Volume Left	0	0	0
Volume Right	5	0	0
cSH	635	1700	1141
Volume to Capacity	0.01	0.25	0.00
Queue Length 95th (m)	0.2	0.0	0.0
Control Delay (s)	10.7	0.0	0.0
Lane LOS	B		
Approach Delay (s)	10.7	0.0	0.0
Approach LOS	B		

Intersection Summary				
Average Delay		0.1		
Intersection Capacity Utilization		34.5%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	15	40	375	15	35	450
Future Volume (Veh/h)	15	40	375	15	35	450
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	16	43	408	16	38	489
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	736	212			424	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	736	212			424	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	95	95			97	
cM capacity (veh/h)	342	793			1132	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	59	272	152	201	326
Volume Left	16	0	0	38	0
Volume Right	43	0	16	0	0
cSH	584	1700	1700	1132	1700
Volume to Capacity	0.10	0.16	0.09	0.03	0.19
Queue Length 95th (m)	2.7	0.0	0.0	0.8	0.0
Control Delay (s)	11.9	0.0	0.0	1.8	0.0
Lane LOS	B			A	
Approach Delay (s)	11.9	0.0		0.7	
Approach LOS	B				

Intersection Summary				
Average Delay	1.1			
Intersection Capacity Utilization	37.6%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	40	5	0	45	5	5
Future Volume (Veh/h)	40	5	0	45	5	5
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)	43	5	0	49	5	5
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			48		94	46
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			48		94	46
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		99	100
cM capacity (veh/h)			1559		905	1024

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	48	49	10
Volume Left	0	0	5
Volume Right	5	0	5
cSH	1700	1559	961
Volume to Capacity	0.03	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.3
Control Delay (s)	0.0	0.0	8.8
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.8
Approach LOS			A

Intersection Summary				
Average Delay	0.8			
Intersection Capacity Utilization	13.3%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	45	5	0	35	15	5
Future Volume (Veh/h)	45	5	0	35	15	5
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)	49	5	0	38	16	5
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			54		90	52
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			54		90	52
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		98	100
cM capacity (veh/h)			1551		911	1016

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	54	38	21
Volume Left	0	0	16
Volume Right	5	0	5
cSH	1700	1551	934
Volume to Capacity	0.03	0.00	0.02
Queue Length 95th (m)	0.0	0.0	0.6
Control Delay (s)	0.0	0.0	8.9
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.9
Approach LOS			A

Intersection Summary				
Average Delay			1.7	
Intersection Capacity Utilization			13.3%	ICU Level of Service A
Analysis Period (min)			15	

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	5	0	0	10	10	0	10	0	5	0	0
Future Volume (Veh/h)	0	5	0	0	10	10	0	10	0	5	0	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	5	0	0	11	11	0	11	0	5	0	0
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	38	21	0	24	21	11	0			11		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	38	21	0	24	21	11	0			11		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	99	100	100	99	99	100			100		
cM capacity (veh/h)	946	870	1085	981	870	1070	1623			1608		

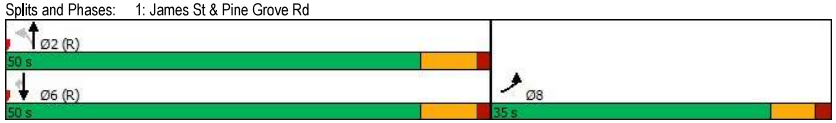
Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	5	22	11	5
Volume Left	0	0	0	5
Volume Right	0	11	0	0
cSH	870	960	1623	1608
Volume to Capacity	0.01	0.02	0.00	0.00
Queue Length 95th (m)	0.1	0.6	0.0	0.1
Control Delay (s)	9.2	8.8	0.0	7.2
Lane LOS	A	A		A
Approach Delay (s)	9.2	8.8	0.0	7.2
Approach LOS	A	A		

Intersection Summary				
Average Delay			6.4	
Intersection Capacity Utilization			14.2%	ICU Level of Service A
Analysis Period (min)			15	

Lane Group	EBL	NBL	NBT	SBT	SBR
Lane Configurations					
Traffic Volume (vph)	140	5	435	415	160
Future Volume (vph)	140	5	435	415	160
Lane Group Flow (vph)	163	5	473	451	174
Turn Type	Prot	Perm	NA	NA	Perm
Protected Phases	8		2	6	
Permitted Phases		2			6
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	25.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.58	0.01	0.37	0.36	0.15
Control Delay	39.9	5.6	7.3	7.2	1.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	39.9	5.6	7.3	7.2	1.4
Queue Length 50th (m)	25.5	0.3	29.2	27.4	0.0
Queue Length 95th (m)	42.2	1.6	55.5	52.3	6.8
Internal Link Dist (m)	15.2		262.9	161.5	
Turn Bay Length (m)		125.0			100.0
Base Capacity (vph)	598	618	1268	1268	1133
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.27	0.01	0.37	0.36	0.15

Intersection Summary
Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green
Natural Cycle: 55
Control Type: Actuated-Coordinated

Splits and Phases: 1: James St & Pine Grove Rd



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	140	10	5	435	415	160
Future Volume (vph)	140	10	5	435	415	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	0.99		1.00	1.00	1.00	0.85
Flt Protected	0.96		0.95	1.00	1.00	1.00
Satd. Flow (prot)	1764		1770	1863	1863	1583
Flt Permitted	0.96		0.49	1.00	1.00	1.00
Satd. Flow (perm)	1764		909	1863	1863	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	152	11	5	473	451	174
RTOR Reduction (vph)	4	0	0	0	0	55
Lane Group Flow (vph)	159	0	5	473	451	119
Turn Type	Prot		Perm	NA	NA	Perm
Protected Phases	8			2	6	
Permitted Phases			2			6
Actuated Green, G (s)	13.4		57.9	57.9	57.9	57.9
Effective Green, g (s)	13.4		57.9	57.9	57.9	57.9
Actuated g/C Ratio	0.16		0.68	0.68	0.68	0.68
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	278		619	1269	1269	1078
v/s Ratio Prot	c0.09			c0.25	0.24	
v/s Ratio Perm			0.01			0.07
v/c Ratio	0.57		0.01	0.37	0.36	0.11
Uniform Delay, d1	33.1		4.3	5.8	5.7	4.7
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	2.8		0.0	0.8	0.8	0.2
Delay (s)	36.0		4.4	6.6	6.5	4.9
Level of Service	D		A	A	A	A
Approach Delay (s)	36.0			6.6	6.0	
Approach LOS	D			A	A	

Intersection Summary			
HCM 2000 Control Delay	10.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	5	5	10	565	570	10
Future Volume (Veh/h)	5	5	10	565	570	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	11	614	620	11
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)				323		
pX, platoon unblocked	0.91					
vC, conflicting volume	1262	626	631			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1239	626	631			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	99			
cM capacity (veh/h)	175	484	951			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	10	625	631
Volume Left	5	11	0
Volume Right	5	0	11
cSH	257	951	1700
Volume to Capacity	0.04	0.01	0.37
Queue Length 95th (m)	1.0	0.3	0.0
Control Delay (s)	19.6	0.3	0.0
Lane LOS	C	A	
Approach Delay (s)	19.6	0.3	0.0
Approach LOS	C		

Intersection Summary				
Average Delay		0.3		
Intersection Capacity Utilization		47.7%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	0	570	0	0	580
Future Volume (Veh/h)	0	0	570	0	0	580
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	620	0	0	630
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	1250	620			620	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1250	620			620	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	191	488			960	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	0	620	630
Volume Left	0	0	0
Volume Right	0	0	0
cSH	1700	1700	960
Volume to Capacity	0.01	0.36	0.00
Queue Length 95th (m)	0.0	0.0	0.0
Control Delay (s)	0.0	0.0	0.0
Lane LOS	A		
Approach Delay (s)	0.0	0.0	0.0
Approach LOS	A		

Intersection Summary				
Average Delay		0.0		
Intersection Capacity Utilization		33.9%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	20	40	545	25	55	560
Future Volume (Veh/h)	20	40	545	25	55	560
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	22	43	592	27	60	609
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	1030	310			619	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1030	310			619	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	90	94			94	
cM capacity (veh/h)	215	686			957	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	65	395	224	263	406
Volume Left	22	0	0	60	0
Volume Right	43	0	27	0	0
cSH	394	1700	1700	957	1700
Volume to Capacity	0.17	0.23	0.13	0.06	0.24
Queue Length 95th (m)	4.7	0.0	0.0	1.6	0.0
Control Delay (s)	15.9	0.0	0.0	2.6	0.0
Lane LOS	C			A	
Approach Delay (s)	15.9	0.0		1.0	
Approach LOS	C				

Intersection Summary				
Average Delay	1.3			
Intersection Capacity Utilization	46.5%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	70	10	0	55	5	0
Future Volume (Veh/h)	70	10	0	55	5	0
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)	76	11	0	60	5	0
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			87		142	82
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			87		142	82
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		99	100
cM capacity (veh/h)			1509		851	978

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	87	60	5
Volume Left	0	0	5
Volume Right	11	0	0
cSH	1700	1509	851
Volume to Capacity	0.05	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.1
Control Delay (s)	0.0	0.0	9.3
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.3
Approach LOS			A

Intersection Summary				
Average Delay	0.3			
Intersection Capacity Utilization	14.3%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	50	20	5	50	10	5
Future Volume (Veh/h)	50	20	5	50	10	5
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)	54	22	5	54	11	5
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			76		129	65
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			76		129	65
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		99	99
cM capacity (veh/h)			1523		862	999

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	76	59	16
Volume Left	0	5	11
Volume Right	22	0	5
cSH	1700	1523	901
Volume to Capacity	0.04	0.00	0.02
Queue Length 95th (m)	0.0	0.1	0.4
Control Delay (s)	0.0	0.6	9.1
Lane LOS		A	A
Approach Delay (s)	0.0	0.6	9.1
Approach LOS			A

Intersection Summary				
Average Delay			1.2	
Intersection Capacity Utilization			16.8%	ICU Level of Service A
Analysis Period (min)			15	

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	10	0	0	0	10	0	5	0	15	5	5
Future Volume (Veh/h)	0	10	0	0	0	10	0	5	0	15	5	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	11	0	0	0	11	0	5	0	16	5	5
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	56	44	8	50	47	5	10			5		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	56	44	8	50	47	5	10			5		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	99	100	100	100	99	100			99		
cM capacity (veh/h)	925	839	1075	933	836	1078	1610			1616		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	11	11	5	26
Volume Left	0	0	0	16
Volume Right	0	11	0	5
cSH	839	1078	1610	1616
Volume to Capacity	0.01	0.01	0.00	0.01
Queue Length 95th (m)	0.3	0.2	0.0	0.2
Control Delay (s)	9.3	8.4	0.0	4.5
Lane LOS	A	A		A
Approach Delay (s)	9.3	8.4	0.0	4.5
Approach LOS	A	A		

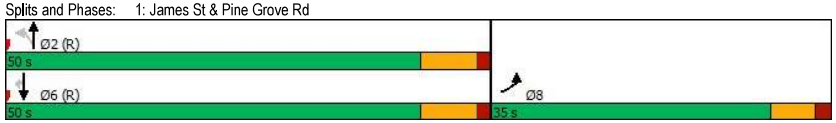
Intersection Summary				
Average Delay			5.9	
Intersection Capacity Utilization			18.1%	ICU Level of Service A
Analysis Period (min)			15	

Lane Group	EBL	NBL	NBT	SBT	SBR
Lane Configurations					
Traffic Volume (vph)	145	5	240	365	140
Future Volume (vph)	145	5	240	365	140
Lane Group Flow (vph)	163	5	261	397	152
Turn Type	Prot	Perm	NA	NA	Perm
Protected Phases	8		2	6	
Permitted Phases		2			6
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	25.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.58	0.01	0.21	0.31	0.14
Control Delay	40.5	5.6	6.1	6.8	1.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	40.5	5.6	6.1	6.8	1.4
Queue Length 50th (m)	26.0	0.3	14.0	23.3	0.0
Queue Length 95th (m)	42.7	1.6	28.5	44.9	6.4
Internal Link Dist (m)	15.2		262.9	161.5	
Turn Bay Length (m)		125.0			100.0
Base Capacity (vph)	598	665	1267	1267	1125
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.27	0.01	0.21	0.31	0.14

Intersection Summary

Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green
Natural Cycle: 55
Control Type: Actuated-Coordinated

Splits and Phases: 1: James St & Pine Grove Rd



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	145	5	5	240	365	140
Future Volume (vph)	145	5	5	240	365	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	1.00		1.00	1.00	1.00	0.85
Flt Protected	0.95		0.95	1.00	1.00	1.00
Satd. Flow (prot)	1769		1770	1863	1863	1583
Flt Permitted	0.95		0.53	1.00	1.00	1.00
Satd. Flow (perm)	1769		978	1863	1863	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	158	5	5	261	397	152
RTOR Reduction (vph)	2	0	0	0	0	49
Lane Group Flow (vph)	161	0	5	261	397	103
Turn Type	Prot		Perm	NA	NA	Perm
Protected Phases	8			2	6	
Permitted Phases			2			6
Actuated Green, G (s)	13.5		57.8	57.8	57.8	57.8
Effective Green, g (s)	13.5		57.8	57.8	57.8	57.8
Actuated g/C Ratio	0.16		0.68	0.68	0.68	0.68
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	280		665	1266	1266	1076
v/s Ratio Prot	c0.09			0.14	c0.21	
v/s Ratio Perm			0.01			0.07
v/c Ratio	0.58		0.01	0.21	0.31	0.10
Uniform Delay, d1	33.1		4.4	5.1	5.5	4.7
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	2.9		0.0	0.4	0.6	0.2
Delay (s)	36.0		4.4	5.4	6.2	4.8
Level of Service	D		A	A	A	A
Approach Delay (s)	36.0			5.4	5.8	
Approach LOS	D			A	A	

Intersection Summary

HCM 2000 Control Delay	10.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	10	5	0	385	500	10
Future Volume (Veh/h)	10	5	0	385	500	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	5	0	418	543	11
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)				323		
pX, platoon unblocked						
vC, conflicting volume	966	548	554			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	966	548	554			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	96	99	100			
cM capacity (veh/h)	282	536	1016			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	16	418	554
Volume Left	11	0	0
Volume Right	5	0	11
cSH	331	1016	1700
Volume to Capacity	0.05	0.00	0.33
Queue Length 95th (m)	1.2	0.0	0.0
Control Delay (s)	16.4	0.0	0.0
Lane LOS	C		
Approach Delay (s)	16.4	0.0	0.0
Approach LOS	C		

Intersection Summary				
Average Delay		0.3		
Intersection Capacity Utilization		36.9%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	90	145	355	40	60	420
Future Volume (Veh/h)	90	145	355	40	60	420
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	98	158	386	43	65	457
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	973	386			429	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	973	386			429	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	63	76			94	
cM capacity (veh/h)	264	662			1130	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	256	386	43	65	457
Volume Left	98	0	0	65	0
Volume Right	158	0	43	0	0
cSH	419	1700	1700	1130	1700
Volume to Capacity	0.61	0.23	0.03	0.06	0.27
Queue Length 95th (m)	31.5	0.0	0.0	1.5	0.0
Control Delay (s)	26.1	0.0	0.0	8.4	0.0
Lane LOS	D			A	
Approach Delay (s)	26.1	0.0		1.0	
Approach LOS	D				

Intersection Summary				
Average Delay		6.0		
Intersection Capacity Utilization		45.9%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	60	60	410	90	40	420
Future Volume (Veh/h)	60	60	410	90	40	420
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	65	65	446	98	43	457
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	810	272			544	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	810	272			544	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	79	91			96	
cM capacity (veh/h)	305	726			1021	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	130	297	247	195	305
Volume Left	65	0	0	43	0
Volume Right	65	0	98	0	0
cSH	429	1700	1700	1021	1700
Volume to Capacity	0.30	0.17	0.15	0.04	0.18
Queue Length 95th (m)	10.1	0.0	0.0	1.1	0.0
Control Delay (s)	17.0	0.0	0.0	2.2	0.0
Lane LOS	C			A	
Approach Delay (s)	17.0	0.0		0.9	
Approach LOS	C				

Intersection Summary				
Average Delay	2.3			
Intersection Capacity Utilization	44.0%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	115	10	0	110	5	5
Future Volume (Veh/h)	115	10	0	110	5	5
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)	125	11	0	120	5	5
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			136		250	130
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			136		250	130
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		99	99
cM capacity (veh/h)			1448		738	919

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	136	120	10
Volume Left	0	0	5
Volume Right	11	0	5
cSH	1700	1448	819
Volume to Capacity	0.08	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.3
Control Delay (s)	0.0	0.0	9.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.5
Approach LOS			A

Intersection Summary				
Average Delay	0.4			
Intersection Capacity Utilization	16.7%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	120	5	0	95	20	5
Future Volume (Veh/h)	120	5	0	95	20	5
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)	130	5	0	103	22	5
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			135		236	132
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			135		236	132
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)			1449		753	917

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	135	103	27
Volume Left	0	0	22
Volume Right	5	0	5
cSH	1700	1449	779
Volume to Capacity	0.08	0.00	0.03
Queue Length 95th (m)	0.0	0.0	0.9
Control Delay (s)	0.0	0.0	9.8
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.8
Approach LOS			A

Intersection Summary				
Average Delay			1.0	
Intersection Capacity Utilization			16.6%	ICU Level of Service
Analysis Period (min)			15	

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	10	0	0	10	15	0	10	0	5	0	0
Future Volume (Veh/h)	0	10	0	0	10	15	0	10	0	5	0	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	11	0	0	11	16	0	11	0	5	0	0
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	42	21	0	26	21	11	0			11		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	42	21	0	26	21	11	0			11		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	99	100	100	99	99	100			100		
cM capacity (veh/h)	935	870	1085	972	870	1070	1623			1608		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	11	27	11	5
Volume Left	0	0	0	5
Volume Right	0	16	0	0
cSH	870	978	1623	1608
Volume to Capacity	0.01	0.03	0.00	0.00
Queue Length 95th (m)	0.3	0.7	0.0	0.1
Control Delay (s)	9.2	8.8	0.0	7.2
Lane LOS	A	A		A
Approach Delay (s)	9.2	8.8	0.0	7.2
Approach LOS	A	A		

Intersection Summary				
Average Delay			6.9	
Intersection Capacity Utilization			14.2%	ICU Level of Service
Analysis Period (min)			15	

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	10	5	0	20	5	0
Future Volume (Veh/h)	10	5	0	20	5	0
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)	11	5	0	22	5	0
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			16		36	14
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			16		36	14
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		99	100
cM capacity (veh/h)			1602		977	1067

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	16	22	5
Volume Left	0	0	5
Volume Right	5	0	0
cSH	1700	1602	977
Volume to Capacity	0.01	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.1
Control Delay (s)	0.0	0.0	8.7
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.7
Approach LOS			A

Intersection Summary				
Average Delay		1.0		
Intersection Capacity Utilization		13.3%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	110	15	5	60	35	10
Future Volume (Veh/h)	110	15	5	60	35	10
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)	120	16	5	65	38	11
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			136		203	128
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			136		203	128
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		95	99
cM capacity (veh/h)			1448		783	922

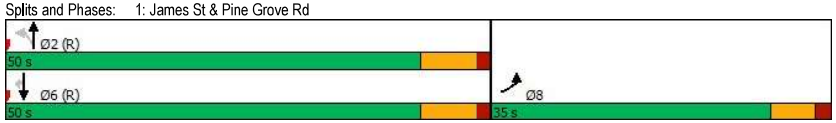
Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	136	70	49
Volume Left	0	5	38
Volume Right	16	0	11
cSH	1700	1448	810
Volume to Capacity	0.08	0.00	0.06
Queue Length 95th (m)	0.0	0.1	1.5
Control Delay (s)	0.0	0.6	9.7
Lane LOS		A	A
Approach Delay (s)	0.0	0.6	9.7
Approach LOS			A

Intersection Summary				
Average Delay		2.0		
Intersection Capacity Utilization		17.3%	ICU Level of Service	A
Analysis Period (min)		15		

Lane Group	EBL	NBL	NBT	SBT	SBR
Lane Configurations					
Traffic Volume (vph)	180	5	430	385	190
Future Volume (vph)	180	5	430	385	190
Lane Group Flow (vph)	207	5	467	418	207
Turn Type	Prot	Perm	NA	NA	Perm
Protected Phases	8		2	6	
Permitted Phases		2			6
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	25.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.65	0.01	0.38	0.34	0.19
Control Delay	40.7	6.4	8.4	8.0	1.5
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	40.7	6.4	8.4	8.0	1.5
Queue Length 50th (m)	32.6	0.3	31.6	27.4	0.0
Queue Length 95th (m)	50.8	1.7	60.2	52.7	8.1
Internal Link Dist (m)	15.2		262.9	161.5	
Turn Bay Length (m)		125.0			100.0
Base Capacity (vph)	598	620	1228	1228	1114
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.35	0.01	0.38	0.34	0.19

Intersection Summary
Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green
Natural Cycle: 55
Control Type: Actuated-Coordinated

Splits and Phases: 1: James St & Pine Grove Rd



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	180	10	5	430	385	190
Future Volume (vph)	180	10	5	430	385	190
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	0.99		1.00	1.00	1.00	0.85
Flt Protected	0.95		0.95	1.00	1.00	1.00
Satd. Flow (prot)	1766		1770	1863	1863	1583
Flt Permitted	0.95		0.51	1.00	1.00	1.00
Satd. Flow (perm)	1766		941	1863	1863	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	196	11	5	467	418	207
RTOR Reduction (vph)	3	0	0	0	0	71
Lane Group Flow (vph)	204	0	5	467	418	136
Turn Type	Prot		Perm	NA	NA	Perm
Protected Phases	8			2	6	
Permitted Phases			2			6
Actuated Green, G (s)	15.3		56.0	56.0	56.0	56.0
Effective Green, g (s)	15.3		56.0	56.0	56.0	56.0
Actuated g/C Ratio	0.18		0.66	0.66	0.66	0.66
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	317		619	1227	1227	1042
v/s Ratio Prot	c0.12			c0.25	0.22	
v/s Ratio Perm			0.01			0.09
v/c Ratio	0.64		0.01	0.38	0.34	0.13
Uniform Delay, d1	32.3		5.0	6.6	6.4	5.4
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	4.4		0.0	0.9	0.8	0.3
Delay (s)	36.7		5.0	7.5	7.1	5.7
Level of Service	D		A	A	A	A
Approach Delay (s)	36.7			7.5	6.7	
Approach LOS	D			A	A	

Intersection Summary			
HCM 2000 Control Delay	11.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	5	5	10	600	570	10
Future Volume (Veh/h)	5	5	10	600	570	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	11	652	620	11
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)				323		
pX, platoon unblocked	0.90					
vC, conflicting volume	1300	626	631			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1278	626	631			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	99			
cM capacity (veh/h)	164	484	951			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	10	663	631
Volume Left	5	11	0
Volume Right	5	0	11
cSH	245	951	1700
Volume to Capacity	0.04	0.01	0.37
Queue Length 95th (m)	1.0	0.3	0.0
Control Delay (s)	20.3	0.3	0.0
Lane LOS	C	A	
Approach Delay (s)	20.3	0.3	0.0
Approach LOS	C		

Intersection Summary				
Average Delay		0.3		
Intersection Capacity Utilization		49.6%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	70	105	515	90	140	510
Future Volume (Veh/h)	70	105	515	90	140	510
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	76	114	560	98	152	554
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	1418	560			658	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1418	560			658	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	40	78			84	
cM capacity (veh/h)	126	528			930	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	190	560	98	152	554
Volume Left	76	0	0	152	0
Volume Right	114	0	98	0	0
cSH	232	1700	1700	930	1700
Volume to Capacity	0.82	0.33	0.06	0.16	0.33
Queue Length 95th (m)	49.7	0.0	0.0	4.7	0.0
Control Delay (s)	65.5	0.0	0.0	9.6	0.0
Lane LOS	F			A	
Approach Delay (s)	65.5	0.0		2.1	
Approach LOS	F				

Intersection Summary				
Average Delay		9.0		
Intersection Capacity Utilization		55.2%	ICU Level of Service	B
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	90	55	530	90	70	560
Future Volume (Veh/h)	90	55	530	90	70	560
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	98	60	576	98	76	609
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	1082	337			674	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1082	337			674	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	50	91			92	
cM capacity (veh/h)	195	659			913	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	158	384	290	279	406
Volume Left	98	0	0	76	0
Volume Right	60	0	98	0	0
cSH	266	1700	1700	913	1700
Volume to Capacity	0.59	0.23	0.17	0.08	0.24
Queue Length 95th (m)	28.0	0.0	0.0	2.2	0.0
Control Delay (s)	36.6	0.0	0.0	3.2	0.0
Lane LOS	E			A	
Approach Delay (s)	36.6	0.0		1.3	
Approach LOS	E				

Intersection Summary				
Average Delay	4.4			
Intersection Capacity Utilization	53.4%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	145	15	0	140	5	0
Future Volume (Veh/h)	145	15	0	140	5	0
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)	158	16	0	152	5	0
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			174		318	166
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			174		318	166
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		99	100
cM capacity (veh/h)			1403		675	878

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	174	152	5
Volume Left	0	0	5
Volume Right	16	0	0
cSH	1700	1403	675
Volume to Capacity	0.10	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.2
Control Delay (s)	0.0	0.0	10.4
Lane LOS			B
Approach Delay (s)	0.0	0.0	10.4
Approach LOS			B

Intersection Summary				
Average Delay	0.2			
Intersection Capacity Utilization	18.5%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	125	20	10	130	15	5
Future Volume (Veh/h)	125	20	10	130	15	5
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)	136	22	11	141	16	5
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			158		310	147
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			158		310	147
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		98	99
cM capacity (veh/h)			1422		677	900

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	158	152	21
Volume Left	0	11	16
Volume Right	22	0	5
cSH	1700	1422	720
Volume to Capacity	0.09	0.01	0.03
Queue Length 95th (m)	0.0	0.2	0.7
Control Delay (s)	0.0	0.6	10.2
Lane LOS		A	B
Approach Delay (s)	0.0	0.6	10.2
Approach LOS			B

Intersection Summary				
Average Delay			0.9	
Intersection Capacity Utilization			25.1%	ICU Level of Service A
Analysis Period (min)			15	

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	15	0	0	0	15	0	5	0	20	5	5
Future Volume (Veh/h)	0	15	0	0	0	15	0	5	0	20	5	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	16	0	0	0	16	0	5	0	22	5	5
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	72	56	8	64	59	5	10			5		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	72	56	8	64	59	5	10			5		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	98	100	100	100	99	100			99		
cM capacity (veh/h)	895	823	1075	906	821	1078	1610			1616		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	16	16	5	32
Volume Left	0	0	0	22
Volume Right	0	16	0	5
cSH	823	1078	1610	1616
Volume to Capacity	0.02	0.01	0.00	0.01
Queue Length 95th (m)	0.5	0.4	0.0	0.3
Control Delay (s)	9.5	8.4	0.0	5.0
Lane LOS	A	A		A
Approach Delay (s)	9.5	8.4	0.0	5.0
Approach LOS	A	A		

Intersection Summary				
Average Delay			6.5	
Intersection Capacity Utilization			18.3%	ICU Level of Service A
Analysis Period (min)			15	

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	25	10	0	10	5	0
Future Volume (Veh/h)	25	10	0	10	5	0
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)	27	11	0	11	5	0
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			38		44	32
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			38		44	32
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		99	100
cM capacity (veh/h)			1572		967	1041

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	38	11	5
Volume Left	0	0	5
Volume Right	11	0	0
cSH	1700	1572	967
Volume to Capacity	0.02	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.1
Control Delay (s)	0.0	0.0	8.7
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.7
Approach LOS			A

Intersection Summary				
Average Delay			0.8	
Intersection Capacity Utilization			13.3%	ICU Level of Service A
Analysis Period (min)			15	

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	100	30	10	120	20	10
Future Volume (Veh/h)	100	30	10	120	20	10
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)	109	33	11	130	22	11
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			142		278	126
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			142		278	126
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)			1441		707	925

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	142	141	33
Volume Left	0	11	22
Volume Right	33	0	11
cSH	1700	1441	767
Volume to Capacity	0.08	0.01	0.04
Queue Length 95th (m)	0.0	0.2	1.1
Control Delay (s)	0.0	0.6	9.9
Lane LOS		A	A
Approach Delay (s)	0.0	0.6	9.9
Approach LOS			A

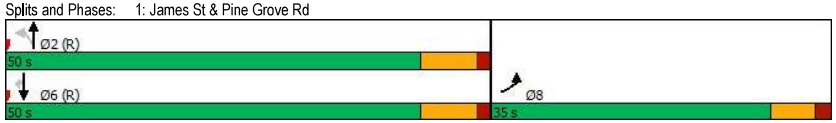
Intersection Summary				
Average Delay			1.3	
Intersection Capacity Utilization			24.6%	ICU Level of Service A
Analysis Period (min)			15	

Lane Group	EBL	NBL	NBT	SBT	SBR
Lane Configurations					
Traffic Volume (vph)	145	5	260	395	140
Future Volume (vph)	145	5	260	395	140
Lane Group Flow (vph)	163	5	283	429	152
Turn Type	Prot	Perm	NA	NA	Perm
Protected Phases	8		2	6	
Permitted Phases		2			6
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	25.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.58	0.01	0.22	0.34	0.14
Control Delay	40.5	5.6	6.2	7.1	1.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	40.5	5.6	6.2	7.1	1.4
Queue Length 50th (m)	26.0	0.3	15.4	25.8	0.0
Queue Length 95th (m)	42.7	1.6	30.9	49.3	6.4
Internal Link Dist (m)	15.2		262.9	161.5	
Turn Bay Length (m)		125.0			100.0
Base Capacity (vph)	598	637	1267	1267	1125
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.27	0.01	0.22	0.34	0.14

Intersection Summary

Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green
Natural Cycle: 55
Control Type: Actuated-Coordinated

Splits and Phases: 1: James St & Pine Grove Rd



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	145	5	5	260	395	140
Future Volume (vph)	145	5	5	260	395	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	1.00		1.00	1.00	1.00	0.85
Flt Protected	0.95		0.95	1.00	1.00	1.00
Satd. Flow (prot)	1769		1770	1863	1863	1583
Flt Permitted	0.95		0.50	1.00	1.00	1.00
Satd. Flow (perm)	1769		937	1863	1863	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	158	5	5	283	429	152
RTOR Reduction (vph)	2	0	0	0	0	49
Lane Group Flow (vph)	161	0	5	283	429	103
Turn Type	Prot		Perm	NA	NA	Perm
Protected Phases	8			2	6	
Permitted Phases			2			6
Actuated Green, G (s)	13.5		57.8	57.8	57.8	57.8
Effective Green, g (s)	13.5		57.8	57.8	57.8	57.8
Actuated g/C Ratio	0.16		0.68	0.68	0.68	0.68
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	280		637	1266	1266	1076
v/s Ratio Prot	c0.09			0.15	c0.23	
v/s Ratio Perm			0.01			0.07
v/c Ratio	0.58		0.01	0.22	0.34	0.10
Uniform Delay, d1	33.1		4.4	5.1	5.7	4.7
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	2.9		0.0	0.4	0.7	0.2
Delay (s)	36.0		4.4	5.5	6.4	4.8
Level of Service	D		A	A	A	A
Approach Delay (s)	36.0			5.5	6.0	
Approach LOS	D			A	A	

Intersection Summary

HCM 2000 Control Delay	10.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	10	5	0	405	530	10
Future Volume (Veh/h)	10	5	0	405	530	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	5	0	440	576	11
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)				323		
pX, platoon unblocked						
vC, conflicting volume	1022	582	587			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1022	582	587			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	96	99	100			
cM capacity (veh/h)	262	513	988			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	16	440	587
Volume Left	11	0	0
Volume Right	5	0	11
cSH	309	988	1700
Volume to Capacity	0.05	0.00	0.35
Queue Length 95th (m)	1.3	0.0	0.0
Control Delay (s)	17.3	0.0	0.0
Lane LOS	C		
Approach Delay (s)	17.3	0.0	0.0
Approach LOS	C		

Intersection Summary				
Average Delay		0.3		
Intersection Capacity Utilization		38.5%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	90	145	375	40	60	450
Future Volume (Veh/h)	90	145	375	40	60	450
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	98	158	408	43	65	489
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	1027	408			451	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1027	408			451	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	60	75			94	
cM capacity (veh/h)	244	643			1109	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	256	408	43	65	489
Volume Left	98	0	0	65	0
Volume Right	158	0	43	0	0
cSH	396	1700	1700	1109	1700
Volume to Capacity	0.65	0.24	0.03	0.06	0.29
Queue Length 95th (m)	35.1	0.0	0.0	1.5	0.0
Control Delay (s)	29.3	0.0	0.0	8.4	0.0
Lane LOS	D			A	
Approach Delay (s)	29.3	0.0		1.0	
Approach LOS	D				

Intersection Summary				
Average Delay		6.4		
Intersection Capacity Utilization		47.0%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	60	60	430	90	40	450
Future Volume (Veh/h)	60	60	430	90	40	450
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	65	65	467	98	43	489
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	846	282			565	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	846	282			565	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	77	91			96	
cM capacity (veh/h)	288	714			1003	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	130	311	254	206	326
Volume Left	65	0	0	43	0
Volume Right	65	0	98	0	0
cSH	411	1700	1700	1003	1700
Volume to Capacity	0.32	0.18	0.15	0.04	0.19
Queue Length 95th (m)	10.7	0.0	0.0	1.1	0.0
Control Delay (s)	17.8	0.0	0.0	2.2	0.0
Lane LOS	C			A	
Approach Delay (s)	17.8	0.0		0.8	
Approach LOS	C				

Intersection Summary				
Average Delay	2.2			
Intersection Capacity Utilization	45.4%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	115	10	0	110	5	5
Future Volume (Veh/h)	115	10	0	110	5	5
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)	125	11	0	120	5	5
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			136		250	130
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			136		250	130
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		99	99
cM capacity (veh/h)			1448		738	919

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	136	120	10
Volume Left	0	0	5
Volume Right	11	0	5
cSH	1700	1448	819
Volume to Capacity	0.08	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.3
Control Delay (s)	0.0	0.0	9.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.5
Approach LOS			A

Intersection Summary				
Average Delay	0.4			
Intersection Capacity Utilization	16.7%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	120	5	0	95	20	5
Future Volume (Veh/h)	120	5	0	95	20	5
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)	130	5	0	103	22	5
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			135		236	132
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			135		236	132
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)			1449		753	917

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	135	103	27
Volume Left	0	0	22
Volume Right	5	0	5
cSH	1700	1449	779
Volume to Capacity	0.08	0.00	0.03
Queue Length 95th (m)	0.0	0.0	0.9
Control Delay (s)	0.0	0.0	9.8
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.8
Approach LOS			A

Intersection Summary				
Average Delay	1.0			
Intersection Capacity Utilization	16.6%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	10	0	0	10	15	0	10	0	5	0	0
Future Volume (Veh/h)	0	10	0	0	10	15	0	10	0	5	0	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	11	0	0	11	16	0	11	0	5	0	0
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	42	21	0	26	21	11	0			11		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	42	21	0	26	21	11	0			11		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	99	100	100	99	99	100			100		
cM capacity (veh/h)	935	870	1085	972	870	1070	1623			1608		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	11	27	11	5
Volume Left	0	0	0	5
Volume Right	0	16	0	0
cSH	870	978	1623	1608
Volume to Capacity	0.01	0.03	0.00	0.00
Queue Length 95th (m)	0.3	0.7	0.0	0.1
Control Delay (s)	9.2	8.8	0.0	7.2
Lane LOS	A	A		A
Approach Delay (s)	9.2	8.8	0.0	7.2
Approach LOS	A	A		

Intersection Summary				
Average Delay	6.9			
Intersection Capacity Utilization	14.2%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	10	5	0	20	5	0
Future Volume (Veh/h)	10	5	0	20	5	0
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)	11	5	0	22	5	0
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			16		36	14
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			16		36	14
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		99	100
cM capacity (veh/h)			1602		977	1067

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	16	22	5
Volume Left	0	0	5
Volume Right	5	0	0
cSH	1700	1602	977
Volume to Capacity	0.01	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.1
Control Delay (s)	0.0	0.0	8.7
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.7
Approach LOS			A

Intersection Summary				
Average Delay		1.0		
Intersection Capacity Utilization		13.3%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	110	15	5	60	35	10
Future Volume (Veh/h)	110	15	5	60	35	10
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)	120	16	5	65	38	11
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			136		203	128
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			136		203	128
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		95	99
cM capacity (veh/h)			1448		783	922

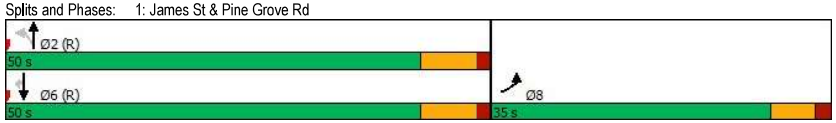
Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	136	70	49
Volume Left	0	5	38
Volume Right	16	0	11
cSH	1700	1448	810
Volume to Capacity	0.08	0.00	0.06
Queue Length 95th (m)	0.0	0.1	1.5
Control Delay (s)	0.0	0.6	9.7
Lane LOS		A	A
Approach Delay (s)	0.0	0.6	9.7
Approach LOS			A

Intersection Summary				
Average Delay		2.0		
Intersection Capacity Utilization		17.3%	ICU Level of Service	A
Analysis Period (min)		15		

Lane Group	EBL	NBL	NBT	SBT	SBR
Lane Configurations					
Traffic Volume (vph)	180	5	465	420	190
Future Volume (vph)	180	5	465	420	190
Lane Group Flow (vph)	207	5	505	457	207
Turn Type	Prot	Perm	NA	NA	Perm
Protected Phases	8		2	6	
Permitted Phases		2			6
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	25.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.65	0.01	0.41	0.37	0.19
Control Delay	40.7	6.6	8.8	8.3	1.5
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	40.7	6.6	8.8	8.3	1.5
Queue Length 50th (m)	32.6	0.3	35.2	30.7	0.0
Queue Length 95th (m)	50.8	1.7	66.7	58.8	8.1
Internal Link Dist (m)	15.2		262.9	161.5	
Turn Bay Length (m)		125.0			100.0
Base Capacity (vph)	598	586	1228	1228	1114
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.35	0.01	0.41	0.37	0.19

Intersection Summary
Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green
Natural Cycle: 55
Control Type: Actuated-Coordinated

Splits and Phases: 1: James St & Pine Grove Rd



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	180	10	5	465	420	190
Future Volume (vph)	180	10	5	465	420	190
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	0.99		1.00	1.00	1.00	0.85
Flt Protected	0.95		0.95	1.00	1.00	1.00
Satd. Flow (prot)	1766		1770	1863	1863	1583
Flt Permitted	0.95		0.48	1.00	1.00	1.00
Satd. Flow (perm)	1766		890	1863	1863	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	196	11	5	505	457	207
RTOR Reduction (vph)	3	0	0	0	0	71
Lane Group Flow (vph)	204	0	5	505	457	136
Turn Type	Prot		Perm	NA	NA	Perm
Protected Phases	8			2	6	
Permitted Phases			2			6
Actuated Green, G (s)	15.3		56.0	56.0	56.0	56.0
Effective Green, g (s)	15.3		56.0	56.0	56.0	56.0
Actuated g/C Ratio	0.18		0.66	0.66	0.66	0.66
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	317		586	1227	1227	1042
v/s Ratio Prot	c0.12			c0.27	0.25	
v/s Ratio Perm			0.01			0.09
v/c Ratio	0.64		0.01	0.41	0.37	0.13
Uniform Delay, d1	32.3		5.0	6.8	6.6	5.4
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	4.4		0.0	1.0	0.9	0.3
Delay (s)	36.7		5.0	7.8	7.4	5.7
Level of Service	D		A	A	A	A
Approach Delay (s)	36.7			7.8	6.9	
Approach LOS	D			A	A	

Intersection Summary			
HCM 2000 Control Delay	11.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	46.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	5	5	10	635	605	10
Future Volume (Veh/h)	5	5	10	635	605	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	11	690	658	11
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)				323		
pX, platoon unblocked	0.88					
vC, conflicting volume	1376	664	669			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1359	664	669			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	99			
cM capacity (veh/h)	143	461	921			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	10	701	669
Volume Left	5	11	0
Volume Right	5	0	11
cSH	218	921	1700
Volume to Capacity	0.05	0.01	0.39
Queue Length 95th (m)	1.1	0.3	0.0
Control Delay (s)	22.3	0.3	0.0
Lane LOS	C	A	
Approach Delay (s)	22.3	0.3	0.0
Approach LOS	C		

Intersection Summary				
Average Delay		0.3		
Intersection Capacity Utilization		51.4%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	70	105	550	90	140	545
Future Volume (Veh/h)	70	105	550	90	140	545
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	76	114	598	98	152	592
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	1494	598			696	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1494	598			696	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	33	77			83	
cM capacity (veh/h)	113	502			900	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	190	598	98	152	592
Volume Left	76	0	0	152	0
Volume Right	114	0	98	0	0
cSH	211	1700	1700	900	1700
Volume to Capacity	0.90	0.35	0.06	0.17	0.35
Queue Length 95th (m)	58.0	0.0	0.0	4.8	0.0
Control Delay (s)	86.1	0.0	0.0	9.8	0.0
Lane LOS	F			A	
Approach Delay (s)	86.1	0.0		2.0	
Approach LOS	F				

Intersection Summary				
Average Delay		11.0		
Intersection Capacity Utilization		57.0%	ICU Level of Service	B
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	90	55	565	90	70	595
Future Volume (Veh/h)	90	55	565	90	70	595
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	98	60	614	98	76	647
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	1138	356			712	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1138	356			712	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	45	91			91	
cM capacity (veh/h)	178	640			884	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	158	409	303	292	431
Volume Left	98	0	0	76	0
Volume Right	60	0	98	0	0
cSH	245	1700	1700	884	1700
Volume to Capacity	0.64	0.24	0.18	0.09	0.25
Queue Length 95th (m)	31.8	0.0	0.0	2.3	0.0
Control Delay (s)	42.8	0.0	0.0	3.2	0.0
Lane LOS	E			A	
Approach Delay (s)	42.8	0.0		1.3	
Approach LOS	E				

Intersection Summary				
Average Delay	4.8			
Intersection Capacity Utilization	55.3%	ICU Level of Service	B	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	145	15	0	140	5	0
Future Volume (Veh/h)	145	15	0	140	5	0
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)	158	16	0	152	5	0
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			174		318	166
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			174		318	166
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		99	100
cM capacity (veh/h)			1403		675	878

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	174	152	5
Volume Left	0	0	5
Volume Right	16	0	0
cSH	1700	1403	675
Volume to Capacity	0.10	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.2
Control Delay (s)	0.0	0.0	10.4
Lane LOS			B
Approach Delay (s)	0.0	0.0	10.4
Approach LOS			B

Intersection Summary				
Average Delay	0.2			
Intersection Capacity Utilization	18.5%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	125	20	10	130	15	5
Future Volume (Veh/h)	125	20	10	130	15	5
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)	136	22	11	141	16	5
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			158		310	147
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			158		310	147
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		98	99
cM capacity (veh/h)			1422		677	900

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	158	152	21
Volume Left	0	11	16
Volume Right	22	0	5
cSH	1700	1422	720
Volume to Capacity	0.09	0.01	0.03
Queue Length 95th (m)	0.0	0.2	0.7
Control Delay (s)	0.0	0.6	10.2
Lane LOS		A	B
Approach Delay (s)	0.0	0.6	10.2
Approach LOS			B

Intersection Summary				
Average Delay			0.9	
Intersection Capacity Utilization			25.1%	ICU Level of Service A
Analysis Period (min)			15	

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	15	0	0	0	15	0	5	0	20	5	5
Future Volume (Veh/h)	0	15	0	0	0	15	0	5	0	20	5	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	16	0	0	0	16	0	5	0	22	5	5
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	72	56	8	64	59	5	10			5		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	72	56	8	64	59	5	10			5		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	98	100	100	100	99	100			99		
cM capacity (veh/h)	895	823	1075	906	821	1078	1610			1616		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	16	16	5	32
Volume Left	0	0	0	22
Volume Right	0	16	0	5
cSH	823	1078	1610	1616
Volume to Capacity	0.02	0.01	0.00	0.01
Queue Length 95th (m)	0.5	0.4	0.0	0.3
Control Delay (s)	9.5	8.4	0.0	5.0
Lane LOS	A	A		A
Approach Delay (s)	9.5	8.4	0.0	5.0
Approach LOS	A	A		

Intersection Summary				
Average Delay			6.5	
Intersection Capacity Utilization			18.3%	ICU Level of Service A
Analysis Period (min)			15	

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	25	10	0	10	5	0
Future Volume (Veh/h)	25	10	0	10	5	0
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)	27	11	0	11	5	0
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			38		44	32
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			38		44	32
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		99	100
cM capacity (veh/h)			1572		967	1041

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	38	11	5
Volume Left	0	0	5
Volume Right	11	0	0
cSH	1700	1572	967
Volume to Capacity	0.02	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.1
Control Delay (s)	0.0	0.0	8.7
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.7
Approach LOS			A

Intersection Summary				
Average Delay		0.8		
Intersection Capacity Utilization		13.3%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	100	30	10	120	20	10
Future Volume (Veh/h)	100	30	10	120	20	10
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)	109	33	11	130	22	11
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			142		278	126
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			142		278	126
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)			1441		707	925

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	142	141	33
Volume Left	0	11	22
Volume Right	33	0	11
cSH	1700	1441	767
Volume to Capacity	0.08	0.01	0.04
Queue Length 95th (m)	0.0	0.2	1.1
Control Delay (s)	0.0	0.6	9.9
Lane LOS		A	A
Approach Delay (s)	0.0	0.6	9.9
Approach LOS			A

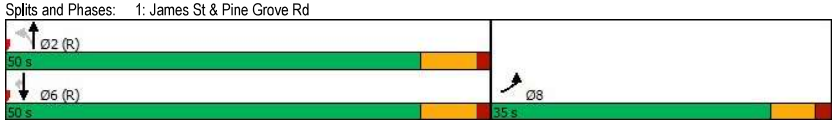
Intersection Summary				
Average Delay		1.3		
Intersection Capacity Utilization		24.6%	ICU Level of Service	A
Analysis Period (min)		15		

Lane Group	EBL	NBL	NBT	SBT	SBR
Lane Configurations					
Traffic Volume (vph)	145	5	285	425	140
Future Volume (vph)	145	5	285	425	140
Lane Group Flow (vph)	163	5	310	462	152
Turn Type	Prot	Perm	NA	NA	Perm
Protected Phases	8		2	6	
Permitted Phases		2			6
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	25.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.58	0.01	0.24	0.36	0.14
Control Delay	40.5	5.6	6.3	7.3	1.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	40.5	5.6	6.3	7.3	1.4
Queue Length 50th (m)	26.0	0.3	17.2	28.4	0.0
Queue Length 95th (m)	42.7	1.6	33.9	53.9	6.4
Internal Link Dist (m)	15.2		262.9	161.5	
Turn Bay Length (m)		125.0			100.0
Base Capacity (vph)	598	608	1267	1267	1125
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.27	0.01	0.24	0.36	0.14

Intersection Summary

Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green
Natural Cycle: 55
Control Type: Actuated-Coordinated

Splits and Phases: 1: James St & Pine Grove Rd



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	145	5	5	285	425	140
Future Volume (vph)	145	5	5	285	425	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	1.00		1.00	1.00	1.00	0.85
Flt Protected	0.95		0.95	1.00	1.00	1.00
Satd. Flow (prot)	1769		1770	1863	1863	1583
Flt Permitted	0.95		0.48	1.00	1.00	1.00
Satd. Flow (perm)	1769		894	1863	1863	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	158	5	5	310	462	152
RTOR Reduction (vph)	2	0	0	0	0	49
Lane Group Flow (vph)	161	0	5	310	462	103
Turn Type	Prot		Perm	NA	NA	Perm
Protected Phases	8			2	6	
Permitted Phases			2			6
Actuated Green, G (s)	13.5		57.8	57.8	57.8	57.8
Effective Green, g (s)	13.5		57.8	57.8	57.8	57.8
Actuated g/C Ratio	0.16		0.68	0.68	0.68	0.68
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	280		607	1266	1266	1076
v/s Ratio Prot	c0.09			0.17	c0.25	
v/s Ratio Perm			0.01			0.07
v/c Ratio	0.58		0.01	0.24	0.36	0.10
Uniform Delay, d1	33.1		4.4	5.2	5.8	4.7
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	2.9		0.0	0.5	0.8	0.2
Delay (s)	36.0		4.4	5.7	6.6	4.8
Level of Service	D		A	A	A	A
Approach Delay (s)	36.0			5.7	6.2	
Approach LOS	D			A	A	

Intersection Summary

HCM 2000 Control Delay	10.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	10	5	0	430	560	10
Future Volume (Veh/h)	10	5	0	430	560	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	5	0	467	609	11
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)				323		
pX, platoon unblocked						
vC, conflicting volume	1082	614	620			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1082	614	620			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	95	99	100			
cM capacity (veh/h)	241	491	960			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	16	467	620
Volume Left	11	0	0
Volume Right	5	0	11
cSH	287	960	1700
Volume to Capacity	0.06	0.00	0.36
Queue Length 95th (m)	1.4	0.0	0.0
Control Delay (s)	18.3	0.0	0.0
Lane LOS	C		
Approach Delay (s)	18.3	0.0	0.0
Approach LOS	C		

Intersection Summary				
Average Delay		0.3		
Intersection Capacity Utilization		40.1%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	90	145	400	40	60	480
Future Volume (Veh/h)	90	145	400	40	60	480
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	98	158	435	43	65	522
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	1087	435			478	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1087	435			478	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	56	75			94	
cM capacity (veh/h)	225	621			1084	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	256	435	43	65	522
Volume Left	98	0	0	65	0
Volume Right	158	0	43	0	0
cSH	371	1700	1700	1084	1700
Volume to Capacity	0.69	0.26	0.03	0.06	0.31
Queue Length 95th (m)	39.8	0.0	0.0	1.5	0.0
Control Delay (s)	33.8	0.0	0.0	8.5	0.0
Lane LOS	D			A	
Approach Delay (s)	33.8	0.0		0.9	
Approach LOS	D				

Intersection Summary				
Average Delay		7.0		
Intersection Capacity Utilization		48.3%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	60	60	455	90	40	480
Future Volume (Veh/h)	60	60	455	90	40	480
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	65	65	495	98	43	522
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	891	296			593	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	891	296			593	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	76	91			96	
cM capacity (veh/h)	270	700			979	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	130	330	263	217	348
Volume Left	65	0	0	43	0
Volume Right	65	0	98	0	0
cSH	389	1700	1700	979	1700
Volume to Capacity	0.33	0.19	0.15	0.04	0.20
Queue Length 95th (m)	11.5	0.0	0.0	1.1	0.0
Control Delay (s)	18.8	0.0	0.0	2.1	0.0
Lane LOS	C			A	
Approach Delay (s)	18.8	0.0		0.8	
Approach LOS	C				

Intersection Summary				
Average Delay	2.3			
Intersection Capacity Utilization	46.9%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	115	10	0	110	5	5
Future Volume (Veh/h)	115	10	0	110	5	5
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)	125	11	0	120	5	5
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			136		250	130
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			136		250	130
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		99	99
cM capacity (veh/h)			1448		738	919

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	136	120	10
Volume Left	0	0	5
Volume Right	11	0	5
cSH	1700	1448	819
Volume to Capacity	0.08	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.3
Control Delay (s)	0.0	0.0	9.5
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.5
Approach LOS			A

Intersection Summary				
Average Delay	0.4			
Intersection Capacity Utilization	16.7%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	120	5	0	95	20	5
Future Volume (Veh/h)	120	5	0	95	20	5
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)	130	5	0	103	22	5
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			135		236	132
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			135		236	132
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)			1449		753	917

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	135	103	27
Volume Left	0	0	22
Volume Right	5	0	5
cSH	1700	1449	779
Volume to Capacity	0.08	0.00	0.03
Queue Length 95th (m)	0.0	0.0	0.9
Control Delay (s)	0.0	0.0	9.8
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.8
Approach LOS			A

Intersection Summary				
Average Delay	1.0			
Intersection Capacity Utilization	16.6%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	10	0	0	10	15	0	10	0	5	0	0
Future Volume (Veh/h)	0	10	0	0	10	15	0	10	0	5	0	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	11	0	0	11	16	0	11	0	5	0	0
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	42	21	0	26	21	11	0			11		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	42	21	0	26	21	11	0			11		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	99	100	100	99	99	100			100		
cM capacity (veh/h)	935	870	1085	972	870	1070	1623			1608		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	11	27	11	5
Volume Left	0	0	0	5
Volume Right	0	16	0	0
cSH	870	978	1623	1608
Volume to Capacity	0.01	0.03	0.00	0.00
Queue Length 95th (m)	0.3	0.7	0.0	0.1
Control Delay (s)	9.2	8.8	0.0	7.2
Lane LOS	A	A		A
Approach Delay (s)	9.2	8.8	0.0	7.2
Approach LOS	A	A		

Intersection Summary				
Average Delay	6.9			
Intersection Capacity Utilization	14.2%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	10	5	0	20	5	0
Future Volume (Veh/h)	10	5	0	20	5	0
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)	11	5	0	22	5	0
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			16		36	14
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			16		36	14
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		99	100
cM capacity (veh/h)			1602		977	1067

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	16	22	5
Volume Left	0	0	5
Volume Right	5	0	0
cSH	1700	1602	977
Volume to Capacity	0.01	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.1
Control Delay (s)	0.0	0.0	8.7
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.7
Approach LOS			A

Intersection Summary				
Average Delay		1.0		
Intersection Capacity Utilization		13.3%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	110	15	5	60	35	10
Future Volume (Veh/h)	110	15	5	60	35	10
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)	120	16	5	65	38	11
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			136		203	128
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			136		203	128
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		95	99
cM capacity (veh/h)			1448		783	922

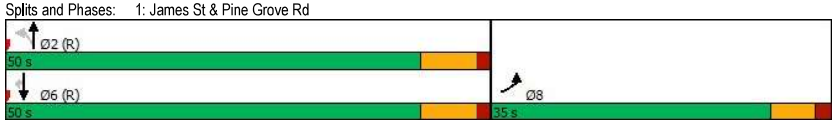
Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	136	70	49
Volume Left	0	5	38
Volume Right	16	0	11
cSH	1700	1448	810
Volume to Capacity	0.08	0.00	0.06
Queue Length 95th (m)	0.0	0.1	1.5
Control Delay (s)	0.0	0.6	9.7
Lane LOS		A	A
Approach Delay (s)	0.0	0.6	9.7
Approach LOS			A

Intersection Summary				
Average Delay		2.0		
Intersection Capacity Utilization		17.3%	ICU Level of Service	A
Analysis Period (min)		15		

Lane Group	EBL	NBL	NBT	SBT	SBR
Lane Configurations					
Traffic Volume (vph)	180	5	505	460	190
Future Volume (vph)	180	5	505	460	190
Lane Group Flow (vph)	207	5	549	500	207
Turn Type	Prot	Perm	NA	NA	Perm
Protected Phases	8		2	6	
Permitted Phases		2			6
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	25.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.65	0.01	0.45	0.41	0.19
Control Delay	40.7	6.6	9.2	8.7	1.5
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	40.7	6.6	9.2	8.7	1.5
Queue Length 50th (m)	32.6	0.3	39.5	34.6	0.0
Queue Length 95th (m)	50.8	1.7	74.7	65.8	8.1
Internal Link Dist (m)	15.2		262.9	161.5	
Turn Bay Length (m)		125.0			100.0
Base Capacity (vph)	598	550	1228	1228	1114
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.35	0.01	0.45	0.41	0.19

Intersection Summary
Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBT, Start of Green
Natural Cycle: 60
Control Type: Actuated-Coordinated

Splits and Phases: 1: James St & Pine Grove Rd



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	180	10	5	505	460	190
Future Volume (vph)	180	10	5	505	460	190
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	0.99		1.00	1.00	1.00	0.85
Flt Protected	0.95		0.95	1.00	1.00	1.00
Satd. Flow (prot)	1766		1770	1863	1863	1583
Flt Permitted	0.95		0.45	1.00	1.00	1.00
Satd. Flow (perm)	1766		834	1863	1863	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	196	11	5	549	500	207
RTOR Reduction (vph)	3	0	0	0	0	71
Lane Group Flow (vph)	204	0	5	549	500	136
Turn Type	Prot		Perm	NA	NA	Perm
Protected Phases	8			2	6	
Permitted Phases			2			6
Actuated Green, G (s)	15.3		56.0	56.0	56.0	56.0
Effective Green, g (s)	15.3		56.0	56.0	56.0	56.0
Actuated g/C Ratio	0.18		0.66	0.66	0.66	0.66
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	317		549	1227	1227	1042
v/s Ratio Prot	c0.12			c0.29	0.27	
v/s Ratio Perm			0.01			0.09
v/c Ratio	0.64		0.01	0.45	0.41	0.13
Uniform Delay, d1	32.3		5.0	7.0	6.8	5.4
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	4.4		0.0	1.2	1.0	0.3
Delay (s)	36.7		5.0	8.2	7.8	5.7
Level of Service	D		A	A	A	A
Approach Delay (s)	36.7			8.2	7.2	
Approach LOS	D			A	A	

Intersection Summary			
HCM 2000 Control Delay	11.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	48.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	5	5	10	675	645	10
Future Volume (Veh/h)	5	5	10	675	645	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	11	734	701	11
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)				323		
pX, platoon unblocked	0.86					
vC, conflicting volume	1462	706	712			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1456	706	712			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	96	99	99			
cM capacity (veh/h)	121	436	888			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	10	745	712
Volume Left	5	11	0
Volume Right	5	0	11
cSH	189	888	1700
Volume to Capacity	0.05	0.01	0.42
Queue Length 95th (m)	1.3	0.3	0.0
Control Delay (s)	25.1	0.3	0.0
Lane LOS	D	A	
Approach Delay (s)	25.1	0.3	0.0
Approach LOS	D		

Intersection Summary				
Average Delay		0.3		
Intersection Capacity Utilization		53.5%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	70	105	590	90	140	585
Future Volume (Veh/h)	70	105	590	90	140	585
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	76	114	641	98	152	636
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	1581	641			739	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1581	641			739	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	23	76			82	
cM capacity (veh/h)	99	475			867	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	190	641	98	152	636
Volume Left	76	0	0	152	0
Volume Right	114	0	98	0	0
cSH	188	1700	1700	867	1700
Volume to Capacity	1.01	0.38	0.06	0.18	0.37
Queue Length 95th (m)	68.4	0.0	0.0	5.1	0.0
Control Delay (s)	119.3	0.0	0.0	10.0	0.0
Lane LOS	F			B	
Approach Delay (s)	119.3	0.0		1.9	
Approach LOS	F				

Intersection Summary				
Average Delay		14.1		
Intersection Capacity Utilization		59.1%	ICU Level of Service	B
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	90	55	605	90	70	635
Future Volume (Veh/h)	90	55	605	90	70	635
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	98	60	658	98	76	690
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	1204	378			756	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1204	378			756	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	39	90			91	
cM capacity (veh/h)	161	620			851	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	158	439	317	306	460
Volume Left	98	0	0	76	0
Volume Right	60	0	98	0	0
cSH	224	1700	1700	851	1700
Volume to Capacity	0.71	0.26	0.19	0.09	0.27
Queue Length 95th (m)	36.9	0.0	0.0	2.3	0.0
Control Delay (s)	52.3	0.0	0.0	3.1	0.0
Lane LOS	F			A	
Approach Delay (s)	52.3	0.0		1.3	
Approach LOS	F				

Intersection Summary				
Average Delay	5.5			
Intersection Capacity Utilization	57.5%	ICU Level of Service	B	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	145	15	0	140	5	0
Future Volume (Veh/h)	145	15	0	140	5	0
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)	158	16	0	152	5	0
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			174		318	166
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			174		318	166
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		99	100
cM capacity (veh/h)			1403		675	878

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	174	152	5
Volume Left	0	0	5
Volume Right	16	0	0
cSH	1700	1403	675
Volume to Capacity	0.10	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.2
Control Delay (s)	0.0	0.0	10.4
Lane LOS			B
Approach Delay (s)	0.0	0.0	10.4
Approach LOS			B

Intersection Summary				
Average Delay	0.2			
Intersection Capacity Utilization	18.5%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	125	20	10	130	15	5
Future Volume (Veh/h)	125	20	10	130	15	5
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)	136	22	11	141	16	5
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			158		310	147
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			158		310	147
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		98	99
cM capacity (veh/h)			1422		677	900

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	158	152	21
Volume Left	0	11	16
Volume Right	22	0	5
cSH	1700	1422	720
Volume to Capacity	0.09	0.01	0.03
Queue Length 95th (m)	0.0	0.2	0.7
Control Delay (s)	0.0	0.6	10.2
Lane LOS		A	B
Approach Delay (s)	0.0	0.6	10.2
Approach LOS			B

Intersection Summary				
Average Delay			0.9	
Intersection Capacity Utilization			25.1%	ICU Level of Service A
Analysis Period (min)			15	

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	15	0	0	0	15	0	5	0	20	5	5
Future Volume (Veh/h)	0	15	0	0	0	15	0	5	0	20	5	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	16	0	0	0	16	0	5	0	22	5	5
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	72	56	8	64	59	5	10			5		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	72	56	8	64	59	5	10			5		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	98	100	100	100	99	100			99		
cM capacity (veh/h)	895	823	1075	906	821	1078	1610			1616		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	16	16	5	32
Volume Left	0	0	0	22
Volume Right	0	16	0	5
cSH	823	1078	1610	1616
Volume to Capacity	0.02	0.01	0.00	0.01
Queue Length 95th (m)	0.5	0.4	0.0	0.3
Control Delay (s)	9.5	8.4	0.0	5.0
Lane LOS	A	A		A
Approach Delay (s)	9.5	8.4	0.0	5.0
Approach LOS	A	A		

Intersection Summary				
Average Delay			6.5	
Intersection Capacity Utilization			18.3%	ICU Level of Service A
Analysis Period (min)			15	

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	25	10	0	10	5	0
Future Volume (Veh/h)	25	10	0	10	5	0
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)	27	11	0	11	5	0
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			38		44	32
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			38		44	32
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		99	100
cM capacity (veh/h)			1572		967	1041

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	38	11	5
Volume Left	0	0	5
Volume Right	11	0	0
cSH	1700	1572	967
Volume to Capacity	0.02	0.00	0.01
Queue Length 95th (m)	0.0	0.0	0.1
Control Delay (s)	0.0	0.0	8.7
Lane LOS			A
Approach Delay (s)	0.0	0.0	8.7
Approach LOS			A

Intersection Summary				
Average Delay			0.8	
Intersection Capacity Utilization			13.3%	ICU Level of Service A
Analysis Period (min)			15	

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	100	30	10	120	20	10
Future Volume (Veh/h)	100	30	10	120	20	10
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)	109	33	11	130	22	11
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			142		278	126
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			142		278	126
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)			1441		707	925

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	142	141	33
Volume Left	0	11	22
Volume Right	33	0	11
cSH	1700	1441	767
Volume to Capacity	0.08	0.01	0.04
Queue Length 95th (m)	0.0	0.2	1.1
Control Delay (s)	0.0	0.6	9.9
Lane LOS		A	A
Approach Delay (s)	0.0	0.6	9.9
Approach LOS			A

Intersection Summary				
Average Delay			1.3	
Intersection Capacity Utilization			24.6%	ICU Level of Service A
Analysis Period (min)			15	

Lane Group	WBL	NBT	NBR	SBL	SBT
Lane Configurations					
Traffic Volume (vph)	90	355	40	60	420
Future Volume (vph)	90	355	40	60	420
Lane Group Flow (vph)	256	386	43	65	457
Turn Type	Prot	NA	Perm	Perm	NA
Protected Phases	8	2			6
Permitted Phases			2	6	
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	29.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.70	0.31	0.04	0.10	0.37
Control Delay	29.4	4.5	0.7	6.6	7.9
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	29.4	4.5	0.7	6.6	7.9
Queue Length 50th (m)	24.6	13.5	0.0	3.3	28.7
Queue Length 95th (m)	45.3	26.4	1.4	10.0	58.5
Internal Link Dist (m)	81.0	124.2			624.4
Turn Bay Length (m)			60.0	115.0	
Base Capacity (vph)	634	1248	1075	663	1248
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.40	0.31	0.04	0.10	0.37

Intersection Summary
Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green
Natural Cycle: 60
Control Type: Actuated-Coordinated

Splits and Phases: 4: James St & Tisdale Rd

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	90	145	355	40	60	420
Future Volume (vph)	90	145	355	40	60	420
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	0.92		1.00	0.85	1.00	1.00
Flt Protected	0.98		1.00	1.00	0.95	1.00
Satd. Flow (prot)	1675		1863	1583	1770	1863
Flt Permitted	0.98		1.00	1.00	0.53	1.00
Satd. Flow (perm)	1675		1863	1583	989	1863
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	98	158	386	43	65	457
RTOR Reduction (vph)	86	0	0	14	0	0
Lane Group Flow (vph)	170	0	386	29	65	457
Turn Type	Prot		NA	Perm	Perm	NA
Protected Phases	8		2			6
Permitted Phases				2	6	
Actuated Green, G (s)	14.3		57.0	57.0	57.0	57.0
Effective Green, g (s)	14.3		57.0	57.0	57.0	57.0
Actuated g/C Ratio	0.17		0.67	0.67	0.67	0.67
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	281		1249	1061	663	1249
v/s Ratio Prot	c0.10		0.21			c0.25
v/s Ratio Perm				0.02	0.07	
v/c Ratio	0.61		0.31	0.03	0.10	0.37
Uniform Delay, d1	32.7		5.8	4.7	4.9	6.1
Progression Factor	1.00		0.57	0.28	1.00	1.00
Incremental Delay, d2	3.7		0.6	0.0	0.3	0.8
Delay (s)	36.4		4.0	1.3	5.2	6.9
Level of Service	D		A	A	A	A
Approach Delay (s)	36.4		3.7			6.7
Approach LOS	D		A			A

Intersection Summary				
HCM 2000 Control Delay	12.0	HCM 2000 Level of Service	B	
HCM 2000 Volume to Capacity ratio	0.41			
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7	
Intersection Capacity Utilization	66.8%	ICU Level of Service	C	
Analysis Period (min)	15			

c Critical Lane Group

Lane Group	WBL	NBT	NBR	SBL	SBT
Lane Configurations					
Traffic Volume (vph)	70	515	90	140	510
Future Volume (vph)	70	515	90	140	510
Lane Group Flow (vph)	190	560	98	152	554
Turn Type	Prot	NA	Perm	Perm	NA
Protected Phases	8	2			6
Permitted Phases			2	6	
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	29.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.60	0.43	0.09	0.28	0.43
Control Delay	25.1	5.9	1.5	7.0	7.2
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	25.1	5.9	1.5	7.0	7.2
Queue Length 50th (m)	15.2	20.4	0.0	7.6	31.6
Queue Length 95th (m)	33.7	57.9	5.3	20.5	64.2
Internal Link Dist (m)	81.0	124.2			624.4
Turn Bay Length (m)			60.0	115.0	
Base Capacity (vph)	630	1300	1134	548	1300
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.30	0.43	0.09	0.28	0.43

Intersection Summary
Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green
Natural Cycle: 60
Control Type: Actuated-Coordinated

Splits and Phases: 4: James St & Tisdale Rd

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	70	105	515	90	140	510
Future Volume (vph)	70	105	515	90	140	510
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	0.92		1.00	0.85	1.00	1.00
Flt Protected	0.98		1.00	1.00	0.95	1.00
Satd. Flow (prot)	1678		1863	1583	1770	1863
Flt Permitted	0.98		1.00	1.00	0.42	1.00
Satd. Flow (perm)	1678		1863	1583	786	1863
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	76	114	560	98	152	554
RTOR Reduction (vph)	82	0	0	30	0	0
Lane Group Flow (vph)	108	0	560	68	152	554
Turn Type	Prot		NA	Perm	Perm	NA
Protected Phases	8		2			6
Permitted Phases				2	6	
Actuated Green, G (s)	12.0		59.3	59.3	59.3	59.3
Effective Green, g (s)	12.0		59.3	59.3	59.3	59.3
Actuated g/C Ratio	0.14		0.70	0.70	0.70	0.70
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	236		1299	1104	548	1299
v/s Ratio Prot	c0.06		c0.30			0.30
v/s Ratio Perm				0.04	0.19	
v/c Ratio	0.46		0.43	0.06	0.28	0.43
Uniform Delay, d1	33.5		5.6	4.1	4.8	5.5
Progression Factor	1.00		0.79	1.09	1.00	1.00
Incremental Delay, d2	1.4		1.0	0.1	1.3	1.0
Delay (s)	34.9		5.4	4.5	6.1	6.6
Level of Service	C		A	A	A	A
Approach Delay (s)	34.9		5.3			6.5
Approach LOS	C		A			A

Intersection Summary			
HCM 2000 Control Delay	9.4	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	71.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	WBL	NBT	NBR	SBL	SBT
Lane Configurations					
Traffic Volume (vph)	90	375	40	60	450
Future Volume (vph)	90	375	40	60	450
Lane Group Flow (vph)	256	408	43	65	489
Turn Type	Prot	NA	Perm	Perm	NA
Protected Phases	8	2			6
Permitted Phases			2	6	
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	29.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.70	0.33	0.04	0.10	0.39
Control Delay	29.4	4.7	0.7	6.6	8.2
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	29.4	4.7	0.7	6.6	8.2
Queue Length 50th (m)	24.6	14.8	0.0	3.3	31.5
Queue Length 95th (m)	45.3	29.2	1.5	10.1	63.8
Internal Link Dist (m)	81.0	124.2			624.4
Turn Bay Length (m)			60.0	115.0	
Base Capacity (vph)	634	1248	1075	642	1248
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.40	0.33	0.04	0.10	0.39

Intersection Summary
Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green
Natural Cycle: 60
Control Type: Actuated-Coordinated

Splits and Phases: 4: James St & Tisdale Rd

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	90	145	375	40	60	450
Future Volume (vph)	90	145	375	40	60	450
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	0.92		1.00	0.85	1.00	1.00
Flt Protected	0.98		1.00	1.00	0.95	1.00
Satd. Flow (prot)	1675		1863	1583	1770	1863
Flt Permitted	0.98		1.00	1.00	0.52	1.00
Satd. Flow (perm)	1675		1863	1583	960	1863
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	98	158	408	43	65	489
RTOR Reduction (vph)	86	0	0	14	0	0
Lane Group Flow (vph)	170	0	408	29	65	489
Turn Type	Prot		NA	Perm	Perm	NA
Protected Phases	8		2			6
Permitted Phases				2	6	
Actuated Green, G (s)	14.3		57.0	57.0	57.0	57.0
Effective Green, g (s)	14.3		57.0	57.0	57.0	57.0
Actuated g/C Ratio	0.17		0.67	0.67	0.67	0.67
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	281		1249	1061	643	1249
v/s Ratio Prot	c0.10		0.22			c0.26
v/s Ratio Perm				0.02	0.07	
v/c Ratio	0.61		0.33	0.03	0.10	0.39
Uniform Delay, d1	32.7		5.9	4.7	4.9	6.3
Progression Factor	1.00		0.59	0.29	1.00	1.00
Incremental Delay, d2	3.7		0.7	0.0	0.3	0.9
Delay (s)	36.4		4.2	1.4	5.3	7.2
Level of Service	D		A	A	A	A
Approach Delay (s)	36.4		3.9			7.0
Approach LOS	D		A			A

Intersection Summary				
HCM 2000 Control Delay	11.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	67.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	WBL	NBT	NBR	SBL	SBT
Lane Configurations					
Traffic Volume (vph)	70	550	90	140	545
Future Volume (vph)	70	550	90	140	545
Lane Group Flow (vph)	190	598	98	152	592
Turn Type	Prot	NA	Perm	Perm	NA
Protected Phases	8	2			6
Permitted Phases			2	6	
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	29.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.60	0.46	0.09	0.29	0.46
Control Delay	25.1	6.0	1.4	7.3	7.5
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	25.1	6.0	1.4	7.3	7.5
Queue Length 50th (m)	15.2	22.8	0.0	7.7	34.7
Queue Length 95th (m)	33.7	54.4	4.6	21.1	70.5
Internal Link Dist (m)	81.0	124.2			624.4
Turn Bay Length (m)			60.0	115.0	
Base Capacity (vph)	630	1300	1134	518	1300
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.30	0.46	0.09	0.29	0.46

Intersection Summary
Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green
Natural Cycle: 60
Control Type: Actuated-Coordinated

Splits and Phases: 4: James St & Tisdale Rd

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	70	105	550	90	140	545
Future Volume (vph)	70	105	550	90	140	545
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	0.92		1.00	0.85	1.00	1.00
Flt Protected	0.98		1.00	1.00	0.95	1.00
Satd. Flow (prot)	1678		1863	1583	1770	1863
Flt Permitted	0.98		1.00	1.00	0.40	1.00
Satd. Flow (perm)	1678		1863	1583	743	1863
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	76	114	598	98	152	592
RTOR Reduction (vph)	82	0	0	30	0	0
Lane Group Flow (vph)	108	0	598	68	152	592
Turn Type	Prot		NA	Perm	Perm	NA
Protected Phases	8		2			6
Permitted Phases				2	6	
Actuated Green, G (s)	12.0		59.3	59.3	59.3	59.3
Effective Green, g (s)	12.0		59.3	59.3	59.3	59.3
Actuated g/C Ratio	0.14		0.70	0.70	0.70	0.70
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	236		1299	1104	518	1299
v/s Ratio Prot	c0.06		c0.32			0.32
v/s Ratio Perm				0.04	0.20	
v/c Ratio	0.46		0.46	0.06	0.29	0.46
Uniform Delay, d1	33.5		5.7	4.1	4.9	5.7
Progression Factor	1.00		0.78	1.04	1.00	1.00
Incremental Delay, d2	1.4		1.1	0.1	1.4	1.2
Delay (s)	34.9		5.5	4.3	6.3	6.9
Level of Service	C		A	A	A	A
Approach Delay (s)	34.9		5.4			6.7
Approach LOS	C		A			A

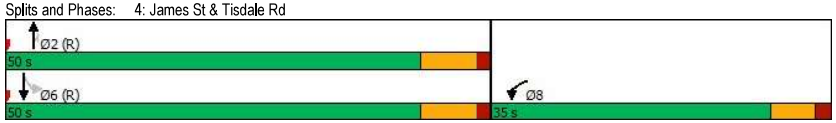
Intersection Summary			
HCM 2000 Control Delay	9.4	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	73.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	WBL	NBT	NBR	SBL	SBT
Lane Configurations					
Traffic Volume (vph)	90	400	40	60	480
Future Volume (vph)	90	400	40	60	480
Lane Group Flow (vph)	256	435	43	65	522
Turn Type	Prot	NA	Perm	Perm	NA
Protected Phases	8	2			6
Permitted Phases			2	6	
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	29.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.70	0.35	0.04	0.11	0.42
Control Delay	29.4	5.0	0.8	6.7	8.5
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	29.4	5.0	0.8	6.7	8.5
Queue Length 50th (m)	24.6	16.6	0.0	3.3	34.4
Queue Length 95th (m)	45.3	32.2	1.6	10.1	69.4
Internal Link Dist (m)	81.0	124.2			624.4
Turn Bay Length (m)			60.0	115.0	
Base Capacity (vph)	634	1248	1075	619	1248
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.40	0.35	0.04	0.11	0.42

Intersection Summary
Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green
Natural Cycle: 60
Control Type: Actuated-Coordinated

Splits and Phases: 4: James St & Tisdale Rd



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	90	145	400	40	60	480
Future Volume (vph)	90	145	400	40	60	480
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	0.92		1.00	0.85	1.00	1.00
Flt Protected	0.98		1.00	1.00	0.95	1.00
Satd. Flow (prot)	1675		1863	1583	1770	1863
Flt Permitted	0.98		1.00	1.00	0.50	1.00
Satd. Flow (perm)	1675		1863	1583	924	1863
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	98	158	435	43	65	522
RTOR Reduction (vph)	86	0	0	14	0	0
Lane Group Flow (vph)	170	0	435	29	65	522
Turn Type	Prot		NA	Perm	Perm	NA
Protected Phases	8		2			6
Permitted Phases				2	6	
Actuated Green, G (s)	14.3		57.0	57.0	57.0	57.0
Effective Green, g (s)	14.3		57.0	57.0	57.0	57.0
Actuated g/C Ratio	0.17		0.67	0.67	0.67	0.67
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	281		1249	1061	619	1249
v/s Ratio Prot	c0.10		0.23			c0.28
v/s Ratio Perm				0.02	0.07	
v/c Ratio	0.61		0.35	0.03	0.11	0.42
Uniform Delay, d1	32.7		6.0	4.7	5.0	6.4
Progression Factor	1.00		0.60	0.32	1.00	1.00
Incremental Delay, d2	3.7		0.8	0.0	0.3	1.0
Delay (s)	36.4		4.4	1.5	5.3	7.4
Level of Service	D		A	A	A	A
Approach Delay (s)	36.4		4.1			7.2
Approach LOS	D		A			A

Intersection Summary			
HCM 2000 Control Delay	11.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	69.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	WBL	NBT	NBR	SBL	SBT
Lane Configurations					
Traffic Volume (vph)	70	590	90	140	585
Future Volume (vph)	70	590	90	140	585
Lane Group Flow (vph)	190	641	98	152	636
Turn Type	Prot	NA	Perm	Perm	NA
Protected Phases	8	2			6
Permitted Phases			2	6	
Detector Phase	8	2	2	6	6
Switch Phase					
Minimum Initial (s)	10.0	20.0	20.0	20.0	20.0
Minimum Split (s)	29.3	27.4	27.4	27.4	27.4
Total Split (s)	35.0	50.0	50.0	50.0	50.0
Total Split (%)	41.2%	58.8%	58.8%	58.8%	58.8%
Yellow Time (s)	4.5	5.9	5.9	5.9	5.9
All-Red Time (s)	1.8	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.3	7.4	7.4	7.4	7.4
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	C-Min	C-Min	C-Min	C-Min
v/c Ratio	0.60	0.49	0.09	0.31	0.49
Control Delay	25.1	6.3	1.4	7.7	7.9
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	25.1	6.3	1.4	7.7	7.9
Queue Length 50th (m)	15.2	25.7	0.0	7.8	38.7
Queue Length 95th (m)	33.7	54.5	4.5	21.9	78.3
Internal Link Dist (m)	81.0	124.2			624.4
Turn Bay Length (m)			60.0	115.0	
Base Capacity (vph)	630	1300	1134	485	1300
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.30	0.49	0.09	0.31	0.49

Intersection Summary
Cycle Length: 85
Actuated Cycle Length: 85
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green
Natural Cycle: 65
Control Type: Actuated-Coordinated

Splits and Phases: 4: James St & Tisdale Rd

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	70	105	590	90	140	585
Future Volume (vph)	70	105	590	90	140	585
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.3		7.4	7.4	7.4	7.4
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	0.92		1.00	0.85	1.00	1.00
Flt Protected	0.98		1.00	1.00	0.95	1.00
Satd. Flow (prot)	1678		1863	1583	1770	1863
Flt Permitted	0.98		1.00	1.00	0.37	1.00
Satd. Flow (perm)	1678		1863	1583	695	1863
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	76	114	641	98	152	636
RTOR Reduction (vph)	82	0	0	30	0	0
Lane Group Flow (vph)	108	0	641	68	152	636
Turn Type	Prot		NA	Perm	Perm	NA
Protected Phases	8		2			6
Permitted Phases				2	6	
Actuated Green, G (s)	12.0		59.3	59.3	59.3	59.3
Effective Green, g (s)	12.0		59.3	59.3	59.3	59.3
Actuated g/C Ratio	0.14		0.70	0.70	0.70	0.70
Clearance Time (s)	6.3		7.4	7.4	7.4	7.4
Vehicle Extension (s)	3.0		4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	236		1299	1104	484	1299
v/s Ratio Prot	c0.06		c0.34			0.34
v/s Ratio Perm				0.04	0.22	
v/c Ratio	0.46		0.49	0.06	0.31	0.49
Uniform Delay, d1	33.5		5.9	4.1	5.0	5.9
Progression Factor	1.00		0.77	0.99	1.00	1.00
Incremental Delay, d2	1.4		1.2	0.1	1.7	1.3
Delay (s)	34.9		5.8	4.1	6.7	7.2
Level of Service	C		A	A	A	A
Approach Delay (s)	34.9		5.6			7.1
Approach LOS	C		A			A

Intersection Summary			
HCM 2000 Control Delay	9.5	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	13.7
Intersection Capacity Utilization	75.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

APPENDIX F:
Signal Timing Plans

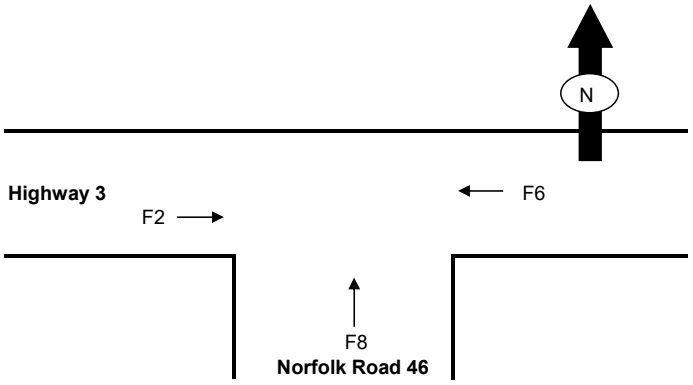
Cover Sheet

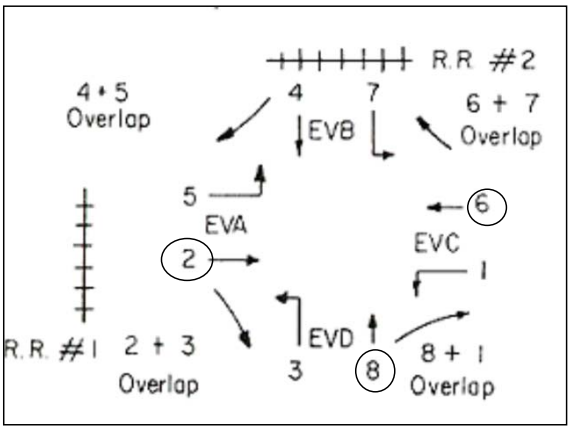
Location: Highway 3 @ Haldimand-Norfolk 46 **Area/District:** _____

Timing Based On T.M. Dated: 28-Mar-19 **Traffic Signal #** 56

Timing Developed By: _____ **Reviewed By:** _____

Installed By: _____ **Installation Date:** _____





Circle Movements and Operations

Dial Out Telephone Number

		D
0	# OF DIGITS	
1	1st DIGIT	
2	2nd DIGIT	
3	3rd DIGIT	
4	4th DIGIT	
5	5th DIGIT	
6	6th DIGIT	
7	7th DIGIT	
8	8th DIGIT	
9	9th DIGIT	
A	10th DIGIT	
B	11th DIGIT	
C		
D		
E		
F		

< C + 0 + C = 2 >

Redial Time = 10

(C\5 + C + 0)

Default is Report All Alarms (no flags set)

Disable Alarm Reporting

Column F

			1	2	3	4	5	6	7	8
0	OMIT ALARMS						X			

< C + 0 + C = 5 >

1 = STOP TIME
2 = FLASH SENSE
3 = KEYBOARD ENTRY
4 = MANUAL PLAN SELECT
5 = ENABLE POLICE CNTRL (Not Used)
6 = EXTERNAL ALARM (Door Alarm)
7 = DETECTOR FAILURE

COMMUNICATIONS ADDRESSING

COMM ADDRESS
(C/0 + 0 + 0) = **1**

ZONE ADDRESS
(C/0 + 0 + 0) = **1**

AREA NUMBER
(C/0 + 0 + 0) = **1**

AREA ADDRESS
(C/0 + 0 + 0) = **56**

NOTE: If Local Controller is part of an Interconnect Ensure Phone Number Is Removed

Observe Redial Timer
(E/2 + D + 6)

ACTUATED INTERVAL TIMING AND FAZE FUNCTIONS

		PHASE 1	2	3	4	5	6	7	8
0	WALK	-	7	-		-		-	12
1	DON'T WALK	-	13	-		-		-	7
2	MIN INITIAL		20				20		10
3	TYPE 3 LIMIT	-		-		-		-	
4	ADD PER VEH	-	1.9	-		-	1.9	-	
5	VEH EXT		4.0				4.0		3.0
6	MAX GAP		4.0				4.0		3.0
7	MIN GAP		4.0				4.0		3.0
8	MAX LIMIT		50				50		35
9	MAXIMUM 2	-		-		-		-	
A	ADV /DLY WALK	-		-		-		-	
B	SEQUENCE TO	-		-		-		-	
C	COND SRV MIN	-		-		-		-	
D	REDUCE EVERY	-		-		-		-	
E	YELLOW		5.9				5.9		4.5
F	RED CLEAR		1.5				1.5		1.8

PHASE BANK # 1 < C + O + F = 1 >

		9	A	B	C	D		E
0							RR1 DLY	
1	PHASE 1	-					RR1 CLR	
2	PHASE 2	35					EVA DLY	
3	PHASE 3	-					EVA CLR	
4	PHASE 4	-					EVB DLY	
5	PHASE 5	-					EVB CLR	
6	PHASE 6	35					EVC DLY	
7	PHASE 7	-					EVC CLR	
8	PHASE 8	-					EVD DLY	
		MAX INT	ALT WALK	ALT FLH D/W	ALT INT	ALT EXT	EVD CLR	
							RR2 DLY	
							RR2 CLR	
							EV CLR	
							EV DLY	
							RR CLR	
							RR DLY	

ALL RED START
(F/1 + C +O) = **5.0**
RED REVERT
(F/1 + O + F) = **5.0**

		COLUMN F PHASES 1	2	3	4	5	6	7	8
0	PERMIT		X				X		X
1	RED LOCK								
2	YELLOW LOCK								
3	VEH MIN CALL						X		
4	PED RECALL		X						
5	PEDESTRIANS			View Only					
6	YIELD AT FLSH D/W								
7	RED REST								
8	DOUBLE ENTRY		X				X		
9	VEH MAX CALL								
A	SOFT RECALL								
B	MAXIMUM 2								
C	COND SERVICE								
D	MAN CONT CALL								
E	YELLOW START		X				X		
F	FIRST PHASES								X

< C + O + F = 1 >

BI Tran Systems, Inc.
510 Bercut Dr., Sacremento, Calif. 95814
916/441-0260
Traffic Signal Program **233** Ontario

Date: 28-Mar-19

LOCATION

Hwy: 3

At: HN Road 46

		A	B	C
PREEMPT		RR1-2	SP	EMER
MINIMUMS		SPEV1	EV2	VEH
A	WLK (DFLT)			
B	FD WALK			
C	INITAL			

< C + O + F = 1 >

Column E Phases / Bits

		1	2	3	4	5	6	7	8
0	EXCLUSIVE								
1	RR1 CLEAR								
2	RR2 CLEAR								
3	RR2 LTD SRV								
4	PROT/PERM								
5	FLH TO PREMT								
6	FLASH ENTRY								
7	DISABL MIN YEL								
8	DISABL OVP YEL								
9	OVP FLH YEL								
A	EM VEH A								
B	EM VEH B								
C	EM VEH C								
D	EM VEH D								
E	EXTRA 1	X		X		X			
F	IC SELECT		X						

Column F Phases / Bits

		1	2	3	4	5	6	7	8
0									
1	EXT PERMIT 1								
2	EXT PERMIT 2								
3	EXCLU PED								
4									
5	PED 2P OUT		X						
6	PED 6P OUT								
7	PED 4P OUT								
8	PED 8P OUT								X
9	FLH YELLOW								
A									
B									
C									
D									
E	RESTRICTED								
F	EXTRA 2								

< C + O + E = 125 >

Column F Phases / Bits

		1	2	3	4	5	6	7	8
0	ADV GRN FLH								
1	PHASE FLASH								
2	FLASH WALK								
3	GUAR PASS								
4	SIMUL GAP		X				X		
5	SEQ TIMING								
6	ADV WALK								
7	DELAY WALK								
8	EXT RECALL								
9									
A	MAX EXTEN								
B	INH PED RSRV								
C	SEMI ACTUATED								
D									
E	STRT VEH CALL						X		
F	STRT PED CALL		X						X

SPECIALS < C + O + F = 2 >

MANUAL PLAN	0
< C/0 + A + 1 >	
MANUAL OFFSET	0
< C/0 + A + 1 >	

MANUAL SELECTION

MANUAL PLAN
0 = Automatic (Master)
9 = Control Plan 1 - 9
14 (E) = Free (Isolated)
15 (F) = Software Flash

MANUAL OFFSET
0 = Automatic (Master)
1 = Offset A
2 = Offset B
3 = Offset C

FLASH TO PREEMPT
1 = EVA
2 = EVB
3 = EVC
4 = EVD
5 = RR1
6 = RR2
7 = SE1
8 = SE2

EXTRA 1
1 = TBC TYPE 1
2 = NEMA EXT. COORD.
3 = DAYLIGHT SAVINGS
4 =
5 = EXPANDED STATUS REPORTING
6 = INTERNATIONAL PED
7 = CLEAR OUTPUTS DURING FLASH
8 = SPLIT RING

EXTRA 2
1 = AWR ON DURING PHASE INITAL
2 = LMU INSTALLED

IC SELECT
2 = 2 WAY MODEM
3 = 7 WIRE SLAVE
4 = FLASH / FREE
5 = SIMPLES MASTER
7 = 7 WIRE MASTER
8 = OFFSET INTURP

PRETIMED ONTARIO 233 PROGRAM

PHASE

	1	2	3	4	5	6	7	8
WALK	-	29	-		-		-	13
DON'T WALK	-	13	-		-		-	7
MIN INTIAL		40				40		20
TYPE 3 LIMIT	-		-		-		-	
ADD PER VEH	-	2	-		-	2	-	
VEH EXT		4.0				4.0		3.0
MAX GAP		4.0				4.0		3.0
MIN GAP		4.0				4.0		3.0
MAX LIMIT		50				50		35
MAXIMUM 2	-		-		-		-	
ADV / DLY WALK	-		-		-		-	
SEQUENCE TO	-		-		-		-	
COND SRV MIN	-		-		-		-	
REDUCE EVERY	-		-		-		-	
YELLOW		5.9				5.9		4.5
RED CLEAR		1.5				1.5		1.8

PHASE BANK # < C + O + F = 1 >

Column F

PHASES

		1	2	3	4	5	6	7	8
0	PERMIT		X				X		X
1	RED LOCK								
2	YELLOW LOCK								
3	VEH MIN CALL								X
4	PED RECALL		X						
5	PEDESTRIANS			View Only					
6	REST IN WALK								
7	RED REST								
8	DOUBLE ENTRY		X				X		
9	VEH MAX CALL								
A	SOFT RECALL								
B	MAXIMUM 2								
C	CORD SERVICE								
D	MAN CONT CALL								
E	YELLOW START		X				X		
F	FIRST PHASES								X

< C + O + F = 1 >

T.O.D. FUNCTIONS

	TIME HH	MM	FUN	DAY OF WEEK S	M	T	W	T	F	S
				1	2	3	4	5	6	7
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										
A										
B										
C										
D										
E										
F										

< C + O + 7 = 1 >

Column 4

PHASES / BITS

1	2	3	4	5	6	7	8

< C+ O + E = 27 >

T.O.D. FUNCTIONS

0 = PERMIT PHASES
1 = RED LOCK
2 = YELLOW LOCK
3 = VEH MIN RECALL
4 = PED RECALL
5 -
6 - REST IN WALK
7 = RED REST
8 = DOUBLE ENTRY
9 = VEH MAX RECALL
A = VEH SOFT RECALL
B = MAXIMUM 2
C = CONDITIONAL SERVICE
D = LAG PHASES
E = BIT 1 - LOCAL OVERIDE
BIT 4 - DISABLE DET OFF MONITOR
BIT 7 - DET COUNT MONITOR
BIT 8 - REAL TIME SPLIT MONITOR
F = OUTPUT BITS 1 THRU 4

LOCATION: **Highway 3 @ HN Rd 46**

BI Tran Systems, Inc.
510 Bercut Dr., Sacremento, Calif. 95814
916/441-0260

*Traffic Signal Program **233** Ontario*
Timing Sheet #2
Revised (02/95)

Issued Date: 03/28/19

Installed Date:

DETECTOR ASSIGNMENTS

STANDARD 332 CABINET LOCATION	column	1	3
		delay	carry over
I-2 U	0		
J-2 U	1		
I-6 U	2		
J-6 U	3	10	
1-2 L	4		
J-2 L	5		
1-6 L	6		
J-6 L	7		
I-4	8		
J-4	9		
I-8	A		
J-8	B		
J-1	C		
I-1	D		
J-5	E		
I-5	F		
	< C + O + D = 0 >		

Column 0	Column 1								Column 2								Column 3							
	ATTRIBUTES								PHASE(S)								ASSIGNMENTS							
C1 Pin #	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
0 39				X	X					X							X	X	X					X
1 40				X	X									X			X	X	X					X
2 41																								
3 42				X	X		X									X	X	X	X					X
4 43																								
5 44																								
6 45																								
7 46																								
8 47																								
9 48																								
A 49																								
B 50																								
C 55																								
D 56																								
E 57																								
F 58																								

DETECTOR ASSIGNMENTS < C + O + E = 126>

STANDARD 332 CABINET LOCATION	column	2	4
		delay	carry over
J-9 U	0		
I-9 U	1		
I-9 L	2		
J-9 L	3		
I-3 U	4		
J-3 U	5		
I-7 U	6		
J-7 U	7		
I-12 U	8		
I-13 U	9		
I-12 L	A		
I-13 L	B		
I-3 L	C		
J-3 L	D		
I-7 L	E		
J-7 L	F		
	< C + O + D = 0 >		

Column 4	Column 5								Column 6								Column 7							
	ATTRIBUTES								PHASE(S)								ASSIGNMENTS							
C1 Pin #	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
0 59																								
1 60																								
2 61																								
3 62																								
4 63																								
5 64																								
6 65																								
7 66																								
8 67																								
9 68																								
A 69																								
B 70		X														X	X	X	X					
C 76																								
D 77																								
E																								
F																								

DETECTOR ASSIGNMENTS < C + O + E = 126 >

DETECTOR ASSIGNMENT SHEET
ONTARIO 233 PROGRAM

LOCATION:
Hwy 3
at HN Rd 46
Issued Date: 03/28/19
Installed Date:

DETECTOR ATTRIBUTES
1 = FULL TIME DELAY
2 = PEDESTRIAN CALL
3 =
4 = COUNT
5 = EXTENSION
6 = TYPE 3
7 = CALLING
8 = ALTERNATE

DETECTOR ASSIGNMENTS
1 = DET. SET # 1
2 = DET. SET # 2
3 = DET. SET # 3
4 =
5 =
6 = MIN RECALL ON FAILURE
7 = MAX RECALL ON FAILURE
8 - REPORT ON FAILURE

DETECTOR MONITOR
MAX OFF: D/0+0+1=120
MAX ON: D/0+0+2=60

ADVANCE WARNING BEACONS
SIGN #1 SIGN #2
PHASE NUMBER
(F/1+C+F)= (F/1+D+F)=
TIME BEFORE YELLOW
(F/1+C+E)= (F/1+D+E)=
OUTPUT PIN NUMBER
(E/127+E+8)= (E/127+E+9)=

Input File Layout

Input File Slot No. →	1	2	3	4	5	6	7	8	9	10	11	12	13	14
"I" FILE	**1** Ext, Cnt, Call <C1-56>	**2** Ext, Cnt, Call <C1-39>	**2** Ext, Cnt, Call <C1-63>	**2** Type 3, Call <C1-47>	**3** Ext, Cnt, Call <C1-58>	**4** Ext, Cnt, Call <C1-41>	**4** Ext, Cnt, Call <C1-65>	**4** Type 3, Call <C1-49>	**1** Ext, Cnt, Call <C1-60>	NOT WIRED	Not Assigned <C1-80>	**2** Ped Call <C1-67>	**6** Ped Call <C1-68>	Flash Sense <C1-81>
		2 Ext, Cnt, Call <C1-43>	**2** Ext, Cnt, Call <C1-76>			**4** Ext, Cnt, Call <C1-45>	**4** Ext, Cnt, Call <C1-78>		**3** Ext, Cnt, Call <C1-62>		Not Assigned <C1-53>	**4** Ped Call <C1-69>	**8** Ped Call <C1-70>	Stop Time <C1-82>
"J" FILE	**5** Ext, Cnt, Call <C1-55>	**6** Ext, Cnt, Call <C1-40>	**6** Ext, Cnt, Call <C1-64>	**6** Type 3, Call <C1-48>	**7** Ext, Cnt, Call <C1-57>	**8** Ext, Cnt, Call <C1-42>	**8** Ext, Cnt, Call <C1-66>	**8** Type 3, Call <C1-50>	**5** Ext, Cnt, Call <C1-59>	NOT WIRED	Not Assigned <C1-54>	EV **A** Preempt <C1-71>	EV **B** Preempt <C1-72>	Railroad 1 <C1-51>
		6 Ext, Cnt, Call <C1-44>	**6** Ext, Cnt, Call <C1-77>			**8** Ext, Cnt, Call <C1-46>	**8** Ext, Cnt, Call <C1-79>		**7** Ext, Cnt, Call <C1-61>		Not Assigned <C1-75>	EV **C** Ped Call <C1-73>	EV **D** Preempt <C1-74>	Railroad 2 <C1-52>

DETECTOR TYPES

Ext = Extension Detector
Detector is only active during the Phase's GREEN Intervals (ie, will NOT *Call* the Phase)

Cnt = Count Detector
Used in computing "Added Initial"

Call = Calling Detector
Detector is only active during the Phase's NON-GREEN Intervals (ie, will NOT *Extend* the Phase)

Type 3 = Type 3 Disconnect
Will allow a Calling Detector to Extend its Phase until the Call first drops or the "Type 3 Limit" is reached

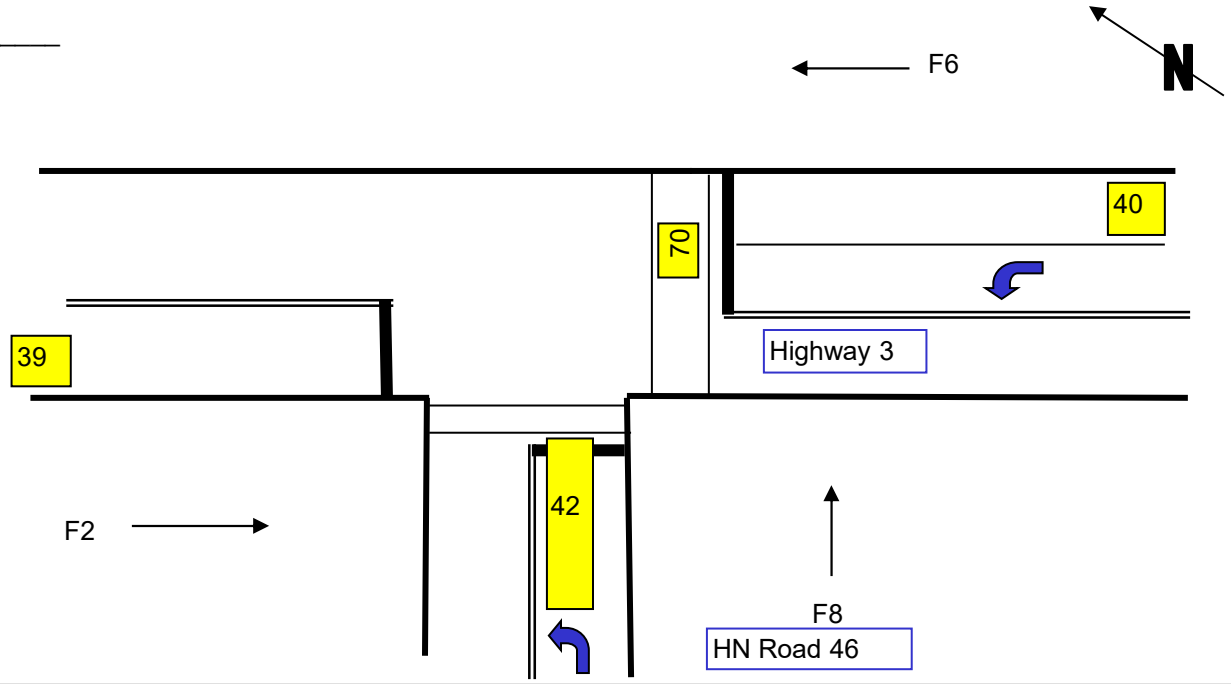
BI Tran Systems, Inc.
510 Bercut Dr., Sacramento, Calif. 95814
916/441-0260

Traffic Signal Program 233
Initialized Detector Assignments
(Revised 8/92) *332 Cabinet*

Intersection: Highway 3_____

At:_____HN Road 46

_____



DEFAULT DETECTOR ASSIGNMENTS

Standard 332 Cabinet Location	Column 0	Column 1 ATTRIBUTES								Column 2 PHASE(S)								Column 3 ASSIGNMENTS							
	C1 PIN NUMBER	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
I-2 U	0 39				X	X		X			X							X	X	X					X
J-2 U	1 40				X	X		X							X			X	X	X					X
I-6 U	2 41				X	X		X					X					X	X	X					X
J-6 U	3 42				X	X		X									X	X	X	X					X
I-2 L	4 43				X	X		X			X							X	X	X					X
J-2 L	5 44				X	X		X							X			X	X	X					X
I-6 L	6 45				X	X		X					X					X	X	X					X
J-6 L	7 46				X	X		X									X	X	X	X					X
I-4	8 47						X	X			X							X	X	X					X
J-4	9 48						X	X							X			X	X	X					X
I-8	A 49						X	X					X					X	X	X					X
J-8	B 50						X	X									X	X	X	X					X
J-1	C 55				X	X		X						X				X	X	X					X
I-1	D 56				X	X		X		X								X	X	X					X
J-5	E 57				X	X		X									X	X	X	X					X
I-5	F 58				X	X		X				X						X	X	X					X

"INITIALIZED" DETECTOR ASSIGNMENTS
< C + 0 + E = 126 >

Standard 332 Cabinet Location	Column 4	Column 5 ATTRIBUTES								Column 6 PHASE(S)								Column 7 ASSIGNMENTS							
	C1 PIN NUMBER	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
J-9 U	0 59				X	X		X						X				X	X	X					X
I-9 U	1 60				X	X		X		X								X	X	X					X
J-9 L	2 61				X	X		X								X		X	X	X					X
I-9 L	3 62				X	X		X				X						X	X	X					X
I-3 U	4 63				X	X		X			X							X	X	X					X
J-3 U	5 64				X	X		X								X		X	X	X					X
I-7 U	6 65				X	X		X						x				X	X	X					X
J-7 U	7 66				X	X		X									X	X	X	X					X
I-12 U	8 67		X								X							X	X	X					X
I-13 U	9 68		X													X		X	X	X					X
I-12 L	A 69		X											X				X	X	X					X
I-13 L	B 70		X														X	X	X	X					X
I-3 L	C 76				X	X		X			X							X	X	X					X
J-3 L	D 77				X	X		X								X		X	X	X					X
I-7 L	E 78				X	X		X						X				X	X	X					X
J-7 L	F 79				X	X		X									X		X	X					X

"INITIALIZED" DETECTOR ASSIGNMENTS
< C + 0 + E = 126 >

DETECTOR ATTRIBUTES

1= Full time Delay
2 = Pedestrian call
3 =
4 = Count
5 = Extention
6 = Type 3
7 = Calling
8 = Alternate

DETECTOR ASSIGNMENTS

1 = Det. Set #1
2 = Det. Set #2
3 = Det. Set #3
4 =
5 =
6 = MIN Recall On Failure
7 = MAX Recall On Failure
8 = Report On Failure

Input File → 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14

"I" FILE	1 Ext, Cnt, Call <C1-56>	2 Ext, Cnt, Call <C1-39> / 2 Ext, Cnt, Call <C1-43>	2 Ext, Cnt, Call <C1-63> / 2 Ext, Cnt, Call <C1-76>	2 Type 3, Call <C1-47>	3 Ext, Cnt, Call <C1-58>	4 Ext, Cnt, Call <C1-41> / 4 Ext, Cnt, Call <C1-45>	4 Ext, Cnt, Call <C1-65> / 4 Ext, Cnt, Call <C1-78>	4 Type 3, Call <C1-49>	1 Ext, Cnt, Call <C1-60> / 3 Ext, Cnt,	NOT WIRED	Not Assigned <C1-80> / Not Assigned <C1-53>	2 Ped Call <C1-67> / 4 Ped Call <C1-69>	6 Ped Call <C1-68> / 8 Ped Call	Flash Sense <C1-81> / Stop Time <C1-82>
"J" FILE	5 Ext, Cnt, Call <C1-55>	6 Ext, Cnt, Call <C1-40> / 6 Ext, Cnt, Call <C1-44>	6 Ext, Cnt, Call <C1-64> / 6 Ext, Cnt, Call <C1-77>	6 Type 3, Call <C1-48>	7 Ext, Cnt, Call <C1-57>	8 Ext, Cnt, Call <C1-42> / 8 Ext, Cnt, Call <C1-46>	8 Ext, Cnt, Call <C1-66> / 8 Ext, Cnt, Call <C1-79>	8 Type 3, Call <C1-50>	5 Ext, Cnt, Call <C1-59> / 7 Ext, Cnt, Call <C1-61>	NOT WIRED	Not Assigned <C1-54> / Not Assigned <C1-75>	EV A Preempt <C1-71> / EV C Ped Call <C1-73>	EV B Preempt <C1-72> / EV D Preempt <C1-74>	Railroad 1 <C1-51> / Railroad 2 <C1-52>

DETECTOR TYPES

Ext = Extension Detector
Detector is only active during the Phase's GREEN Intervals (ie, will NOT *Call* the Phase)
Cnt = Count Detector
Used in computing "Added Initial"
Call = Calling Detector
Detector is only active during the Phase's NON-GREEN Intervals (ie, will NOT *Extend* the Phase)
Type 3 = Type 3 Disconnect
Will allow a Calling Detector to Extend its Phase until the Call first drops or the "Type 3 Limit" is reached

BI Tran Systems, Inc.
510 Bercut Dr., Sacramento, Calif. 95814
916/441-0260

Traffic Signal Program 233
Initialized Detector Assignments
(Revised 8/92) 332 Cabinet

REFERENCE SHEET

Controller Intervals

0 = Walk	8 = Red Rest
1 = FDW	9 = Preemption
2 = Min. Green	A = Stop Time
3 =	B = Red Revert
4= Var. Initial	C = Yellow-Gap Termination
5 = Extension	D = Yellow-Max. Termination
6 =	E = Yellow-Forceoff Termination
7 = Reduce Gap	F = Red Clearance

Continuous Memory Error Monitoring

The controller's RAM and EPROM memories are continuously checked for errors. If an erro is found, the intersection will go into FLASH (via Watch Dog Timer), and one of the following will be shown on the controller's display:

bAd A = An error was detected in the CPU's RAM, or a new program has been installed on the memory module. Often caused by a bad controller "gel-cell" battery.

bAd b = An error was detected in the memory module's RAM. Often caused by a bad "lithium" battery on the memory module.

bAd E = An error was detected in the 233 Program EPROM.

bAd F = An error was detected in the Z-RAM (Dallas chip) on the memory module.

412/C Memory Module
Lithium Battery Condition

To check the condition of the 3.6 volt Lithium Battery on the 412/C Memory Module:

If E/112 + 0 + A = 84 - the battery is BAD
If E/112 + 0 + A = 85 - the battery is O.K.

Monitor "Activate" Flags

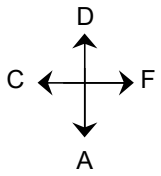
(Also Requires T.O.D. Function "E" Flag)

Detector Count Recording:
E/2 + 0 + 9 = Not Zero

Real Time Split Monitor:
E/2 + 0 + E = Not Zero

E Page Enable: F/1 + 9 + E = Not Zero

Display Movement Codes



A = Advance ROW
D = Decrement ROW
C = COLUMN Back
F = Forward COLUMN

Special Event Schedules

Special Event #1: C + 0 + E = 27
Special Event #2: C + 0 + E = 28

Current Interval = E + 5 + 0
Current Interval Timer = E + 5 + B
Current Interval Clearance Phases = E + 5 + C

Time of Day Function (7 Key)

Current T.O.D. "E Function" Control Bits = C/0 + E + E
Current T.O.D. "F Function" Output Bits = C/0 + E + F

Logic DELAY Gate
Delay Timer Display

DELAY A Timer = C/0 + 9 +A
DELAY B Timer = C/0 + 9 + B
thru thru
DELAY F Timer = C/0 + 9 + F

Interval Timer Display

Ring A = F/0 + A + Interval Row
Ring B = F/0 + B + (Interval Row From PHASE BANK data)

Display Locations

	Plan Select	Offset Select
Manual	C/0 + A + 1	C/0 + B + 1
Master	C/0 + A + 2	C/0 + B + 2
Current	C/0 + A + 3	C/0 + B + 3
Next	C/0 + A + 4	C/0 + B + 4
TOD	C/0 + A +5	C/0 + B + 5

Master Cycle = C/0 + A + 0
Ring A Cycle = C/0 + B + 0
Ring B Cycle = C/0 + D + 0

MIN Cycle = C/0 + A + E
MAX Cycle = C/0 + B + E

Phase Hold = C/0 + F + D
Phase Next = C/0 + F + E
Force Off = C/0 + F + F
(with Ring A Cycle Timer)

Current Calculated Cycle Length = C/0 + B + F
Current Permitted Phases = E/0 + 7 +8
Current Phase Bank = F/0 + C + E

Last Power Failure:
(HR-MIN-DOW) = 8 + 4
(DOW-YR-MONTH) = 8 + 5
Last Cabinet Flash
(HR-MIN-DOW) = 8 + 6
(DOW-YR-MONTH) = 8 + 7
Power Fail Counts:
(Long Failures) = F/1 + 0 + C
(Short Failures) = F/1 + 0 + D
Current Time:
(HR-MIN-DOW) = 8 + 0
(DOW-YR-MONTH) = 8 + 1
(MIN-SEC-1/10SEC) = 8 + F

BI Tran Systems, Inc.
510 Bercut Dr., Sacramento, Calif. 95814
916/441-0260

Traffic Signal Program 233
"View" Locations
(Revised 03/94

APPENDIX G:
Signal Warrant and Turn Lane Warrants

Input Data Sheet

Analysis Sheet | Results Sheet | Proposed Collision

GO TO Justification:

What are the intersecting roadways? James St / Tisdale Dr

What is the direction of the Main Road street? North-South

When was the data collected? Future Total Traffic Volumes (2038)

Justification 1 - 4: Volume Warrants

a.- Number of lanes on the Main Road? 1

b.- Number of lanes on the Minor Road? 1

c.- How many approaches? 3

d.- What is the operating environment? Rural Population < 10,000 AND Speed >= 70 km/hr

e.- What is the eight hour vehicle volume at the intersection? (Please fill in table below)

Hour Ending	Main Northbound Approach			Minor Eastbound Approach			Main Southbound Approach			Minor Westbound Approach			Pedestrians Crossing Main Road
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
8:00		400	40				60	480		90		145	0
10:00		364	30				45	437		53		85	0
12:00		445	41				64	442		48		73	0
13:00		402	49				76	399		81		121	0
14:00		448	45				70	444		48		73	0
15:00		507	70				108	503		43		65	0
16:00		590	90				140	585		70		105	0
17:00		535	82				127	530		113		170	0
Total	**0**	**3,691**	**446**	**0**	**0**	**0**	**690**	**3,819**	**0**	**547**	**0**	**836**	**0**

Justification 5: Collision Experience

Preceding Months	Number of Collisions*
1-12	
13-24	
25-36	

* Include only collisions that are susceptable to correction through the installation of traffic signal control

Justification 6: Pedestrian Volume

a.- Please fill in table below summarizing total pedestrians crossing major roadway at the intersection or in proximity to the intersection (zones). Please reference Section 4.8 of the Manual for further explanation and graphical representation.

	Zone 1		Zone 2		Zone 3 (if needed)		Zone 4 (if needed)		Total
	Assisted	Unassisted	Assisted	Unassisted	Assisted	Unassisted	Assisted	Unassisted	
Total 8 hour pedestrian volume									
Factored 8 hour pedestrian volume	0		0		0		0		
% Assigned to crossing rate	100%		50%		0%		0%		
Net 8 Hour Pedestrian Volume at Crossing									0
Net 8 Hour Vehicular Volume on Street Being Crossed									6,411

b.- Please fill in table below summarizing delay to pedestrians crossing major roadway at the intersection or in proximity to the intersection (zones). Please reference Section 4.8 of the Manual for further explanation and graphical representation.

	Zone 1		Zone 2		Zone 3 (if needed)		Zone 4 (if needed)		Total
	Assisted	Unassisted	Assisted	Unassisted	Assisted	Unassisted	Assisted	Unassisted	
Total 8 hour pedestrian volume	0	0	0	0	0	0	0	0	
Total 8 hour pedestrians delayed greater than 10 seconds								0	
Factored volume of total pedestrians	0		0		0		0		
Factored volume of delayed pedestrians	0		0		0		0		
% Assigned to Crossing Rate	100%		50%		0%		0%		
Net 8 Hour Volume of Total Pedestrians									0
Net 8 Hour Volume of Delayed Pedestrians									0

Analysis Sheet

Input Sheet | Results Sheet | Proposed Collision | GO TO Justification:

Intersection: James St / Tisdale Dr | Count Date: Future Total Traffic Volumes (2038)

Justification 1: Minimum Vehicle Volumes

Free Flow Rural Conditions

Justification	Guidance Approach Lanes				Percentage Warrant								Total Across	Section Percent
	1 Lanes		2 or More Lanes		Hour Ending									
Flow Condition	FREE FLOW ☑	RESTR. FLOW ☐	FREE FLOW ☐	RESTR. FLOW ☐	8:00	10:00	12:00	13:00	14:00	15:00	16:00	17:00		
1A	480	720	600	900	1,215	1,014	1,113	1,128	1,129	1,295	1,580	1,557		
	COMPLIANCE %				100	100	100	100	100	100	100	100	800	100
1B	180	255	180	255	235	138	121	202	121	108	175	283		
	COMPLIANCE %				100	77	67	100	67	60	97	100	668	84

Free Flow Signal Justification 1:	Both 1A and 1B 100% Fulfilled each of 8 hours	Yes ☐	No ☑
	Lesser of 1A or 1B at least 80% fulfilled each of 8 hours	Yes ☑	No ☐

Justification 2: Delay to Cross Traffic

Free Flow Rural Conditions

Justification	Guidance Approach Lanes				Percentage Warrant								Total Across	Section Percent
	1 lanes		2 or More lanes		Hour Ending									
Flow Condition	FREE FLOW ☑	RESTR. FLOW ☐	FREE FLOW ☐	RESTR. FLOW ☐	8:00	10:00	12:00	13:00	14:00	15:00	16:00	17:00		
2A	480	720	600	900	980	876	991	926	1,007	1,187	1,405	1,274		
	COMPLIANCE %				100	100	100	100	100	100	100	100	800	100
2B	50	75	50	75	90	53	48	81	48	43	140	113		
	COMPLIANCE %				100	100	97	100	97	86	100	100	780	98

Free Flow Signal Justification 2:	Both 2A and 2B 100% fulfilled each of 8 hours	Yes ☐	No ☑
	Lesser of 2A or 2B at least 80% fulfilled each of 8 hours	Yes ☑	No ☐

Justification 3: Combination

Combination Justification 1 and 2

Justification Satisfied 80% or More				Two Justifications Satisfied 80% or More	
Justification 1	Minimum Vehicle Volume	YES ☑	NO ☐	YES ☑	NO ☐
Justification 2	Delay Cross Traffic	YES ☑	NO ☐	JUSTIFIED	

Justification 4: Four Hour Volume

Justification	Time Period	Total Volume of Both Approaches (Main) X	Heaviest Minor Approach Y (actual)	Required Value Y (warrant threshold)	Average % Compliance	Overall % Compliance
Justification 4	14:00	1,007	121	115	100 %	100 %
	15:00	1,187	108	82	100 %	
	16:00	1,405	175	80	100 %	
	17:00	1,274	283	80	100 %	

Justification 5: Collision Experience

Justification	Preceding Months	% Fulfillment	Overall % Compliance
Justification 5	1-12	0 %	0 %
	13-24	0 %	

	25-36	0 %	

Justification 6: Pedestrian Volume

Pedestrian Volume Analysis

8 Hour Vehicular Volume V_8		Net 8 Hour Pedestrian Volume				
		< 200	200 - 275	276 - 475	476 - 1000	>1000
Justification 6A	< 1440					
	1440 - 2600					
	2601 - 7000	Not Justified				
	> 7000					

Pedestrian Delay Analysis

Net Total 8 Hour Volume of Total Pedestrians		Net Total 8 Hour Volume of Delayed Pedestrians		
		< 75	75 - 130	> 130
Justification 6B	< 200	Not Justified		
	200 - 300			
	> 300			

Results Sheet

Input Sheet | Analysis Sheet | Proposed Collision

GO TO Justification:

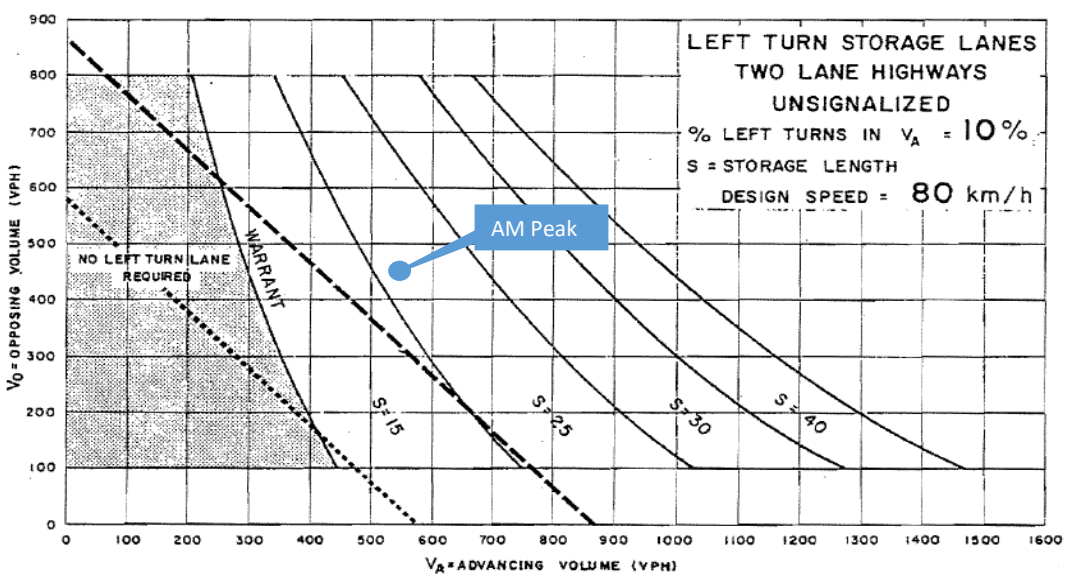
Intersection: James St / Tisdale Dr

Count Date: Future Total Traffic Volumes (2038)

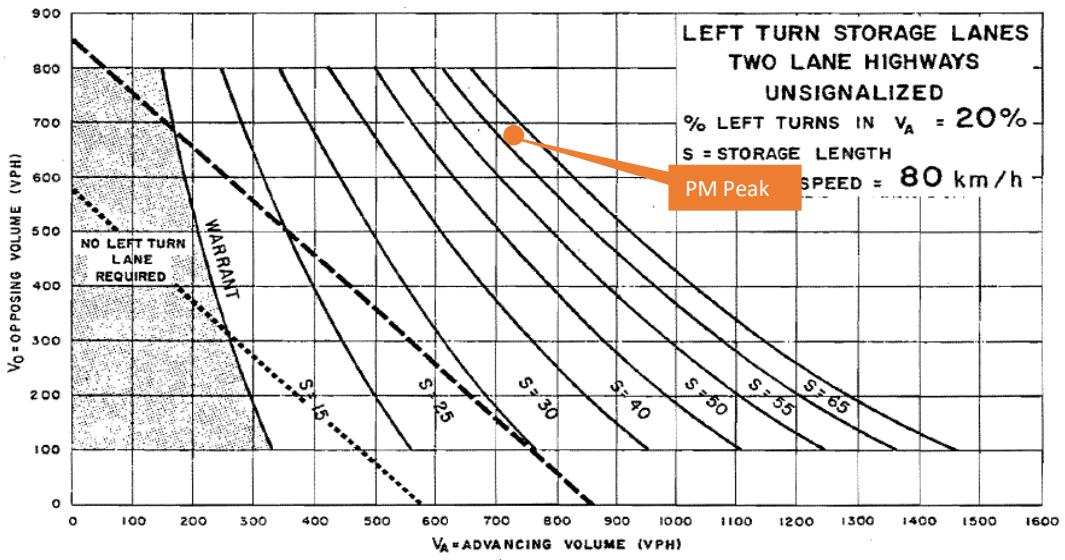
Summary Results

Justification			Compliance		Signal Justified? YES	Signal Justified? NO
1. Minimum Vehicular Volume	A	Total Volume	100	%	☐	☑
	B	Crossing Volume	84	%		
2. Delay to Cross Traffic	A	Main Road	100	%	☐	☑
	B	Crossing Road	98	%		
3. Combination	A	Justificaton 1	84	%	☑	☐
	B	Justification 2	98	%		
4. 4-Hr Volume			100	%	☑	☐
5. Collision Experience			0	%	☐	☑
6. Pedestrians	A	Volume	Justification not met		☐	☑
	B	Delay	Justification not met			

Project No: 6860-41
Project: Delhi Golf Course
Study: Unsignalized Left Turn Lane Warrant
Intersection: James Street (Highway 3) / Tisdale Drive
Scenario: Future Total Traffic Volumes (2038)
Municipality: Norfolk County
Source Geometric Design Standards for Ontario Highways - Section E.9



Graph Inputs	AM Peak	PM Peak
Advancing Volume (V_A)	540	725
Opposing Volume (V_O)	440	680
Left Turn Volume	60	140
Percentage Left Turns in V_A	11%	19%
Design Speed (km/h)	80	80



Turn Lane Lengths	AM Peak	PM Peak
Storage Length (m)	25	65
Parallel Lane Length (m)	50	50
Taper Length (m)	130	130
Turn Lane Length (m)	**205**	**245**

HWY DESIGN SPEED (km/h)	TAPER (m)	PARALLEL LANE (m)	DECELERATION LANE (m)	DECELERATION LENGTH (m)
50	85	20	105	77
60	100	30	130	97
70	115	40	155	117
80	130	50	180	137
90	145	60	205	157
100	160	70	230	177
110	170	80	250	193
120	180	90	270	210

Table E9-1

**Deceleration Lengths for Left Turn Lanes;
For 2-Lane and 4-Lane Highways
Flat Grades 2% Less**

Project No: 6860-41
Project: Delhi Golf Course
Study: Unsignalized Right Turn Lane Warrant
Intersection: James Street (Highway 3) / Tisdale Drive
Scenario: Future Total Traffic Volumes (2038)
Municipality: Norfolk County
Source Geometric Design Standards for Ontario Highways - Section E.7

Highway Design Speed (km/h)	Length of Taper (m)	Length of Parallel Lane (m)	Total Length of Deceleration Lane (m)
50	40	20	60
60	50	30	80
70	60	45	105
80	70	60	130
90	75	70	145
100	80	85	165
110	85	100	185
120	90	110	200

Table E7-1

Right Turn Taper with Parallel Deceleration Lane Lengths

Flat Grades 2% or Less

Turn Lane Lengths	
Parallel Lane Length (m)	60
Taper Length (m)	70
Turn Lane Length (m)	**130**

Note: Section E7.2 of the Geometric Design Standards for Ontario Highways note that consideration should be given to a right turn deceleration lane when the volumes approaches 60 vehicles per hour or more.

Input Data Sheet

Analysis Sheet | Results Sheet | Proposed Collision

GO TO Justification:

What are the intersecting roadways? James St / Wilson Avenue

What is the direction of the Main Road street? North-South

When was the data collected? Future Total Traffic Volumes (2038)

Justification 1 - 4: Volume Warrants

a.- Number of lanes on the Main Road? 2 or more

b.- Number of lanes on the Minor Road? 1

c.- How many approaches? 3

d.- What is the operating environment? Rural **Population < 10,000 AND Speed >= 70 km/hr**

e.- What is the eight hour vehicle volume at the intersection? (Please fill in table below)

Hour Ending	Main Northbound Approach			Minor Eastbound Approach			Main Southbound Approach			Minor Westbound Approach			Pedestrians Crossing Main Road
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
8:00		455	90				40	480		60		60	0
10:00		414	92				41	437		61		61	0
12:00		457	61				47	479		61		37	0
13:00		412	66				51	433		66		40	0
14:00		459	70				54	482		70		43	0
15:00		520	65				51	545		65		40	0
16:00		605	90				70	635		90		55	0
17:00		548	62				48	576		62		38	0
Total	**0**	**3,871**	**596**	**0**	**0**	**0**	**403**	**4,067**	**0**	**535**	**0**	**374**	**0**

Justification 5: Collision Experience

Preceding Months	Number of Collisions*
1-12	
13-24	
25-36	

* Include only collisions that are susceptable to correction through the installation of traffic signal control

Justification 6: Pedestrian Volume

a.- Please fill in table below summarizing total pedestrians crossing major roadway at the intersection or in proximity to the intersection (zones). Please reference Section 4.8 of the Manual for further explanation and graphical representation.

	Zone 1		Zone 2		Zone 3 (if needed)		Zone 4 (if needed)		Total
	Assisted	Unassisted	Assisted	Unassisted	Assisted	Unassisted	Assisted	Unassisted	
Total 8 hour pedestrian volume									
Factored 8 hour pedestrian volume	0		0		0		0		
% Assigned to crossing rate	100%		50%		0%		0%		
Net 8 Hour Pedestrian Volume at Crossing									0
Net 8 Hour Vehicular Volume on Street Being Crossed									6,411

b.- Please fill in table below summarizing delay to pedestrians crossing major roadway at the intersection or in proximity to the intersection (zones). Please reference Section 4.8 of the Manual for further explanation and graphical representation.

	Zone 1		Zone 2		Zone 3 (if needed)		Zone 4 (if needed)		Total
	Assisted	Unassisted	Assisted	Unassisted	Assisted	Unassisted	Assisted	Unassisted	
Total 8 hour pedestrian volume	0	0	0	0	0	0	0	0	
Total 8 hour pedestrians delayed greater than 10 seconds								0	
Factored volume of total pedestrians	0		0		0		0		
Factored volume of delayed pedestrians	0		0		0		0		
% Assigned to Crossing Rate	100%		50%		0%		0%		
Net 8 Hour Volume of Total Pedestrians									0
Net 8 Hour Volume of Delayed Pedestrians									0

Analysis Sheet

Input Sheet | Results Sheet | Proposed Collision | GO TO Justification:

Intersection: James St / Wilson Avenue | Count Date: Future Total Traffic Volumes (2038)

Justification 1: Minimum Vehicle Volumes

Free Flow Rural Conditions

Justification	Guidance Approach Lanes				Percentage Warrant								Total Across	Section Percent
	1 Lanes		2 or More Lanes		Hour Ending									
Flow Condition	FREE FLOW ☐	RESTR. FLOW ☐	FREE FLOW ☑	RESTR. FLOW ☐	8:00	10:00	12:00	13:00	14:00	15:00	16:00	17:00		
1A	480	720	600	900	1,185	1,106	1,142	1,069	1,177	1,287	1,545	1,334		
	COMPLIANCE %				100	100	100	100	100	100	100	100	800	100
1B	180	255	180	255	120	122	98	107	112	105	145	100		
	COMPLIANCE %				67	68	54	59	62	59	81	56	505	63

Free Flow Signal Justification 1:	Both 1A and 1B 100% Fulfilled each of 8 hours	Yes ☐	No ☑
	Lesser of 1A or 1B at least 80% fulfilled each of 8 hours	Yes ☐	No ☑

Justification 2: Delay to Cross Traffic

Free Flow Rural Conditions

Justification	Guidance Approach Lanes				Percentage Warrant								Total Across	Section Percent
	1 lanes		2 or More lanes		Hour Ending									
Flow Condition	FREE FLOW ☐	RESTR. FLOW ☐	FREE FLOW ☑	RESTR. FLOW ☐	8:00	10:00	12:00	13:00	14:00	15:00	16:00	17:00		
2A	480	720	600	900	1,065	984	1,044	962	1,065	1,182	1,400	1,234		
	COMPLIANCE %				100	100	100	100	100	100	100	100	800	100
2B	50	75	50	75	60	61	61	66	70	65	90	62		
	COMPLIANCE %				100	100	100	100	100	100	100	100	800	100

Free Flow Signal Justification 2:	Both 2A and 2B 100% fulfilled each of 8 hours	Yes ☑	No ☐
	Lesser of 2A or 2B at least 80% fulfilled each of 8 hours	Yes ☑	No ☐

Justification 3: Combination

Combination Justification 1 and 2

Justification Satisfied 80% or More				Two Justifications Satisfied 80% or More	
Justification 1	Minimum Vehicle Volume	YES ☐	NO ☑	YES ☐	NO ☑
Justification 2	Delay Cross Traffic	YES ☑	NO ☐		NOT JUSTIFIED

Justification 4: Four Hour Volume

Justification	Time Period	Total Volume of Both Approaches (Main) X	Heaviest Minor Approach Y (actual)	Required Value Y (warrant threshold)	Average % Compliance	Overall % Compliance
Justification 4	14:00	1,065	112	175	64 %	78 %
	15:00	1,182	105	143	74 %	
	16:00	1,400	145	115	100 %	
	17:00	1,234	100	132	76 %	

Justification 5: Collision Experience

Justification	Preceding Months	% Fulfillment	Overall % Compliance
Justification 5	1-12	0 %	0 %
	13-24	0 %	

	25-36	0 %	

Justification 6: Pedestrian Volume

Pedestrian Volume Analysis

8 Hour Vehicular Volume V_8		Net 8 Hour Pedestrian Volume				
		< 200	200 - 275	276 - 475	476 - 1000	>1000
Justification 6A	< 1440					
	1440 - 2600					
	2601 - 7000	Not Justified				
	> 7000					

Pedestrian Delay Analysis

Net Total 8 Hour Volume of Total Pedestrians		Net Total 8 Hour Volume of Delayed Pedestrians		
		< 75	75 - 130	> 130
Justification 6B	< 200	Not Justified		
	200 - 300			
	> 300			

Results Sheet

Input Sheet | Analysis Sheet | Proposed Collision

GO TO Justification:

Intersection: James St / Wilson Avenue

Count Date: Future Total Traffic Volumes (2038)

Summary Results

Justification			Compliance		Signal Justified? YES	Signal Justified? NO
1. Minimum Vehicular Volume	A	Total Volume	100	%	☐	☑
	B	Crossing Volume	63	%		
2. Delay to Cross Traffic	A	Main Road	100	%	☑	☐
	B	Crossing Road	100	%		
3. Combination	A	Justificaton 1	63	%	☐	☑
	B	Justification 2	100	%		
4. 4-Hr Volume			78	%	☐	☑
5. Collision Experience			0	%	☐	☑
6. Pedestrians	A	Volume	Justification not met		☐	☑
	B	Delay	Justification not met			

Input Data Sheet

Analysis Sheet | Results Sheet | Proposed Collision

GO TO Justification:

What are the intersecting roadways? James St / Wilson Avenue

What is the direction of the Main Road street? North-South

When was the data collected? Future Total Traffic Volume (2038)

Justification 1 - 4: Volume Warrants

a.- Number of lanes on the Main Road? 2 or more

b.- Number of lanes on the Minor Road? 1

c.- How many approaches? 3

d.- What is the operating environment? Urban Population >= 10,000 AND Speed < 70 km/hr

e.- What is the eight hour vehicle volume at the intersection? (Please fill in table below)

Hour Ending	Main Northbound Approach			Minor Eastbound Approach			Main Southbound Approach			Minor Westbound Approach			Pedestrians Crossing Main Road
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
8:00		455	90				40	480		60		60	0
10:00		414	92				41	437		61		61	0
12:00		457	61				47	479		61		37	0
13:00		412	66				51	433		66		40	0
14:00		459	70				54	482		70		43	0
15:00		520	65				51	545		65		40	0
16:00		605	90				70	635		90		55	0
17:00		548	62				48	576		62		38	0
Total	**0**	**3,871**	**596**	**0**	**0**	**0**	**403**	**4,067**	**0**	**535**	**0**	**374**	**0**

Justification 5: Collision Experience

Preceding Months	Number of Collisions*
1-12	
13-24	
25-36	

* Include only collisions that are susceptable to correction through the installation of traffic signal control

Justification 6: Pedestrian Volume

a.- Please fill in table below summarizing total pedestrians crossing major roadway at the intersection or in proximity to the intersection (zones). Please reference Section 4.8 of the Manual for further explanation and graphical representation.

	Zone 1		Zone 2		Zone 3 (if needed)		Zone 4 (if needed)		Total
	Assisted	Unassisted	Assisted	Unassisted	Assisted	Unassisted	Assisted	Unassisted	
Total 8 hour pedestrian volume									
Factored 8 hour pedestrian volume	0		0		0		0		
% Assigned to crossing rate	100%		50%		0%		0%		
Net 8 Hour Pedestrian Volume at Crossing									0
Net 8 Hour Vehicular Volume on Street Being Crossed									6,411

b.- Please fill in table below summarizing delay to pedestrians crossing major roadway at the intersection or in proximity to the intersection (zones). Please reference Section 4.8 of the Manual for further explanation and graphical representation.

	Zone 1		Zone 2		Zone 3 (if needed)		Zone 4 (if needed)		Total
	Assisted	Unassisted	Assisted	Unassisted	Assisted	Unassisted	Assisted	Unassisted	
Total 8 hour pedestrian volume	0	0	0	0	0	0	0	0	
Total 8 hour pedestrians delayed greater than 10 seconds								0	
Factored volume of total pedestrians	0		0		0		0		
Factored volume of delayed pedestrians	0		0		0		0		
% Assigned to Crossing Rate	100%		50%		0%		0%		
Net 8 Hour Volume of Total Pedestrians									0
Net 8 Hour Volume of Delayed Pedestrians									0

Analysis Sheet

Input Sheet | Results Sheet | Proposed Collision | GO TO Justification:

Intersection: James St / Wilson Avenue | Count Date: Future Total Traffic Volume (2038)

Justification 1: Minimum Vehicle Volumes

Restricted Flow Urban Conditions

Justification	Guidance Approach Lanes				Percentage Warrant								Total Across	Section Percent
	1 Lanes		2 or More Lanes		Hour Ending									
Flow Condition	FREE FLOW ☐	RESTR. FLOW ☐	FREE FLOW ☐	RESTR. FLOW ☑	8:00	10:00	12:00	13:00	14:00	15:00	16:00	17:00		
1A	480	720	600	900	1,185	1,106	1,142	1,069	1,177	1,287	1,545	1,334		
	COMPLIANCE %				100	100	100	100	100	100	100	100	800	100
1B	180	255	180	255	120	122	98	107	112	105	145	100		
	COMPLIANCE %				47	48	38	42	44	41	57	39	357	45
Restricted Flow Signal Justification 1:					**Both 1A and 1B 100% Fulfilled each of 8 hours** Yes ☐ No ☑ **Lesser of 1A or 1B at least 80% fulfilled each of 8 hours** Yes ☐ No ☑									

Justification 2: Delay to Cross Traffic

Restricted Flow Urban Conditions

Justification	Guidance Approach Lanes				Percentage Warrant								Total Across	Section Percent
	1 lanes		2 or More lanes		Hour Ending									
Flow Condition	FREE FLOW ☐	RESTR. FLOW ☐	FREE FLOW ☐	RESTR. FLOW ☑	8:00	10:00	12:00	13:00	14:00	15:00	16:00	17:00		
2A	480	720	600	900	1,065	984	1,044	962	1,065	1,182	1,400	1,234		
	COMPLIANCE %				100	100	100	100	100	100	100	100	800	100
2B	50	75	50	75	60	61	61	66	70	65	90	62		
	COMPLIANCE %				80	82	81	88	93	87	100	83	693	87
Restricted Flow Signal Justification 2:					**Both 2A and 2B 100% fulfilled each of 8 hours** Yes ☐ No ☑ **Lesser of 2A or 2B at least 80% fulfilled each of 8 hours** Yes ☑ No ☐									

Justification 3: Combination

Combination Justification 1 and 2

Justification Satisfied 80% or More				Two Justifications Satisfied 80% or More	
Justification 1	Minimum Vehicle Volume	YES ☐	NO ☑	YES ☐	NO ☑
Justification 2	Delay Cross Traffic	YES ☑	NO ☐		NOT JUSTIFIED

Justification 4: Four Hour Volume

Justification	Time Period	Total Volume of Both Approaches (Main) X	Heaviest Minor Approach Y (actual)	Required Value Y (warrant threshold)	Average % Compliance	Overall % Compliance
Justification 4	14:00	1,065	112	173	65 %	79 %
	15:00	1,182	105	141	75 %	
	16:00	1,400	145	115	100 %	
	17:00	1,234	100	130	77 %	

Justification 5: Collision Experience

Justification	Preceding Months	% Fulfillment	Overall % Compliance
Justification 5	1-12	0 %	0 %
	13-24	0 %	

	25-36	0 %	

Justification 6: Pedestrian Volume

Pedestrian Volume Analysis

8 Hour Vehicular Volume V_8		Net 8 Hour Pedestrian Volume				
		< 200	200 - 275	276 - 475	476 - 1000	>1000
Justification 6A	< 1440					
	1440 - 2600					
	2601 - 7000	Not Justified				
	> 7000					

Pedestrian Delay Analysis

Net Total 8 Hour Volume of Total Pedestrians		Net Total 8 Hour Volume of Delayed Pedestrians		
		< 75	75 - 130	> 130
Justification 6B	< 200	Not Justified		
	200 - 300			
	> 300			

Results Sheet

Input Sheet | Analysis Sheet | Proposed Collision

GO TO Justification:

Intersection: James St / Wilson Avenue

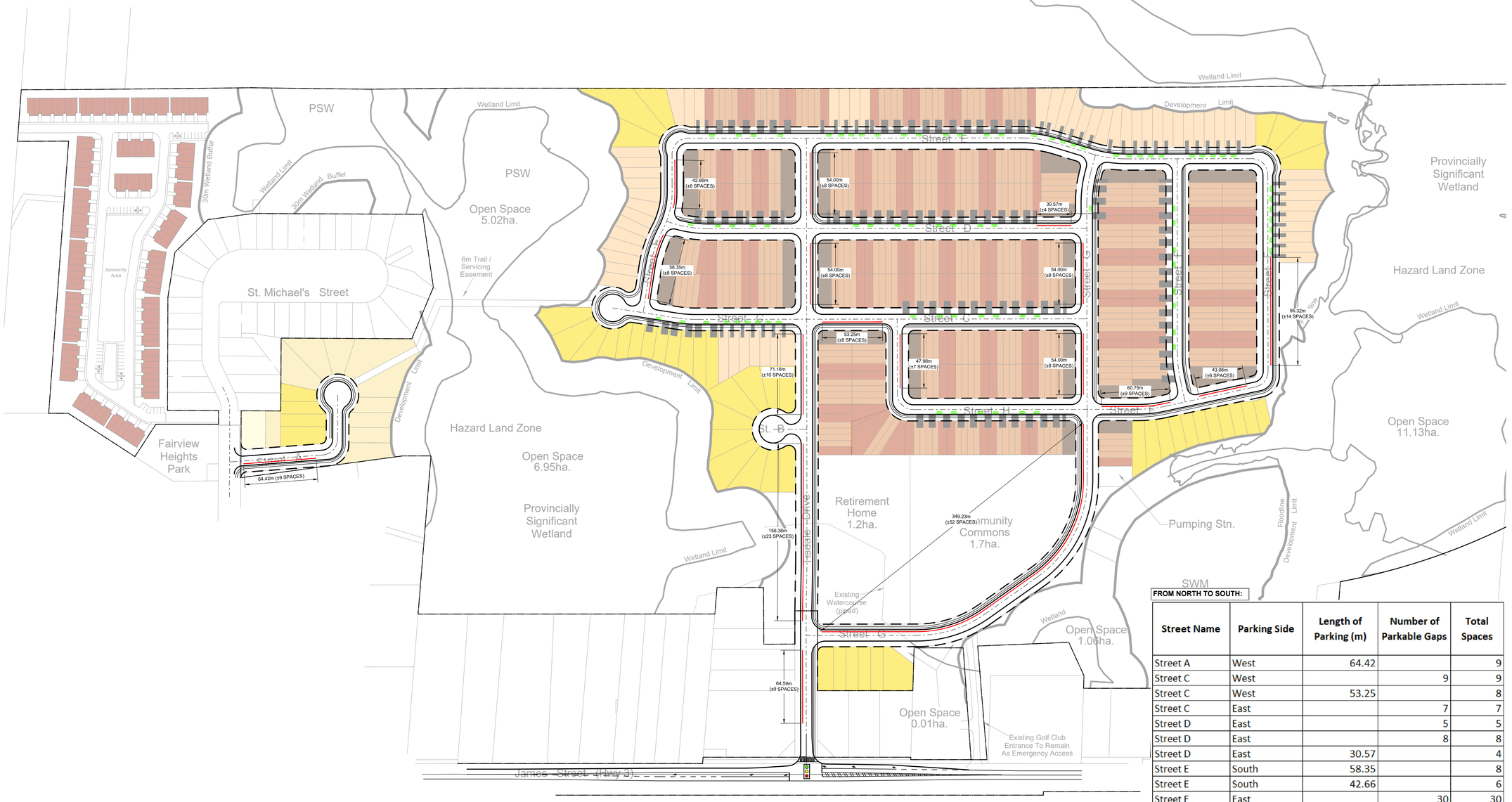
Count Date: Future Total Traffic Volume (2038)

Summary Results

Justification			Compliance		Signal Justified? YES	Signal Justified? NO
1. Minimum Vehicular Volume	A	Total Volume	100	%	☐	☑
	B	Crossing Volume	45	%		
2. Delay to Cross Traffic	A	Main Road	100	%	☐	☑
	B	Crossing Road	87	%		
3. Combination	A	Justificaton 1	45	%	☐	☑
	B	Justification 2	87	%		
4. 4-Hr Volume			79	%	☐	☑
5. Collision Experience			0	%	☐	☑
6. Pedestrians	A	Volume	Justification not met		☐	☑
	B	Delay	Justification not met			

APPENDIX H:
On-Street Parking Plan

7.296 / 5.486 / 11



GENERAL NOTES

1. ARCHITECTURAL GROUND FLOOR PLAN DATED FEBRUARY 23, 2023, PREPARED BY GSP GROUP.
2. SURVEY DATED SEPTEMBER 8, 2022, PREPARED BY R-PE SURVEYING LTD.
3. CURB / GUTTER DIMENSION HAS BEEN ADOPTED AS PER OPSD 600.040 STANDARD.
4. LOCATION OF MAILBOX AND FIRE HYDRANTS HAVE NOT BEEN DETERMINED AT THIS STAGE, WHICH WILL IMPACT ON-STREET PARKING SPACES.
5. THE SIDEWALK LOCATION IS SUBJECT TO CONFIRMATION THROUGH THE DESIGN PROCESS.
6. THE ROAD ALIGNMENT AND THE SIDEWALK SHOULD TIE INTO EXISTING.
7. THIS PLAN IS ILLUSTRATIVE FOR THE PURPOSE OF SHOWING PARKING ALLOCATION AND SHALL NOT BE RELIED UPON FOR DETAILED DESIGN OR CONSTRUCTION.

LEGEND:

- NUMBER OF SPACES DETERMINED BY LENGTH
- POTENTIAL KEY DRIVEWAY LOCATION
- POTENTIAL ON-STREET PARKING SPACE

DRIVEWAY ASSUMPTIONS:
SINGLE DETACHED LOTS = 60 feet (18.3m) = TRIPLE DRIVEWAY 8m
SINGLE DETACHED LOTS = 44 feet (13.4m) = DOUBLE DRIVEWAY 6m
SINGLE DETACHED LOTS = 36 feet (11m) = DOUBLE DRIVEWAY 6m
SINGLE DETACHED LOTS = 30 feet (9.15m) = SINGLE DRIVEWAY 3m
TOWNHOUSE LOTS = 22-18 feet (6.70m-5.49m) = SINGLE DRIVEWAY 3m, BUT WILL BE PAIRED = 6m

PARKING ASSUMPTIONS:

SINGLE PARALLEL SPACE: 6.00

DOUBLE PARALLEL SPACE: 12.00

2+ SPACES IN A ROW (NO DRIVEWAYS): 6.00 6.00 / 6.70 6.70

Parking offset from intersection: 9.00

Parking offset from inside of elbow: 15.00

NOTE: NO ON-STREET PARKING CURRENTLY SHOWN ALONG 60' OR 44' LOTS

- 18' Townhouses (129)
- 18' Street Townhouses (313)
- 20' Street Townhouses (130)
- 22' Street Townhouses (32)
- 30' Lots (57)
- 36' Lots (50)
- 44' Lots (10)
- 60' Lots (3)
- Retirement Home (150)

FROM NORTH TO SOUTH:

Street Name	Parking Side	Length of Parking (m)	Number of Parkable Gaps	Total Spaces
Street A	West	64.42		9
Street C	West		9	9
Street C	West	53.25		8
Street C	East		7	7
Street D	East		5	5
Street D	East		8	8
Street D	East	30.57		4
Street E	South	58.35		8
Street E	South	42.66		6
Street E	East		30	30
Street E	South		7	7
Street E	South	95.32		14
Street E	East	43.06		6
Street E	East	60.75		9
Street F	North		8	8
Street G	Northeast	349.23		52
Street G	North	54.00		8
Street G	North	54.00		8
Street G	North		1	1
Street H	South	47.98		7
Street H	West		6	6
Tisdale Drive	North	64.59		9
Tisdale Drive	North	156.36		23
Tisdale Drive	North	71.16		10
Tisdale Drive	South	54.00		8
Tisdale Drive	South	54.00		8
Total On-Street Parking Spaces:				**278**

04	03-16-23	WGC	ISSUED FOR RESUBMISSION
03	02-01-23	CJ	ISSUED FOR RESUBMISSION
02	12-19-22	WG	ISSUED FOR SUBMISSION
01	11-25-22	MA	ISSUED FOR INTERNAL COORDINATION
00	MM-DD-YR	INT	REVISION NOTE

BA Group
BA Consulting Group Ltd.
300 - 45 St. Clair Ave. W.
Toronto ON M4V 1K9
TEL 416 961 7110
EMAIL bagroup@bagroup.com
MOVEMENT IN URBAN ENVIRONMENTS
BAGROUP.COM

DELHI GOLF AND COUNTRY CLUB

PARKING SUPPLY DIAGRAM

Date: March 17, 2023
Project No.: 6860-41
Scale: 1:1,500 (0 25 50m)

PP-01

Date Plotted: March 17, 2023 Filename: J:\6860-41\BA\Concept Plan\5- March 15, 2023\BA-Delhi Golf And Country Club-R5-Mar15-23-6860-41.dwg

Stormwater Management Report
Delhi Golf & Country Club Redevelopment

Delhi Development Inc.
c/o Geranium
3190 Steeles Avenue East
Suite 300
Markham, ON L3R 1G9

R.J. Burnside & Associates Limited
1465 Pickering Parkway Suite 200
Pickering ON L1V 7G7 CANADA

March 2023
300053471.0000

Distribution List

No. of Hard Copies	PDF	Email	Organization Name
0	Yes	Yes	Geranium
0	Yes	Yes	Norfolk County

Record of Revisions

Revision	Date	Description
0	February 1, 2023	Initial Submission to Norfolk County
1	March 15, 2023	2nd Submission to Norfolk County

R.J. Burnside & Associates Limited

Report Prepared By:

Holly Hudyma, EIT.
Engineering Assistant
HH:cvh/tp

Report Reviewed By:

Laura Garner, P.Eng.
Project Engineer
LG:cvh/tp

Table of Contents

1.0 Introduction and Background 1
1.1 Site Description and Context 1
1.2 Background Studies and Documentations 1
2.0 Existing Site Conditions 4
2.1 Land Uses 4
2.2 Flood Hazard Mapping 4
2.3 Soil Conditions 4
2.4 Groundwater Conditions 5
2.5 Environmental Features 5
3.0 Proposed Conditions 7
3.1 Proposed Development Limit 7
3.2 Proposed Land Use 8
4.0 Existing Storm Drainage 10
4.1 Existing Drainage Pattern 10
4.2 Catchment Areas 10
4.3 External Drainage Areas 11
5.0 Proposed Storm Drainage 14
5.1 Minor System 15
5.2 Major System 15
5.3 External Drainage Conveyance 15
6.0 Stormwater Management Plan 18
6.1 Stormwater Management Design Criteria 18
6.2 Existing Hydrologic Conditions 18
6.2.1 Curve Number 19
6.2.2 Impervious Values 20
6.2.3 Existing Flows 20
6.3 Proposed Hydrologic Conditions 21
6.3.1 Proposed Flows 22
6.4 Quantity Control 23
6.4.1 North Site 23
6.4.2 South Site 24
6.5 Quality Control and Extended Detention 25
6.5.1 North Site 25
6.5.2 South Site 25
6.6 Stormwater Management Facility 25
7.0 Erosion and Sediment Control 29
8.0 Conclusions and Recommendations 30

Tables

Table 1: Floodplain Cut/Fill 7
Table 2: Existing Site Catchments 11
Table 3: Existing External Catchments 11
Table 4: Proposed Site Catchments 14
Table 5: Proposed External Catchments 15
Table 6: Wetland 1 Storage Curve 19
Table 7: Curve Numbers by Land Cover and Soil Group 19
Table 8: Pre-Development Peak Flow Rates 20
Table 9: Post-Development Peak Flow Rates 23
Table 10: Flow Rate Summary 23
Table 11: Catchment 101/201 Release Rates 24
Table 12 Summary Table for SWM Pond 1 26

Figures

Figure 1: Site Location Plan 3
Figure 2: Existing Site Conditions 6
Figure 3: Proposed Draft Plan 9
Figure 4: Pre-Development (Existing) Drainage Plan 13
Figure 5: Post-Development Drainage Plan 17
Figure 6: Proposed SWMF1 Plan View 27
Figure 7: Proposed SWMF1 Sections 28

Drawing List

STM1 – Preliminary Storm Servicing Plan
G1 – Grading Plan
G2 – Grading Plan

Appendices

Appendix A Floodplain Mapping
Appendix B PCSWMM Modelling Parameters
Appendix C PCSWMM Model Output
Appendix D Stormwater Management Facility Design Calculations

Disclaimer

Other than by the addressee, copying or distribution of this document, in whole or in part, is not permitted without the express written consent of R.J. Burnside & Associates Limited.

1.0 Introduction and Background

R.J. Burnside & Associates Limited (Burnside) has been retained by Delhi Development Inc. c/o Geranium, to prepare a Stormwater Management (SWM) Report for the proposed redevelopment of the Delhi Golf and Country Club. This SWM Report has been prepared to accompany the application for Official Plan Amendment (for an urban boundary expansion and redesignation of the lands), Zoning By-law Amendment, Plan of Subdivision and Plan of Condominium applications and demonstrates that the subject lands can provide adequate SWM measures in accordance with applicable regulatory requirements and criteria. A Functional Servicing Report (FSR) has been prepared in February 2023 by Burnside, under a separate cover, and should be reviewed in conjunction with this report.

1.1 Site Description and Context

The Delhi Golf and Country Club redevelopment (the “Site”) is located along Highway 3 (James Street), south of Dalton Road, in the County of Norfolk, Ontario.

The Site consists of two developable areas, separated by an existing Provincially Significant Wetland (PSW) and is 55.32ha in size. For the purposes of this report, the developable area will be referenced as the North and South Sites. The north developable area (the “North Site”) has frontage on Wilson Ave and St. Michael’s Street and consists of a proposed residential condominium block and freehold residential block. The south developable area (the “South Site”) fronts onto Highway 3 (James Street) and Tisdale Drive and consists of the remaining proposed freehold residential blocks, wastewater services, SWM facilities, a retirement block and community spaces. Please refer to Figure 1 for the location of the Site.

The existing South Site includes two PSWs, connected via the Delhi Golf Estates Municipal Drain which flows from the north side of the property downstream towards Stoney Creek, located on the southern boundary of the Site. The Site has roughly 15m of elevation fall from the northeast limit of the property to the wetlands in the south.

To properly develop the land, portions of the existing open ditch drains will need to be relocated and piped to the proposed SWM block at the southern limit of the Site.

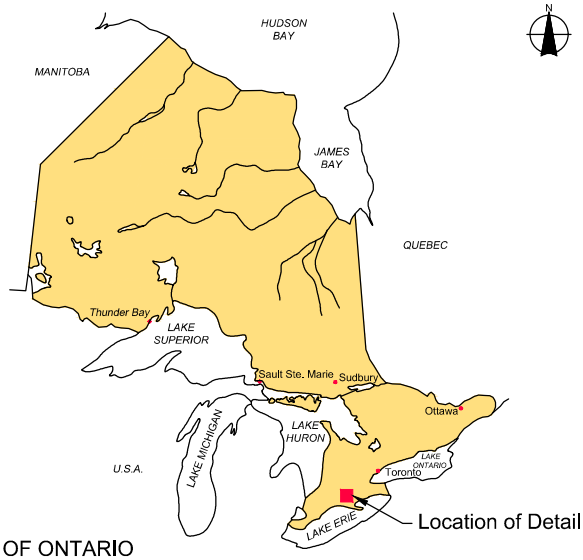
1.2 Background Studies and Documentations

The development concepts contained in this report are an extension of, and in accordance with, the information contained in the following reports and engineering drawings:

- Functional Servicing Report – Delhi Golf Course Redevelopment, R.J. Burnside & Associates Limited, March 2023.

This report has also been prepared in accordance with, and consideration of, the information and recommendations provided in the following documents:

- SWM Planning and Design Manual, previously Ministry of Environment (MOE), now Ministry of the Environment, Conservation and Parks (MECP), March 2003.
- Technical Report: Long Point Region Riverine Flood Hazard Mapping Update, Long Point Region Conservation Authority (LPRCA), March 2020 (Prepared by Wood Environment & Infrastructure Solutions).
- Design Standards, Norfolk County, 2017.
- Preliminary Geotechnical Investigation Report, Proposed Residential Development – Delhi Golf and Country Club, Golder Associates Limited, November 2022.
- Environmental Impact Study, Beacon Environmental, December 2022.
- Hydrogeological Assessment Delhi Golf and Country Club, Golder Associates Limited, December 2022.
- Delhi Golf and Country Club, Norfolk County, Proposed Residential Subdivision – Transportation Study, December 2022.



KEY MAP OF ONTARIO

BURNSIDE

Client

DELHI DEVELOPMENT INC.

Figure Title

DELHI GOLF COURSE

SITE LOCATION PLAN

Drawn	Checked	Date	Figure No.
BF	FG	23/03/15	1
Scale		Project No.	
1:20,000		053741.05	

File: \\SHERLOCK\Shared Work Areas\053741 Delhi GC\053741.05 FSR\07_Figures\SHARED FIGURES\053741.05 FIG1_SITE LOCATION.dwg Date Plotted: March 14, 2023 - 2:15 PM

2.0 Existing Site Conditions

2.1 Land Uses

The Subject Site is comprised of mainly the Delhi Golf and Country Club. The North Site also includes an existing residential property that has frontage on Wilson Ave. The Delhi Golf Estates municipal drain runs through the South Site and consists of both piped and ditched sections connecting wetlands on the Site with each other. There are multiple wetlands, online ponds, and watercourses within the redevelopment area, portions of which are proposed to be retained as part of the redevelopment plan per the Environmental Impact Study done by Beacon Environmental.

More details regarding existing Site conditions can be seen in Figure 2.

2.2 Flood Hazard Mapping

A portion of the Site is situated within the floodplain of the Stoney Creek watercourse as per the LPRCA's Long Point Region Riverine Flood Hazard Mapping Update, a technical report prepared in March of 2020. The update focused on watercourse-based flood hazard mapping for select vulnerable/flood susceptible watercourses. The base hydraulic modelling used for the study was created using HEC-GeoRAS, an integration of HEC-RAS software with ArcGIS, to create a geo-referenced hydraulic model, and using MNRF Lake Erie DTM as the core topography data. The flow data used in the study is described in the LPRCA Hydrology Model Update Study - Technical Memorandum prepared by Schroeter & Associates, April 2019. The hydrologic modelling was completed using GAWSER as part of a separate investigation. The 100-Year Flood Line and the Regional Storm Flood Line of the Stoney Creek watercourse enter the Site boundary at the south-west corner of the property as per the Flood Hazard Map for Gilbertville Stoney Creek in Appendix A.

As indicated in Appendix A, the limit of study for the report is located along Cross-Section Number 1289.35 and is situated within the Site, however, the extent of the 100-Year and Region Storm Flood Lines are only partially defined within the Site. As such, Burnside has expanded the study limit of the existing model so the Site is fully contained by the model scope. The purpose of this exercise was to accurately delineate the development limit within the Site. Please refer to Section 3.1, Proposed Development Limit, for details.

2.3 Soil Conditions

A preliminary geotechnical investigation for the study area was completed by Golder Associates Limited. Based upon the findings, the Site is covered by topsoil underlain by clayey sand to silt to clayey silt to silty clay. The topsoil thickness generally ranged from 150 mm to 900 mm. In addition, cobbles and boulders in the till deposit were detected

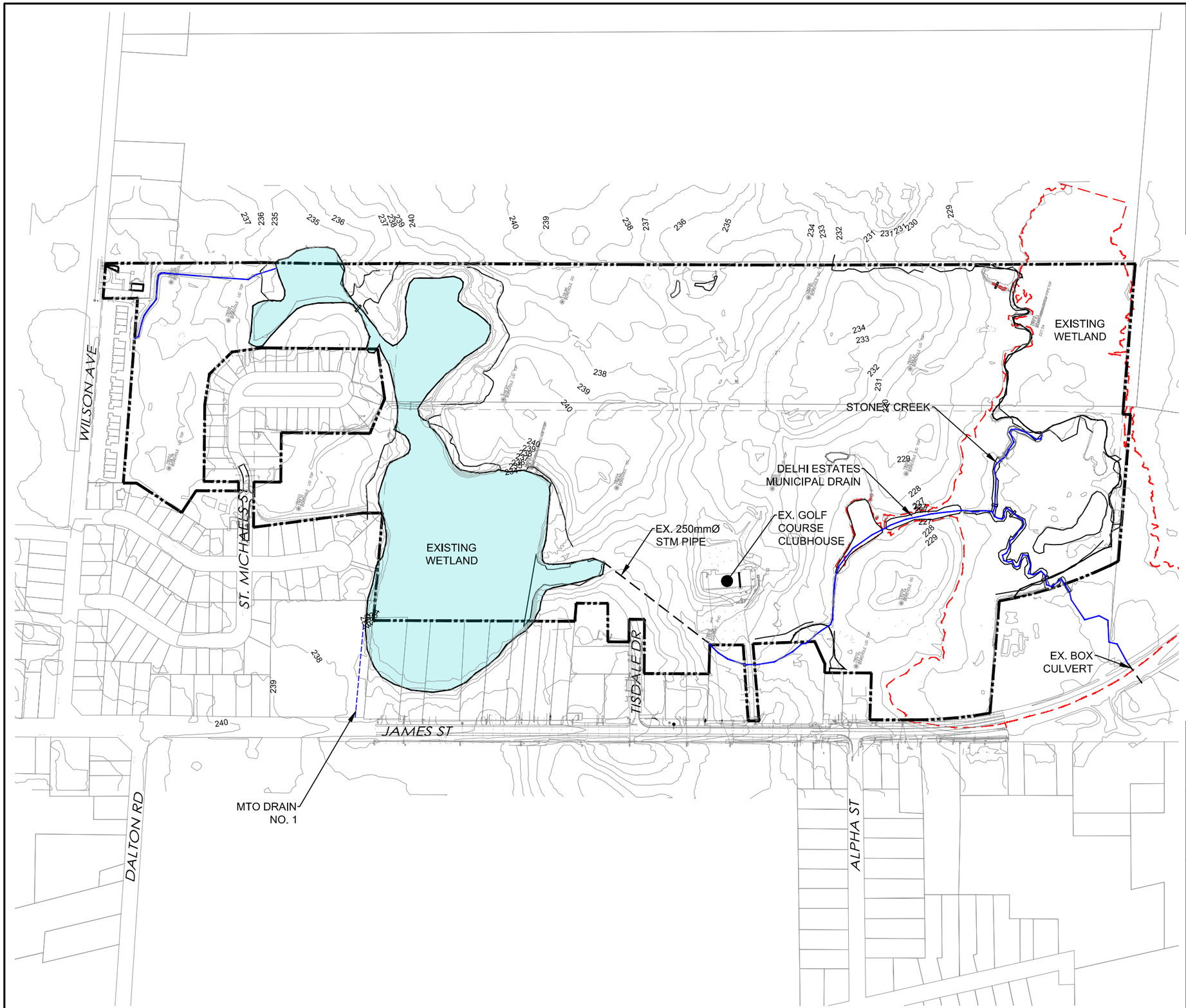
within the Site. For any additional detail information, please refer to the Preliminary Geotechnical Investigation by Golder Associates Limited (2022).

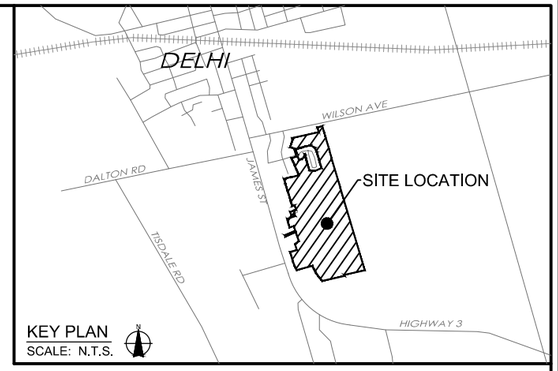
2.4 Groundwater Conditions

Groundwater conditions on site were monitored, and it was found that the water tables varied from 0.0 m to 6.1 m below ground level. The shallower water table depths were generally located in the southern portion of the property, adjacent to existing wetlands, the Municipal Drain, and Stoney Creek floodplain. The stormwater management design and approach were completed based on the recommendations made by Golder's Hydrogeological report, December 2022, submitted as part of the Site's application. based on the recommendations from the Hydrogeological report, foundation drain collection systems will be explored during detailed design.

2.5 Environmental Features

A detailed description of the natural features and their related functions within the subject property is presented in the Environmental Impact Study by Beacon Environmental (2022). One of the natural features described within the report is the open ditch channel that forms a part of the Delhi Golf Estate Municipal Drain. This drain provides a connection between the PSWs on site and contributes to the wetlands and natural features on site. The proposed redevelopment includes the widening and naturalization of the channel. The proposed enhancements to the drain are discussed in more detail in Section 3.1 as it relates to the floodplain analysis.





LEGEND

- PROPERTY BOUNDARY
- EXISTING 100-YR FLOODLINE
- 320.5 EXISTING CONTOUR
- EXISTING WATERCOURSE

N

0 50 100 200 300 400

Metres

BURNSIDE

Client

DELHI DEVELOPMENT INC.

Figure Title

DELHI GOLF COURSE

EXISTING CONDITIONS

Drawn	Checked	Date	Figure No.
BF	FG	23/03/15	**2**
Scale		Project No.	
1:5000		053741.05	

File: \\SHERLOCK\Shared Work Areas\053741 Delhi GC\053741.05 FSR\07_ Figures\SHARED FIGURES\053741.05 FIG2_ EXISTING CONDITIONS.dwg Date Plotted: March 14, 2023 - 2:16 PM

3.0 Proposed Conditions

3.1 Proposed Development Limit

The development limit within the site has been defined as the greatest constraint; either 100-Year Flood Line, which is the regulated limit per Long Point Region Conservation Authority, the 30 m regulated area from the naturalized channel, or the 30-metre buffer from the Provincially Significant Wetland.

The 100-Year Flood Line Hazard was originally established in the HEC-RAS model that was prepared for the Stoney Creek watercourse as per the Long Point Region Riverine Flood Hazard Mapping Update. This HEC-RAS model, received from the LPRCA, was updated to include the remainder of the Site, establishing the existing 100-Year Flood Line limit within the Site. The model extended the study limit from river station (i.e., Cross-Section Number) 1289.35 to river station 3608. The update to the model was completed using topographic information in CVGD 2013 format, consistent with the model received from the LPRCA. The updated existing 100-Year Flood Line is presented in Figure A in Appendix A.

To optimize the developable area and streamline development limits, floodplain modifications, by means of cut/fill works, is proposed. The cut/fill works will maintain an incremental cut/fill balance of floodplain storage by providing compensating cut areas to offset proposed fill areas. Specifically, the man-made in-line pond, located along the Delhi Golf Estates Municipal Drain is proposed to be filled and removed from the floodplain. In Beacon Environmental's report, this pond was deemed appropriate for removal. In addition, a small portion of floodplain along James Street at the southern limit of the property is proposed to be filled, to allow for two additional lots fronting on James Street. Compensating floodplain storage is proposed by the widening and naturalization of the open ditch channel located at the south end of the site adjacent to the SWM block. Overall floodplain storage is maintained under post-development conditions. Refer to Table 1 and Figure B in Appendix A for the locations of the proposed cut and fill.

Table 1: Floodplain Cut/Fill

	Fill Volume (m^3)			
Elevation	(Pond)	(James Street Lots)	Total Fill Volume	Cut Volume (m^3)
226.3	*	3	3	225
226.4	*	15	15	324
226.5	0	41	41	458
226.6	105	88	193	633
226.72	233	179	412	926

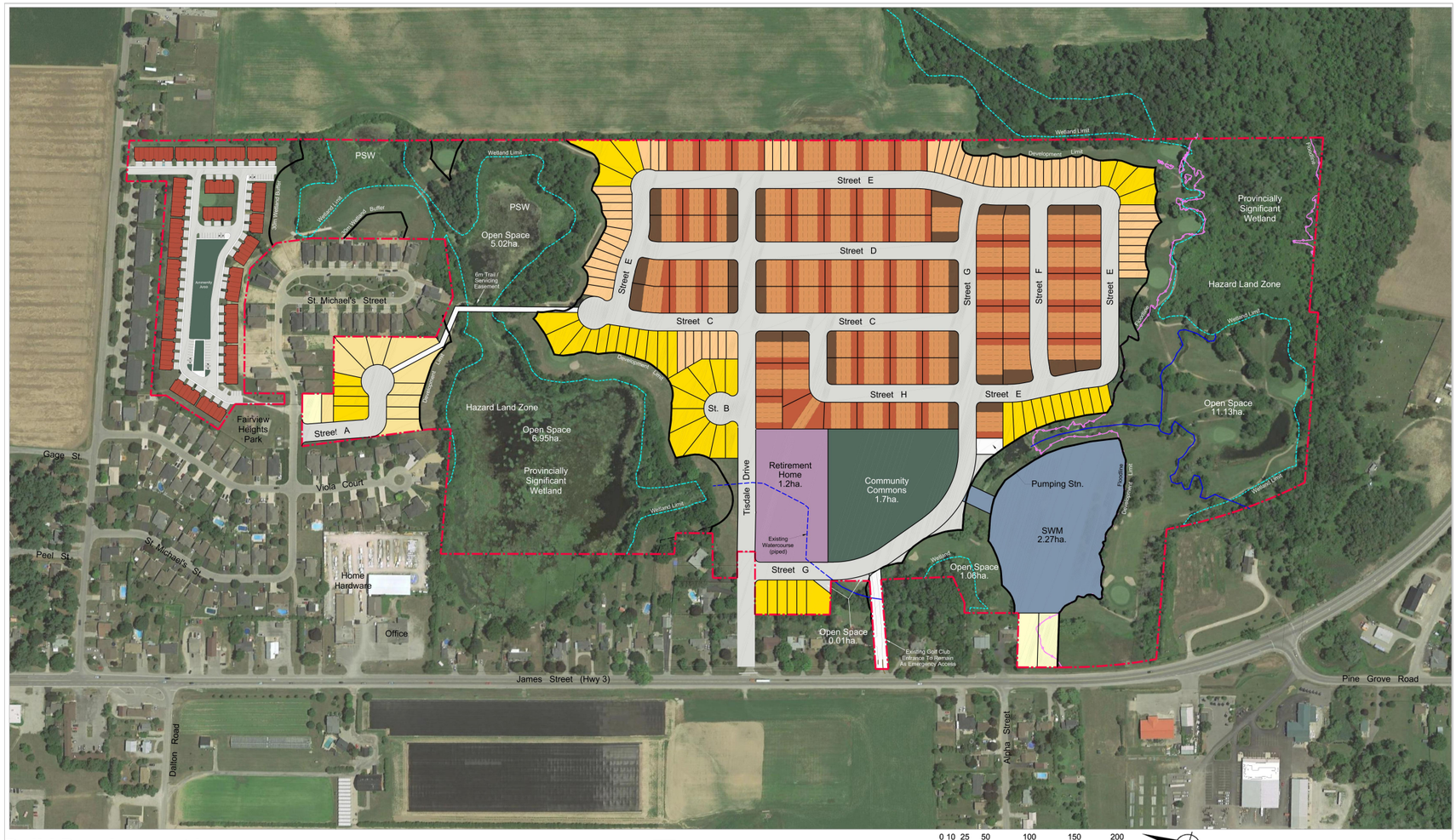
* Note: Pond water level at 226.5 m, therefore floodplain storage available above 226.5 m elevation.

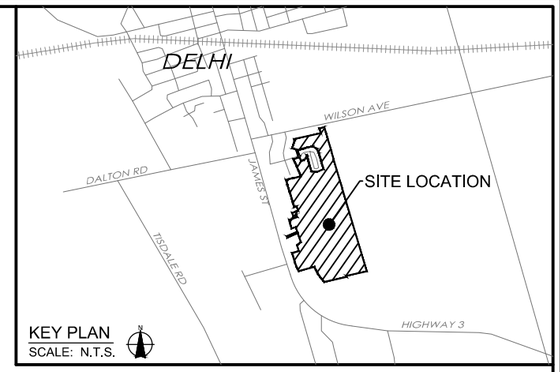
Refer to Beacon Environmental's report for details on the Regulated Area hazard limit and the Provincially Significant Wetland buffer hazard limit.

3.2 Proposed Land Use

The proposed redevelopment will be on the 29.73 ha of developable land within the boundaries of the property and will include 120 single family dwelling lots, 475 street townhouses, a townhouse block (with 129 townhouses), a retirement home, a 1.7 ha Community Commons Block, a proposed sanitary pumping station (0.06 ha), and a SWM Pond (2.27 ha) for quality and quantity control.

The conceptual plan for the Site is depicted on Figure 3 below.





Delhi Development Inc.

DEVELOPMENT CONCEPT

Delhi Golf & Country Club

Site Area: 55.32ha. (136.7ac.)
Developable Area: 29.73ha. (73.4ac)
No. of Lots / Units: 874

- 18' Townhouses (129)
- 18' Street Townhouses (313)
- 20' Street Townhouses (130)
- 22' Street Townhouses (32)
- 30' Lots (57)
- 36' Lots (50)
- 44' Lots (10)
- 60' Lots (3)
- Retirement Home (150)

0 10 25 50 100 150 200
Metres

NOTE: This concept should be considered as a preliminary demonstration model that illustrates an 'order of magnitude' development scenario for the site and is subject to municipal planning approvals.

Scale 1:4,000 | February 23, 2023 | Project No.: 21208 | Drawn By: SL

BURNSIDE

Client

DELHI DEVELOPMENT INC.

Figure Title

DELHI GOLF COURSE

PROPOSED DRAFT PLAN

Drawn	Checked	Date	Figure No.
BF	FG	23/03/15	3
Scale		Project No.	
N.T.S.		053741.05	

File: \\SHERLOCK\Shared Work Areas\053741 Delhi GC\053741.05 FSR\07_Figures\SHARED FIGURES\053741.05 FIG3_PROPOSED DRAFT PLAN.dwg Date Plotted: March 14, 2023 - 2:16 PM

4.0 Existing Storm Drainage

4.1 Existing Drainage Pattern

Under existing conditions, the Site generally drains in a southerly direction and outlets to Stoney Creek. The North Site drains to a PSW (identified as Wetland 1) before outletting the wetland at its most southern point via a weir into a catch basin (CB), which is the start of the Delhi Golf Estates Municipal drain. The drain then continues piped via a 250 mm diameter PVC sewer for approximately 175 m. Flows that exceed the capacity of the 250 mm diameter sewer flow overland via a channel. Both the sewer and channel outlet into a ditch which flows south and connects to a smaller PSW (identified as Wetland 2) and a pond via a series of culverts that drain a portion of the southern half of the Site and outlet into Stoney Creek. Stoney Creek is located within the southern PSW (identified as Wetland 3) and generally flows in a southwesterly direction ultimately connecting to Big Creek. Refer to Figure 4 for the location of the existing wetlands.

4.2 Catchment Areas

To calculate runoff volumes and peak drainage flows in the existing condition, the Site was divided into ten catchments, including three above-referenced Wetland areas, that will not be developed. Catchment boundaries were delineated using topographic base mapping for the Site and surrounding areas.

Catchments 101, 102 and 103 comprise the North Site and a portion of the South Site that first drain into the largest PSW in the centre of the Site, Wetland 1, before draining south into Stoney Creek.

Catchments 104, 105, and 106 comprise the majority of the South Site and drain via the other two PSW’s, Wetlands 2 and 3, as well as a series of overland channels and culverts into Stoney Creek. Catchment 107 complete the remaining area of the South Site but drains into Stoney Creek downstream of the proposed outlet for the Site in the post-development condition.

The catchments are described in Table 2 below and depicted in Figure 4.

Table 2: Existing Site Catchments

Catchment ID	Area (ha)	Land Use	Outlet Location
101	3.3	Golf Course/Lawn	Stoney Creek
102	1.4	Golf Course/Lawn	Stoney Creek
103	6.9	Golf Course/Lawn	Stoney Creek
Wetland1	6.8	Wetland	Stoney Creek
104	25.9	Golf Course/Lawn	Stoney Creek
105	1.3	Golf Course/Lawn	Offsite
106	0.6	Golf Course/Lawn	Offsite
107	5.5	Golf Course/Lawn	Stoney Creek
Wetland2	0.6	Wetland	Stoney Creek
Wetland3	3.6	Wetland	Stoney Creek
Total	**55.8 ha***		

*Note: The subject site area is 55.32 ha, however, the total drainage area modelled is 55.8 ha as Wetland 1 and Wetland 2 overlap the property boundary and include a small amount of external area.

4.3 External Drainage Areas

In addition to the catchments within the Site, there are also nine external drainage areas that flow through the Site under existing conditions. The catchments are shown in

Table 3 below and illustrated in Figure 4.

Table 3: Existing External Catchments

Catchment ID	Area (ha)	Land Use	Outlet Location
EXT1	58.3	Rural Lawn	Stoney Creek
EXT2	17.8	Rural Lawn	Stoney Creek
EXT3	16.4	Residential	Stoney Creek
EXT4	2.2	Residential	Stoney Creek
EXT5	0.8	Residential	Stoney Creek
EXT6	10.2	Mixed-Use	Stoney Creek
EXT7	2.8	Residential	Stoney Creek
EXT8	1.2	Golf Course/Lawn	Stoney Creek
EXT9	0.4	Golf Course/Lawn	Stoney Creek
Total	**110.0 ha**		

The first external drainage area (EXT1) is located north-west of the Site and drains overland to the Site into Wetland 1. The area is mainly comprised of rural lawns.

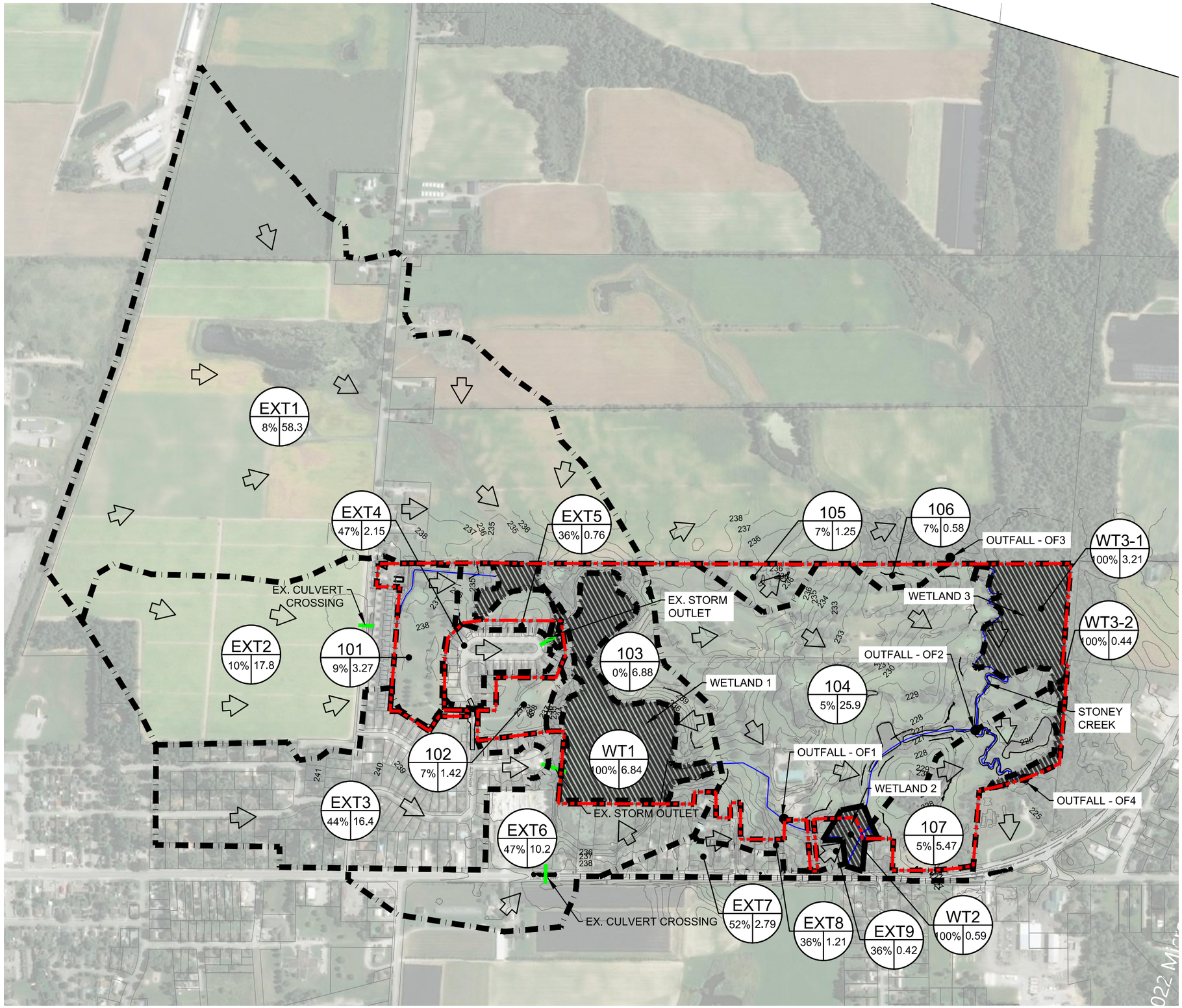
The second external drainage area (EXT2) is located north of the Site and drains overland and via a culvert into the Site. The area is mainly comprised of rural lawns.

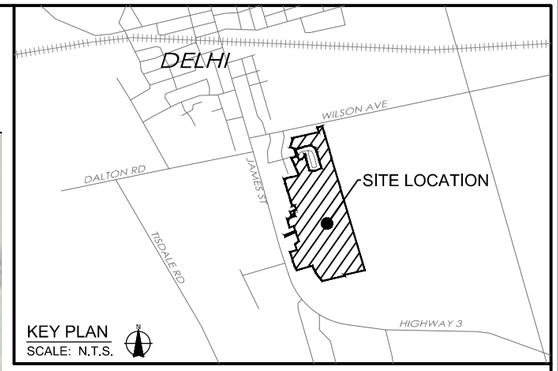
The third external drainage area (EXT3) is located north-west of the Site and drains to the Site via an external area (EXT6) that is located farther south, and north-west of the Site. EXT3 is comprised of single-family residential buildings along St. Michael's Street and Viola Court.

The fourth and fifth external drainage areas (EXT4 and EXT5, respectively), are comprised of single-family residential buildings along St. Michael's Street.

The sixth external drainage area (EXT6) is comprised of farmland, a commercial lot, and single-family residential buildings. The farmland is separated from the Site by James Street (Highway 3) and drains through a combination of overland flow, conveyance through a culvert crossing that passes under the road into the Site, and through the MTO Drain No. 1.

The final three external drainage areas (EXT7, EXT8 and EXT9) are located south of EXT6 on the west side of the Site and are bound by James Street (Highway 3) to the west. EXT8 and EXT9 comprise of the existing golf course and lawns which drain into Catchment 104. EXT7 is comprised of single-family residential buildings and drains south into the Site via Catchment 107 and outlets to Stoney Creek downstream of the proposed outlet for the Site in post-development.





LEGEND

- PROPERTY BOUNDARY
- EXISTING DRAINAGE BOUNDARY
- 230.9
- EXISTING OVERLAND FLOW DIRECTION
- 101 / 0.50 | 1.21 — CATCHMENT No. / CATCHMENT AREA / IMPERVIOUS FRACTION
- EXISTING WETLAND

N

0 100 200 400 600
Metres

BURNSIDE

Client

DELHI DEVELOPMENT INC.

Figure Title

DELHI GOLF COURSE

PRE-DEVELOPMENT DRAINAGE PLAN

Drawn	Checked	Date	Figure No.
BF	LG	23/01/31	4
Scale		Project No.	
1:7500		053741.05	

File: \\SHERLOCK\Shared Work Areas\053741 Delhi GC\053741.05 FSR\07_Figures\SHARED FIGURES\053741.05 FIG4_PRE-DEVELOPMENT DRAINAGE PLAN.dwg Date Plotted: March 14, 2023 - 2:17 PM

5.0 Proposed Storm Drainage

The post-development drainage scheme generally follows the existing drainage pattern. The North Site is comprised of Catchment 201 and 202 which will drain to Wetland 1, consistent with existing conditions. Catchment 201 is a proposed residential condominium block that will incorporate its own SWM measures to control post-development flows prior to discharging to Wetland 1. Refer to Section 6.4.1 below for additional details. Catchment 202 is comprised of single-family lots and has limited opportunity for stormwater control measures, therefore will have a direct storm discharge to Wetland 1.

One SWM facility, SWMF1, is proposed to capture Catchment 203 which makes up the majority of the South Site and is detailed in the following sections. All drainage from the Site, including SWMF1, will discharge to Stoney Creek. SWMF1 will be overcontrolled to accommodate for the uncontrolled flows from Catchment 202 mentioned above.

The proposed stormwater management details for the Site are included in subsequent sections. The proposed general drainage areas are presented on Figure 5, and summarized in Table 4 and Table 5 below.

Table 4: Proposed Site Catchments

Catchment ID	Area (ha)	Land Use	Outlet Location
201	3.3	Residential	Stoney Creek
202	1.4	Residential	Stoney Creek
203	23.7	Residential	Stoney Creek
Wetland 1	6.8	Wetland	Stoney Creek
UNC1	0.2	Residential	Stoney Creek
UNC2	6.3	Residential	Offsite
UNC3	0.3	Residential	Stoney Creek
UNC4	0.1	Residential	Stoney Creek
UNC5	5.0	Lawn	Stoney Creek
UNC6	4.5	Residential/Lawn	Stoney Creek
Wetland 2	0.59	Wetland	Stoney Creek
Wetland 3	3.65	Wetland	Stoney Creek
Total	**55.8 ha**		

Table 5: Proposed External Catchments

Catchment ID	Area (ha)	Land Use	Outlet Location
EXT1	58.3	Rural Lawn	Stoney Creek
EXT2	17.8	Rural Lawn	Stoney Creek
EXT3	16.4	Residential	Stoney Creek
EXT4	2.2	Residential	Stoney Creek
EXT5	0.8	Residential	Stoney Creek
EXT6	10.2	Mixed-Use	Stoney Creek
EXT7	2.8	Residential	Stoney Creek
EXT8	1.2	Golf Course/Lawn	Stoney Creek
EXT9	0.4	Golf Course/Lawn	Stoney Creek
Total	**110.0 ha**		

5.1 Minor System

The minor storm system will consist of a series of storm sewers situated within the road right-of-ways (ROWs) sized to convey the 5-year return period storm as per Norfolk County standards. The storm sewers will ultimately outlet to Wetland 1 for the North Site and SWMF1 for the South Site. SWMF1 will discharge to Stoney Creek at Outfall 2. The storm drainage infrastructure for the redevelopment is highlighted on Drawing STM1.The roof drainage from the individual lots will be directed to the surface to pervious areas to promote infiltration and reduce surface runoff.

5.2 Major System

The major system will safely convey overland flows above the 5-year event, up to and including the 100-year event, either via the proposed ROWs or within overland flow blocks. The entire 100-year flow will be contained within the major system flow route.

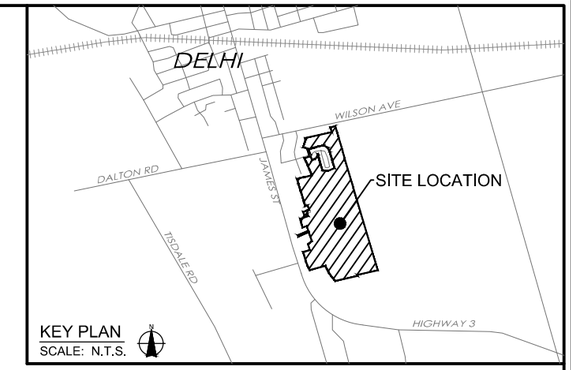
Major system flows will be directed to Wetland 1 for the North Site and SWMF1 for the South Site. The discharge from Wetland 1 will include a piped bypass for the major system flows, which will discharge to the channel described above, bypassing SWMF1 and outletting directly to Stoney Creek.

During detailed design, flow conveyance capacity calculations will be completed to ensure the overland flow route is sufficiently sized to accommodate the flow. As the grading becomes more refined during detailed design, if the major flow exceeds the capacity of the ROW, oversized piping may be required to ensure containment of the flow within the ROW limits. Preliminary grading is highlighted on Drawings G1 and G2.

5.3 External Drainage Conveyance

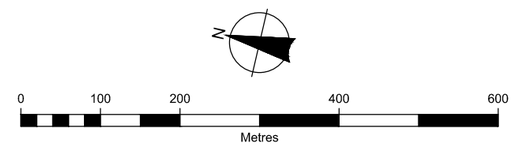
The external drainage will continue to be conveyed through the Site in post-development.

External areas EXT1 through EXT6 will be conveyed through the Site into Wetland 1, and outlet at Outfall 1. External areas EXT8 and EXT9 will be conveyed through the Site via proposed uncontrolled Catchment UNC5 and outlet at Outfall 2. External area EXT7 will be conveyed through the Site via proposed uncontrolled Catchment UNC6 and outlet at Outfall 4, downstream of Outfall 2. Refer to Table 5 for details.



LEGEND

- PROPERTY BOUNDARY
- PROPOSED DRAINAGE BOUNDARY
- PROPOSED OVERLAND FLOW DIRECTION
- 201 / 55% / 1.21 — CATCHMENT No., CATCHMENT AREA, % IMPERVIOUS
- EXISTING WETLAND



BURNSIDE

Client

DELHI DEVELOPMENT INC.

Figure Title

DELHI GOLF COURSE

POST-DEVELOPMENT DRAINAGE PLAN

Drawn	Checked	Date	Figure No.
BF	LG	23/03/15	5
Scale		Project No.	
1:7500		053741.05	

File: \\SHERLOCK\Shared Work Areas\053741 Delhi GC\053741.05 FSR\07_ Figures\SHARED FIGURES\053741.05 FIG5_ POST-DEVELOPMENT DRAINAGE PLAN.dwg Date Plotted: March 14, 2023 - 2:18 PM

6.0 Stormwater Management Plan

Stormwater management for the proposed redevelopment will be achieved through a combination of various SWM measures. Specifically, on-site flow controls in the form of underground and/or parking lot storage, as well as Oil/Grit Separator water quality treatment units will be provided within the residential condominium block on the North Site, while the remainder of the Site will be treated via an offline wet pond SWM facility, SWMF1, which will provide quality, quantity and erosion control, with an outlet to Stoney Creek that will receive most of the drainage from the South Site. Any uncontrolled areas that will drain from the Site have been accommodated for by overcontrolling the release rates from SWMF1.

6.1 Stormwater Management Design Criteria

The following describes the SWM pond design criteria that was used in the design of the proposed SWM pond in accordance with Norfolk County, Long Point Region Conservation Authority Design Criteria, and the Ministry of the Environment, Conservation and Parks (MECP) SWM Guidelines:

- Quality Control: Level 1 (Enhanced)
- Erosion Control: 24-hour retention of 25mm runoff event
- Quantity Control: Post- to Pre-Control for 2- through 100-year storm events

6.2 Existing Hydrologic Conditions

The computer model PCSWMM was used to simulate peak flow rates for different design storms based on the existing conditions of the Site. The Chicago 3-hour rainfall distribution and the 24-hour SCS Type II rainfall distribution using the Norfolk County Intensity-Duration-Frequency (IDF) values were used to simulate the 2- through 100-year storm event. It was determined that the results of the 24-hour SCS modelling proved to be more conservative (i.e., higher peak flows generated in pre- and post-development and storage volumes required in SWMF1 were greater) therefore, the Site has been modelled using the 24-hour SCS Type II rainfall distribution. Refer to Appendix B PCSWMM Modelling Parameters and IDF parameter details.

This existing drainage conditions were simulated in PCSWMM. The outlets of the Site catchments and external areas in the northern half of the Site were set to drain into Wetland 1, which was assigned a storage curve (described in Table 6 below). A weir and 250 mm diameter PVC conduit were added as the primary outlet for the wetland storage. An outfall layer element was placed where the 250 mm diameter PVC conduit presently outlets, approximately 175 m south of the wetland. The existing overland flow route was also added to the model via a trapezoidal conduit to capture wetland flows at the spill point and outlet at Outfall 1, the downstream outlet for Wetland 1.

Table 6: Wetland 1 Storage Curve

Description	Elevation (m)	Area (m²)	Depth (m)
Initial Water Level (At Weir Elevation)	233.97	75,367	0.00
-	234.07	76,765	0.10
-	234.17	78,589	0.20
Spill Point	234.27	79,736	0.30

A second outfall, Outfall 2, was placed at the proposed post-development outlet location of the Delhi Golf Estate Municipal Drain into Stoney Creek. This location also generally aligns with the proposed SWMF1 outfall location. The outlets of the remaining Site catchments and external areas were set to this outfall except for Catchments 105, 106, 107 and EXT7. A third outfall, Outfall 3, was placed east of the Site (offsite and upstream of proposed Site outlet) to capture runoff from uncontrolled catchments 105 and 106, and a fourth outfall, Outfall 4, was placed southwest of the Site (offsite and downstream of proposed Site outlet) to capture runoff from EXT7 and 107 that outlet into Stoney Creek downstream of the proposed SWMF1 outlet location.

Please refer to Appendix C for the pre-development PCSWMM model output.

6.2.1 Curve Number

The curve numbers used in the PCSWMM model were determined using Tables 9-1 and 9-5 from the National Engineering Handbook. Based on existing soil mapping, soils on the Site are Gravelling Sandy Till (Soil Group AB), Lacustrine Sand & Loamy Sand (Soil Groups A and AB), and Sandy Textures Over Gravelly Sandy Till (Soil Groups A and AB). The Site is comprised of existing golf course, woodlots, and wetlands. As curve numbers are based on the pervious surfaces within the catchment areas, the wetland areas are excluded from the calculation. Table 7 outlines the curve number associated with the specific land covers and soil types.

Table 7: Curve Numbers by Land Cover and Soil Group

Land Cover	Soil Group	Curve Number
Golf Course/Lawn	AB	50
Woods		43
Agricultural/Meadow		44
Golf Course/Lawn	B	61
Woods		55
Agricultural/Meadow		58

For each of the catchments, a composite curve number was calculated. Please refer to Appendix B for composite curve number calculations.

6.2.2 Impervious Values

The Impervious values used in the PCSWMM model were determined by converting the runoff coefficients (RC) from the Norfolk County Design Criteria into impervious fractions (i) by using the following equation:

$$RC = (0.7 \times i) + 0.2$$

Composite impervious values were calculated for each catchment where required. Please refer to Appendix B for composite impervious calculations.

6.2.3 Existing Flows

Based on the model set-up and input parameters described above, the pre-development model was run. Table 8 summarizes the resultant pre-development peak flows for each storm event at each of the four noted outfalls, with total flows conservatively comprising a summation of each outfall.

Table 8: Pre-Development Peak Flow Rates

	Outfall 1 (m^3/s)	Outfall 2 (m^3/s)	Outfall 3 (m^3/s)	Outfall 4 (m^3/s)	Total
Outfall Location	**Wetland1 Outlet**	**Proposed Outlet**	**Off Site (Upstream of Proposed Outlet)**	**Off Site (Downstream of Proposed Outlet)**	
Contributing Catchments	**EXT1-6, 101-103**	**104, EXT8, EXT9**	**105, 106**	**EXT7, 107**	
Drainage Area (ha)	124.0	31.3	1.8	8.7	**165.8**
2-Year	0.062	0.821	0.028	0.162	**1.073**
5-Year	0.07	1.287	0.041	0.271	**1.669**
10-Year	0.27	1.57	0.049	0.349	**2.238**
50-Year	1.062	2.378	0.11	0.601	**4.151**
100-Year	1.611	2.771	0.155	0.742	**5.279**

As the table above shows, Outfall 1 drains the largest drainage area (from both the Site and external areas), as most of the runoff originates in the large external areas being conveyed through the Site. These areas drain to Wetland 1 prior to outletting via Outfall 1. As described above, the flows at Outfall 1 are comprised of the combined discharge via the 250 mm diameter PVC outlet pipe and overland channel that both outlet into a ditch further south. The overland flow route from Wetland 1 is only operating in storms 10-year and greater.

Outfall 2 drains most of the Site, primarily from Catchment 104. Outfall 3 drains a minimal amount of runoff originating from small areas of the Site that discharge offsite to the east, upstream of Outfall 2. Outfall 4 drains flows that bypass SWMF1 and originate from external area EXT7 and Catchment 107, and as these areas remain generally unchanged by the proposed redevelopment, the flows are also relatively consistent with the pre-development scenario.

6.3 Proposed Hydrologic Conditions

The PCSWMM model has been used to simulate the anticipated post-development peak stormwater runoff rates for all design storm events. This model, like the pre-development model, considers soil type, land use and development type for each catchment. Composite curve numbers and impervious values were calculated for each catchment. Please refer to Appendix B for post-development composite curve number and impervious value calculations.

The four outfall locations set-up in the pre-development model remained unchanged in the post-development scenario. Wetland 1 storage and discharge are proposed to remain in post-development. As such, the PCSWMM model has used the same outlet configuration comprised of a storage element, a weir and two conduits representing the 250 mm diameter piped discharge and overland flow outlet. At detailed design, a proposed outlet structure will be designed to replicate the wetland discharge to the best extent possible. The 250 mm diameter outlet pipe will be re-routed within the proposed road and will continue to discharge at the same location in order to continue to feed Wetland 2. An overflow pipe is proposed to capture major system flows that exceed the capacity of the 250 mm diameter outlet pipe and convey such flows to the channel that will remain. refer to Drawing STM1 for the proposed alignment of these storm sewers.

As previously noted, Catchments 201 and 202 within the North Site, are proposed to be redeveloped. Catchment 201 will be controlled to pre-development levels using on-site controls. A storage element and control structure were added to the post-development model to simulate proposed quantity control, with a storage curve and outlet curve defined by pre-development peak runoff flows from Catchment 101. Refer to Section 6.4.1 for details on these controls.

Due to the nature of the redevelopment proposed for Catchment 202, single-family residential lots, there is limited opportunity for on-site controls. It is proposed that this catchment area discharge to Wetland 1 with Enhanced quality treatment provided to preserve the integrity of the wetland. refer to Section 6.5, Quality Control for details. Overcontrol of post-development flows will be provided in the wet pond SWM facility to accommodate the uncontrolled release of this catchment area.

In addition, since the proposed Catchment 202 will discharge to Wetland 1 uncontrolled, there will be a slight increase in flows discharging from Wetland 1 (Outfall 1) under post-development conditions. Generally, in storm events 10 through 100-year, the HGL increases in Wetland 1 by approximately 1 cm, which based on the significant size of Wetland 1 is expected to have negligible impact on the wetland.

Under pre-development conditions, the bypass pipe (for flows above the capacity of the 250 mm diameter storm sewer) is expected to be functioning in the 10-year event and above. Under post-development conditions, this pipe will receive flows in the 5-year event and above. The downstream infrastructure, including the bypass pipe, shall be designed to convey the post-development 100-year flow of approximately 1.795 m^3/s.

To ensure the total flows leaving the Site are reduced to at or below pre-development levels, SWMF1 has been designed to overcontrol the flows outletting to Outfall 2. A storage element and control structure were added to the post-development model to provide the required quantity control. refer to Section 6.3.1 for a comparison of pre- and post-development runoff rates from the Site.

Please refer to Appendix C for the post-development PCSWMM model output.

6.3.1 Proposed Flows

The post-development peak flow rates for the 2- through 100-year storm events are summarized in Table 9. The flow rates have been calculated at specific outfall locations for comparison purposes to pre-development conditions. The PCSWMM runs for the 100-year storms are included in Appendix C.

The proposed flow rates presented in Table 9 below account for the flow control storage provided in both the condo block within Catchment 201 as well as SWMF1, both of which are described in further detail in Section 6.4.

Table 9: Post-Development Peak Flow Rates

	Outfall 1 (m^3/s)	Outfall 2 (m^3/s)	Outfall 3 (m^3/s)	Outfall 4 (m^3/s)	Total
Outfall Location	**Wetland1 Outlet**	**Proposed Outlet**	**Off Site (Upstream of Proposed Outlet)**	**Off Site (Downstream of Proposed Outlet)**	
Contributing Catchments	**EXT1-6, 201, 202, UNC1-2**	**203, UNC4-5, EXT8-9**	**UNC3**	**UNC6,EXT7,**	
Drainage Area (ha)	123.6	34.2	0.3	7.7	**165.8**
2-Year	0.077	0.732	0.025	0.183	**1.017**
5-Year	0.141	1.138	0.038	0.305	**1.622**
10-Year	0.353	1.398	0.048	0.388	**2.187**
50-Year	1.266	2.128	0.078	0.648	**4.12**
100-Year	1.881	2.477	0.093	0.793	**5.244**

Table 10 summarizes the net storm flows leaving the Site under both pre- and post-development conditions for all outfalls.

Table 10: Flow Rate Summary

Storm Event	Flow Rates (m^3/s)	
	Total Flows Exiting Site (m^3/s)	
	Pre-Development	Post-Development
2-Year	1.073	1.017
5-Year	1.669	1.622
10-Year	2.238	2.187
50-Year	4.151	4.12
100-Year	5.279	5.244

As demonstrated in the table above, the total post-development flows will be below the pre-development flows for the 2 through 100-year storm events.

6.4 Quantity Control

6.4.1 North Site

As previously noted, quantity control of post-development flows is proposed within Catchment 201 for the North Site within the residential condominium block. The pre-development flows from Catchment 101 were utilized to determine allowable release rates for the block. Pre-development and controlled post-development flows are summarized in Table 11 below.

Table 11: Catchment 101/201 Release Rates

Storm Event	Flow Rates (m^3/s)	
	Pre-Development (Catchment 101)	Post-Development (Catchment 201, Controlled)
2-Year	0.06	0.054
5-Year	0.09	0.083
10-Year	0.11	0.100
50-Year	0.17	0.141
100-Year	0.21	0.156

As shown in the table above, the post-development flows will be controlled to less than pre-development levels for the 2 through 100-year storm events.

The maximum storage required is 2,212 m³ in the 100-year event to achieve the noted 0.156 m³/s discharge rate. This storage will need to be provided on the 3.67 ha residential condominium site. The details of the flow control elements and volumes required will be refined at detailed design and Site Plan Application (SPA), however, the above provides a functional stage-storage-discharge relationship to demonstrate the impacts on the overall Site release rates.

As previously discussed, Catchment 202 is comprised of single-family residential lots with limited opportunity for on-site controls. This catchment is therefore proposed to discharge to Wetland 1 without quantity control provided, with overcontrol provided in SWMF1 to compensate for the increase in flow.

6.4.2 South Site

Quantity control for the South Site will be provided utilizing a SWM wet pond, SWMF1. The pond is situated at the south end of the Site, roughly in the middle, adjacent to Stoney Creek at a low point. The functional operating characteristics (i.e., stage-storage-discharge relationship) of the SWM facility are provided in Section 6.6 below.

6.5 Quality Control and Extended Detention

6.5.1 North Site

An oil-grit separator and/or surface LID measures are proposed for Catchments 201 and 202 to ensure the provision of the 80% TSS removal associated with Level 1 quality control prior to entering Wetland 1. Further details will be provided at the detailed design stage.

6.5.2 South Site

The SWM facility will be sized in accordance with the MECP requirements for the provision of Level 1 Quantity Control. Based on the 23.72 ha tributary area draining to the SWM facility, a permanent pool volume of 4,075m^3 is required, while 8,503 m^3 is provided.

Extended Detention of the runoff volume from the 25 mm storm event will be provided to meet the greater of the 40 m^3/ha noted in the MECP manual or the equivalent runoff from the 2 5mm storm event. The extended detention will be released over a minimum 24-hour period. Based on the functional design of the pond, the extended detention elevation is 227.63 m, which accommodates a volume of 3,914 m^3 at a release rate of approximately 0.068 m^3/s.

6.6 Stormwater Management Facility

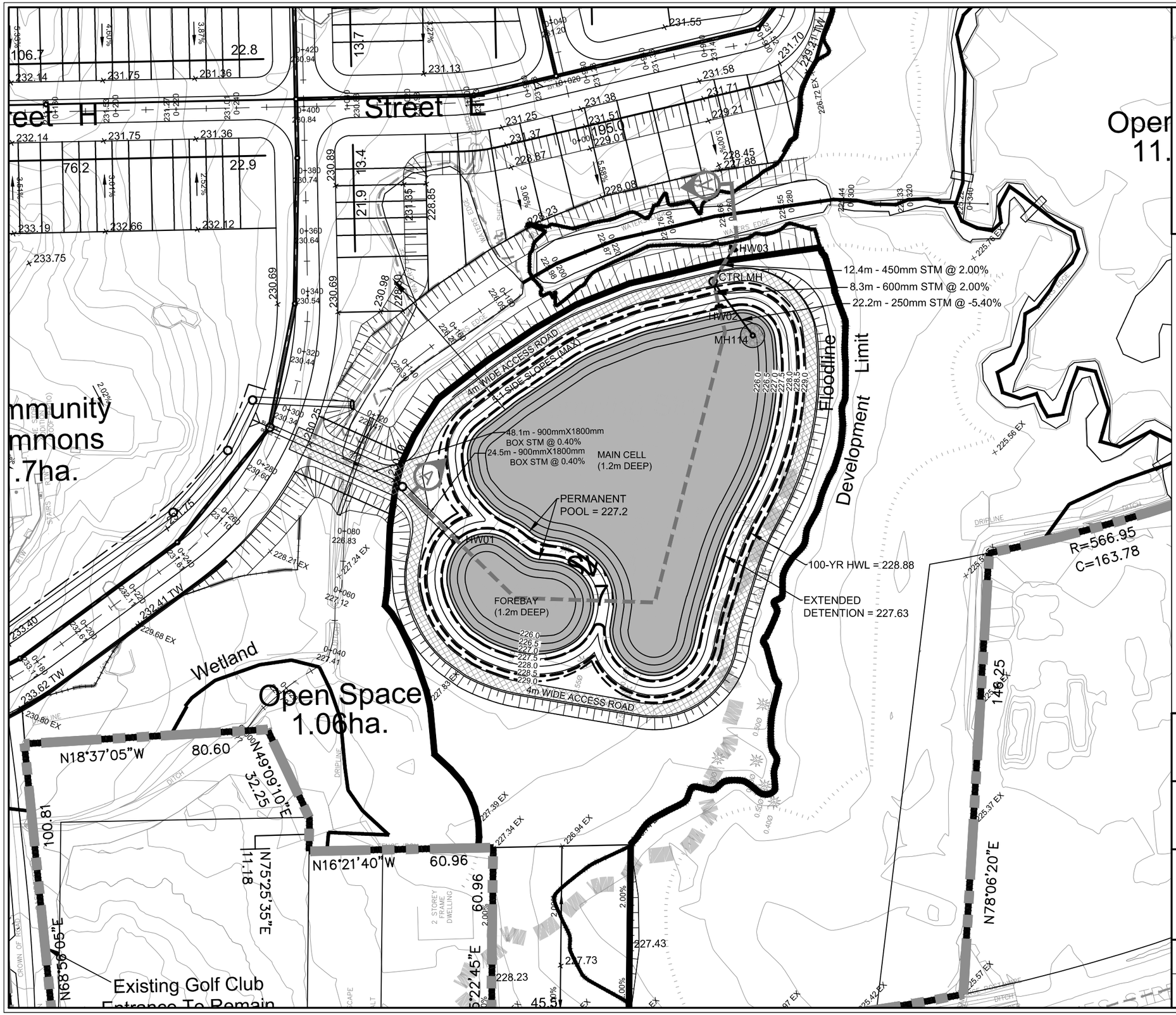
Table 12 below summarizes the operating characteristics and performance of SWMF1.

Table 12 Summary Table for SWM Pond 1

Drainage Area	=	23.72 ha	
Pond Block Area	=	2.27 ha	
Permanent Pool Required	=	4,075 m^3	
Permanent Pool Provided	=	8,503 m^3	
Permanent Pool Max Depth	=	1.20 m	
Permanent Pool Elevation	=	227.20 m	
Extended Detention Volume	=	3,914 m^3	
Extended Detention Release Rate	=	0.068 m^3/s	
Extended Detention Elevation	=	227.63 m	
Extended Detention Depth	=	0.43 m	

Return Event	Pond Out-Flow (m^3/s)	Storage Volume (m^3)	Water Elevation (m)
2-year	0.195	5,455	227.78
5-year	0.226	8,380	228.06
10-year	0.251	10,156	228.23
50-year	0.352	14,753	228.67
100-year	0.36	16,947	228.88

Calculations associated with the SWM pond sizing are included in Appendix D. Figure 6 and Figure 7 illustrate the proposed SWMF1 configuration and section, including minor grading around the pond.



BURNSIDE

Client

DELHI DEVELOPMENT INC.

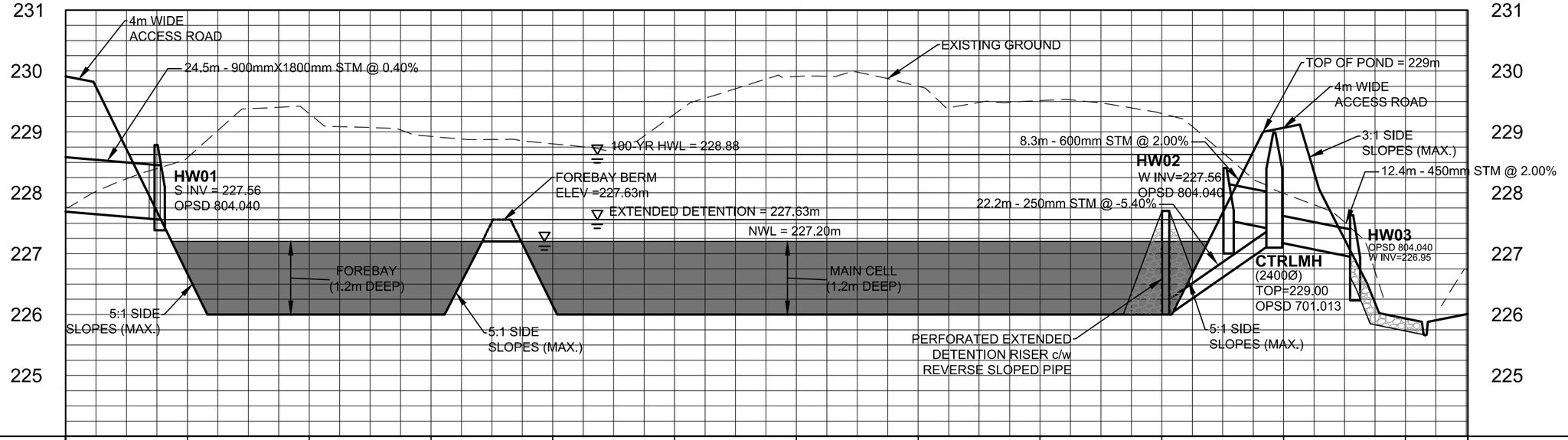
Figure Title

DELHI GOLF COURSE

SWM POND PLAN

Drawn	Checked	Date	Figure No.
BF	LG	23/03/15	6
Scale		Project No.	
1:1250		053741.05	

File: \\SHERLOCK\Shared Work Areas\053741 Delhi GC\053741.05 FSR\07_Figures\SWM FIGURES\053741.05 SWM POND.dwg Date Plotted: March 14, 2023 - 2:55 PM



EXIST\PROP CENTERLINE ELEVATION	227.76	228.559	228.58	226.668	229.30	226.000	228.93	226.000	228.80	226.147	229.29	226.000	229.91	226.000	229.75	226.000	229.51	226.000	229.30	226.000	227.99		226.74	EXIST\PROP CENTERLINE ELEVATION
CHAINAGE	0+000	0+020		0+040		0+060		0+080		0+100		0+120		0+140		0+160		0+180		0+200		0+220	0+230.25	CHAINAGE

SWM POND SECTION A-A
SCALE H1:750 V1:75

BURNSIDE

Client
DELHI DEVELOPMENT INC.

Figure Title
DELHI GOLF COURSE

SWM POND SECTION

Drawn	Checked	Date	Figure No.
BF	LG	23/03/15	7
Scale: AS NOTED		Project No.: 053741.05	

File: \\SHERLOCK\Shared Work Areas\053741 Delhi GC\053741.05 FSR\07_Figures\SWM FIGURES\053741.05 SWM POND.dwg Date Plotted: March 14, 2023 - 2:56 PM

7.0 Erosion and Sediment Control

The erosion and sediment control plan for the Site will be developed in accordance with the County and LPRCA guidelines. The plan will be completed at the detailed design stage prior to the undertaking of any grading activity on the Site.

Erosion and sediment control will be implemented for all construction activities including topsoil stripping, foundation excavation, and stockpiling of material. The following erosion and sediment control measures will be implemented:

a) Temporary sediment control fence will be placed around the perimeter of all areas to be disturbed prior to grading. Double row fencing may be appropriate adjacent to natural areas;

b) Appropriately designed sediment control ponds will be provided;

c) CB sediment traps will be provided on existing CBs affected by construction as well as newly installed CBs within the new development Site;

d) Check dams, etc., for erosion / velocity control will be provided; and

e) Gravel mud mats will be provided at all construction access points to minimize off-site tracking of sediment.

All temporary erosion and sediment control measures will be routinely inspected and repaired if required during construction. Temporary controls will not be removed until the serviced areas have been restored and stabilized.

Connection to Low Impact Development (LID) measures (if any) will not be completed until the Site is stabilized with vegetation to minimize sediment accumulation and maintenance issues.

All reasonable measures will be taken to ensure that sediment loading is minimized both during and following construction. Additional details will be provided as part of the detailed design.

8.0 Conclusions and Recommendations

This report addresses the requirements for submission of a SWM Report to accompany the Official Plan Amendment (for an urban boundary expansion and redesignation of the lands), Zoning By-Law Amendment, Plan of Subdivision, and Plan of Condominium applications for the Delhi Golf and Country Club Subdivision Redevelopment. This SWM Report demonstrates that the SWM block provided in the Draft Plan of Subdivision and additional stormwater management features are adequate to support the SWM measures required to meet the Norfolk County design criteria.

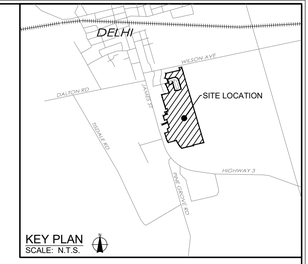
BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Drawings

STM1 – Preliminary Storm Servicing Plan
G1 – Grading Plan
G2 – Grading Plan

KEY PLAN
SCALE: N.T.S.
DELHI
SITE LOCATION
DALSON RD
HIGHWAY 3
WILSON AVE
Wetland Limit
Development Limit
Floodline
PSW
Open Space 5.02ha.
Provincially Significant Wetland
Hazard Land Zone
Open Space 11.13ha.
Open Space 6.95ha.
Provincially Significant Wetland
Retirement Home 1.2ha.
Community Commons 1.7ha.
Open Space 1.06ha.
Open Space 0.01ha.
Fairview Heights Park
Amenity Area
30m Wetland Buffer
6m Trail / Servicing Easement
St. Michael's Street
Street A
Street B
Street C
Street D
Street E
Street F
Street G
Street H
Tisdale Drive
WILSON AVENUE
ST. MICHAEL'S STREET
TISDALE DRIVE
JAMES STREET
ALPHA STREET
(HIGHWAY No. 3)
MH108 TOP=238.62 OBV=237.50
MH109 TOP=237.90 OBV=236.08
MH110 NW INV=235.30
MH77 TOP=237.90 OBV=236.65
MH78 TOP=236.88 OBV=235.98
MH79 N INV=235.42
MH95 TOP=236.66 OBV=236.06
MH50 TOP=238.57 OBV=238.26
MH51 TOP=237.78 OBV=235.92
MH53 TOP=238.19 OBV=234.11
MH52 TOP=234.09 OBV=232.27
MH45 TOP=237.43 OBV=235.48
MH48 TOP=239.12 OBV=237.22
MH42 TOP=237.10 OBV=234.84
MH47 TOP=239.06 OBV=237.45
MH41 TOP=238.90 OBV=236.81
MH43 TOP=234.75 OBV=233.29
MH44 TOP=232.91 OBV=231.27
MH94 TOP=238.57 OBV=237.05
MH35 TOP=236.32 OBV=234.49
MH39 TOP=234.00 OBV=232.38
MH40 TOP=232.38 OBV=230.85
MH36 TOP=238.97 OBV=237.00
MH37 TOP=237.46 OBV=235.47
MH66 TOP=236.08 OBV=234.13
MH20 TOP=235.12 OBV=233.36
MH32 TOP=233.42 OBV=232.10
MH01 TOP=235.58 OBV=233.91
MH38 TOP=231.77 OBV=233.33
MH09 TOP=232.85 OBV=230.57
MH126 TOP=231.76 OBV=230.40
MH10 TOP=231.89 OBV=230.21
MH11 TOP=231.19 OBV=229.94
MH12 TOP=230.76 OBV=229.57
MH112 TOP=230.43 OBV=229.34
MH92 N INV=228.43
MH65 TOP=232.39 OBV=230.59
MH64 TOP=231.65 OBV=230.14
MH127 TOP=231.21 OBV=229.86
MH62 TOP=231.07 OBV=229.74
MH57 TOP=232.54 OBV=230.84
MH59 TOP=231.95 OBV=230.41
HW03 W INV=226.85
HW02 NE INV=227.56
HW01 NE INV=227.56
MH67 TOP=230.08 OBV=228.56
MH68 TOP=236.12 OBV=234.30
MH91 S INV=233.95
MH15 S INV=233.42
MH75 TOP=230.54 OBV=227.49
MH05 TOP=230.22 OBV=226.80
MH72 TOP=233.76 OBV=230.27
MH18 TOP=235.33 OBV=230.96
MH28 TOP=231.50 OBV=229.81
MH70 Existing Watercourse (piped) TOP=236.99 OBV=232.45
MH17 TOP=236.98 OBV=232.59
MH02 TOP=237.39 OBV=235.48
MH19 TOP=230.54
MH113 TOP=233.87 OBV=232.41
PROPOSED BYPASS SEWER FOR EXISTING FLOWS 900mm x 1800mm BOX
REALIGNED 250mmØ STORM SEWER
PROPOSED BOX CULVERT 17.4m @ 0.30%
Existing Golf Club Entrance To Remain As Emergency Access
LEGEND
PROPERTY BOUNDARY
PROPOSED DRAINAGE BOUNDARY
PROPOSED STORM BYPASS SEWER
PROPOSED STORM SEWER
EXISTING STORM SEWER
PROPOSED OVERLAND FLOW ROUTE
0 40 80 120 160
Metres
BURNSIDE
Client
DELHI DEVELOPMENT INC.
Figure Title
DELHI GOLF COURSE
PRELIMINARY STORM SERVICING PLAN
Drawn BF
Checked FG
Date 23/03/15
Scale 1:2000
Project No. 053741.05
Figure No. STM1



LEGEND

- PROPERTY BOUNDARY
- EASEMENT
- 320.5 EXISTING CONTOUR
- ×319.36 EX EXISTING ELEVATION
- ×326.26 PROPOSED ELEVATION
- 2.00% PROPOSED SLOPE
- PROPOSED OVERLAND FLOW DIRECTION
- MAX. 3:1 SIDE SLOPES
- PROPOSED SWALE

N

0 25 50 75 100
Metres

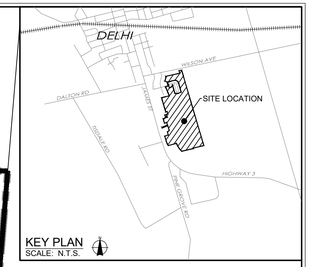
BURNSIDE

Client
DELHI DEVELOPMENT INC.

Figure Title
DELHI GOLF COURSE
GRADING PLAN

Drawn	Checked	Date	Figure No.
BF	FG	23/03/15	G1
Scale		Project No.	
1:1250		053741.05	

M:\2015\05\053741.05\Civil\Drawings\053741.05-GRADING.dwg, Date Printed: March 14, 2023 - 11:15 PM



Wetland Limit

Development Limit

Floodline

PSW

Open Space
5.02ha.

Provincially Significant Wetland

Hazard Land Zone

PROPOSED RETAINING WALL

Open Space
11.13ha.

Open Space
6.95ha.

Provincially Significant Wetland

REFER TO DWG G1

Retirement Home
1.2ha.

Community Commons
1.7ha.

Existing Watercourse (piped)

Wetland

Open Space
1.06ha.

Open Space
0.01ha.

Existing Golf Club Entrance To Remain As Emergency Access

Street E

Street D

Street F

Street C

Street G

Street H

Street B

LEGEND

- PROPERTY BOUNDARY
- EASEMENT
- 330.5 EXISTING CONTOUR
- ×319.36 EX EXISTING ELEVATION
- ×326.26 PROPOSED ELEVATION
- 2.00% PROPOSED SLOPE
- PROPOSED OVERLAND FLOW DIRECTION
- MAX. 3:1 SIDE SLOPES
- PROPOSED SWALE

0 25 50 75 100
Metres

BURNSIDE

Client: DELHI DEVELOPMENT INC.

Figure Title: DELHI GOLF COURSE

GRADING PLAN

Drawn	Checked	Date	Figure No.
BF	FG	23/03/15	G2
Scale: 1:1250		Project No.: 053741.05	

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix A

Floodplain Mapping

Figures from Long Point Region Flood Hazard Map Update Technical Report

HEC-RAS Model and Results

E541400m
E542650m
N4742400m
N4741400m

791.43
864.57
934.91
729.82
679.59
570.42
505.13
383.16
222.67
96.34
20.16
1289.35
1232.73
1150.66
1103.38
1085.16
1052.13
1034.39
1007.76
988.94
963.67

Stony Creek

Path: K:\LPRCA\FRM-Gilbertville.dwg
Plotted By: richard.bartolo
Last Saved By: richard.bartolo
Plotted: 2020-03-30
Last Saved: 2020-03-27

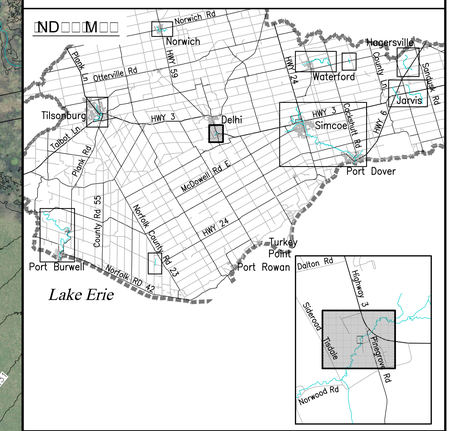
Long Point Region Conservation Authority

□□□□d□□ □□□rd□M□□

□ □□□□r□□□□□

□□□□□□□□r□□□

□ND□□□M□□



□□□□ND

- PARCEL FABRIC
- WATERCOURSE
- CONTOUR (1m)
- 1425.15 — CROSS SECTION NUMBER; REGIONAL STORM FLOOD ELEVATION (m); CROSS SECTION LOCATION; 100-YEAR FLOOD LINE ELEVATION (m)
- REGIONAL STORM FLOOD LINE
- 100-YEAR FLOOD LINE
- □□□□N D□M — DAM LOCATION AND NAME/ID#
- □□□ □□□□ — STREAM FLOW GAUGE AND REFERENCE ID#
- □□M□□□□□ — SURVEYED BENCHMARK AND REFERENCE ID#

wood.

Please note that the Professional Engineer's stamp verifies the flood line and associated data, not the map unless otherwise noted.

LICENSED PROFESSIONAL ENGINEER
M. J. SENIOR
100116537
5/19/2020
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P.RAJANIKANTH
100220595
05/19/2020
PROVINCE OF ONTARIO

REVISIONS

No.	Description	BY	DATE

□□□□□□□□□□□

□□R□□□N□□□□R□ □□□□□N□
□□M□N□D□□□□□N□□□□

□□R□□□□D□□□M□
□□□D□□□□□

□□□□□□□□□□□
□□□d□r□□□□□□□□□□

M□□□ □ M□r□□
□□□ □ □□□ □□□ □□□

HEC-RAS Plan: SSD-rev_man River: Upper Reach Exte Reach: Upper Reach Exte Profile: 100yr

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Upper Reach Exte	3608	100yr	15.20	226.47	227.04		227.04	0.002004	0.38	54.57	159.97	0.16
Upper Reach Exte	3345	100yr	15.20	226.10	226.83		226.84	0.001733	0.40	57.73	163.14	0.16
Upper Reach Exte	3188	100yr	15.20	226.05	226.71		226.72	0.003128	0.50	46.44	152.24	0.21
Upper Reach Exte	3057	100yr	15.20	225.85	226.57		226.57	0.002614	0.48	51.56	171.72	0.19
Upper Reach Exte	2766	100yr	15.20	225.70	226.35		226.35	0.002141	0.43	53.55	172.22	0.17
Upper Reach Exte	2566	100yr	15.20	225.61	226.31		226.31	0.000264	0.16	110.07	200.27	0.06
Upper Reach Exte	2104	100yr	15.20	224.66	226.29		226.29	0.000112	0.40	93.81	204.98	0.10
Upper Reach Exte	2041	100yr	15.20	224.47	226.29	225.56	226.29	0.000049	0.26	150.25	356.86	0.07
Upper Reach Exte	1289.35	100yr	15.20	224.43	226.28	225.14	226.28	0.000007	0.10	266.12	253.64	0.03
Upper Reach Exte	1232.73	100yr	15.20	224.01	226.28	225.07	226.28	0.000015	0.16	199.54	412.19	0.04
Upper Reach Exte	1150.66	100yr	15.20	224.02	226.28	224.97	226.28	0.000003	0.07	412.60	406.70	0.02
Upper Reach Exte	1103.38	100yr	13.63	223.89	226.28	224.87	226.28	0.000002	0.06	443.35	410.95	0.01
Upper Reach Exte	1085.16	100yr	13.63	223.77	226.18	225.03	226.26	0.000769	1.23	11.07	398.39	0.28
Upper Reach Exte	1069.89		Bridge									
Upper Reach Exte	1052.13	100yr	13.63	223.77	225.48	224.87	225.63	0.004341	1.69	8.14	123.69	0.44
Upper Reach Exte	1034.39	100yr	13.63	223.74	225.55	224.84	225.55	0.000133	0.41	57.68	69.20	0.11
Upper Reach Exte	1007.76	100yr	15.20	223.67	225.55	224.69	225.55	0.000095	0.34	64.74	84.84	0.09
Upper Reach Exte	988.94	100yr	15.20	223.66	225.35	224.69	225.50	0.001981	1.79	8.86	72.00	0.44
Upper Reach Exte	974.52		Bridge									
Upper Reach Exte	963.67	100yr	15.20	223.67	225.01	224.96	225.42	0.010540	2.88	5.39	33.77	0.91
Upper Reach Exte	934.91	100yr	15.20	223.65	225.12	224.71	225.15	0.001217	1.05	29.52	85.21	0.32
Upper Reach Exte	864.57	100yr	15.20	223.54	224.95	224.94	225.01	0.005278	1.92	28.03	128.42	0.59
Upper Reach Exte	791.43	100yr	15.20	223.48	224.76	224.56	224.78	0.002761	1.10	35.91	113.17	0.40
Upper Reach Exte	729.82	100yr	15.20	223.50	224.63		224.65	0.002978	1.04	41.55	144.12	0.43
Upper Reach Exte	679.59	100yr	15.20	223.33	224.52	224.37	224.53	0.001993	0.89	51.96	204.82	0.35
Upper Reach Exte	570.42	100yr	15.20	223.09	224.36	224.20	224.38	0.003063	1.12	42.54	163.55	0.42
Upper Reach Exte	505.13	100yr	15.20	223.00	224.26	223.88	224.27	0.001211	0.91	65.97	224.71	0.30
Upper Reach Exte	383.16	100yr	15.20	222.71	224.18	223.83	224.19	0.000619	0.63	81.83	247.18	0.21
Upper Reach Exte	222.67	100yr	15.20	222.64	224.05	223.85	224.07	0.002627	1.19	36.40	142.95	0.42
Upper Reach Exte	96.34	100yr	15.20	222.64	223.88	223.68	223.89	0.001669	0.95	51.91	171.72	0.34
Upper Reach Exte	20.16	100yr	15.20	222.34	223.79	223.59	223.81	0.001400	0.89	45.90	154.55	0.32

100 YR STORM FLOODLINE

DELHI

DALSON AVE

DALSON RD

SITE LOCATION

SWAMP RD

HIGHWAY 3

SPRUCE ST

KEY PLAN
SCALE: N.T.S.

Wetland Limit

Development Limit

Floodline

Provincially Significant Wetland

Hazard Land Zone

PSW

Open Space 5.02ha.

6m Trail / Servicing Easement

Street E

Street D

Street C

Street H

Street F

Street G

St. B

Open Space 6.95ha.

Provincially Significant Wetland

Hazard Land Zone

Tisdale Drive

Retirement Home 1.2ha.

Community Commons 1.7ha.

Existing Watercourse (piped)

Wetland

Open Space 1.06ha.

Open Space 0.01ha.

Existing Golf Club Entrance To Remain

Pumping Stn.

SWM 2.27ha.

Open Space 11.13ha.

(HIGHWAY No. 3)

James Street (Hwy 3)

Pine Grove Road

Alpha Street

LEGEND

- CROSS SECTION NUMBER
- CROSS SECTION LOCATION
- 100-YEAR FLOOD LINE ELEVATION (m)
- 100 YR STORM FLOODLINE
- PROPERTY BOUNDARY
- EXISTING CONTOUR

0 25 50 75 100
Metres

BURNSIDE

Client
DELHI DEVELOPMENT INC.

Figure Title
DELHI GOLF COURSE
STONEY CREEK FLOOD PLAIN MAPPING

Drawn	Checked	Date	Figure No.
RS	LG	22/11/24	**FIG A**
Scale		Project No.	
1:1500		053741.05	

START OF OUTLET CHANNEL

PROPOSED FLOODPLAIN STORAGE TO BE FILLED.

PROPOSED AREA OF FLOODPLAIN STORAGE COMPENSATION (CUT).

PROPOSED OUTLET CHANNEL TO BE WIDENED AND NATURALIZED. REFER TO OUTLET CHANNEL SECTION A-A

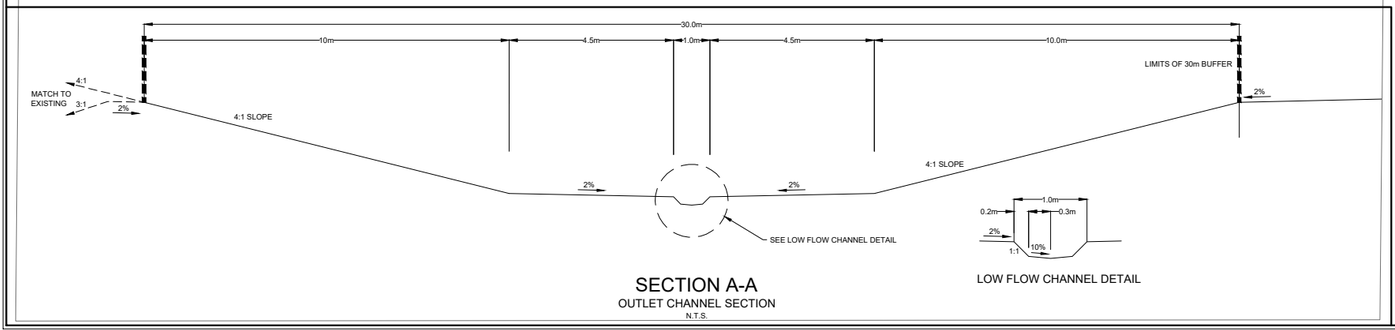
PROPOSED SWM FACILITY

100YR FLOOD LINE

30m BUFFER FROM WATER'S EDGE

PROPOSED FLOODPLAIN STORAGE TO BE FILLED.

END OF OUTLET CHANNEL (APPROX 200m LONG)



SECTION A-A
OUTLET CHANNEL SECTION
N.T.S.

LOW FLOW CHANNEL DETAIL

	FILL VOLUME (m3)			
Elevation	(Pond)	(James Street Lots)	Total	CUT VOLUME (m3)
226.3	*	3	3	225
226.4	*	15	15	324
226.5	0	41	41	458
226.6	105	88	193	633
226.72	233	179	412	926

* Note: Pond water level at 226.5m, therefore floodplain storage available above 226.5m elevation

N

0 10 20 40 60
Metres

BURNSIDE

Client
DELHI DEVELOPMENT INC.

Figure Title
DELHI GOLF COURSE
FLOODPLAIN CUT & FILL STORAGE AREAS

Drawn	Checked	Date	Figure No.
RS	LG	22/12/19	FIG B
Scale		Project No.	
1:750		053741.05	

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix B

PCSWMM Modelling Parameters

BURNSIDE

Project: **Delhi Golf Course**
Task: **Curve Number Summary**
Date: **18-Nov-22**

Prepared by: **L.Garner**
Project no.: **300052719**

Pre-Development

Map Unit Symbol	WIL1	FOX 1	GNY 1 & 24	VSS1	STD1
Soil Description	Mainly gravelly sandy till	Mainly lacustrine sand & loamy sand		40-100 cm sandy textures over gravelly sandy till	
Drainage	Rapid to well	Rapid to well	Poor	Poor	Rapid to well
Soil Group	AB	AB	B	B	AB

Referenced from Soils of the Regional Municipality of Haldimand-Norfolk, Soil Survey Report No 57 (Map - Sheet 9)

Soil Group	**AB**			**B**		
Land Cover	**Golf Course/Lawn**	**Woods**	**Agriculture/Meadow**	**Golf Course/Lawn**	**Woods**	**Agriculture/Meadow**
CN Number	50	43	44	61	55	58

Curve Numbers from Referenced from Chapter 9, Table 9-1 of the National Engineering Handbook outlining Hydrologic Soil-Cover Complexes, Table 9-1 included in this Appendix

		Soil Group AB			**Soil Group B**			**CN Number**
Catchment	**Total Area**	**Golf Course/Lawn**	**Woods**	**Agriculture/Meadow**	**Golf Course/Lawn**	**Woods**	**Agriculture/Meadow**	
101	3.27	2.99			0.28			51
102	1.42	1.28			0.13			51
103	6.88	4.84			2.04			53
104	25.87	20.02			5.85			52
105	1.25	1.30						52
106	0.58	0.60						51
107	5.47	1.57			3.04	0.86		57
EXT1	58.27			47.47		3.80	7.00	46
EXT2	18.05	1.67	1.03	15.35				44
EXT3	16.40	16.40						50
EXT4	2.15	1.20			0.95			55
EXT5	0.76				0.76			61
EXT6	10.21	10.20						50
EXT7	2.79	2.10						38
EXT8	1.21	1.21						50
EXT9	0.42	0.42						50

Note: CN value is based solely on the pervious surfaces within the catchment area.

Post-Development 0.00

		Soil Group AB			**Soil Group B**			**CN Number**
Catchment	**Total Area**	**Golf Course/Lawn**	**Woods**	**Agriculture/Meadow**	**Golf Course**	**Woods**	**Agriculture/Meadow**	
201	3.27	2.99			0.28			51
202	1.42	1.42						50
203	23.24	20.89			2.35			51
UNC-1	0.20	0.20						50
UNC-2	6.34	4.71			1.63			53
UNC-3	0.32	0.32						50
UNC-4	0.04	0.04						50
UNC-5	5.45	2.37			3.08			56
UNC-6	4.46	0.70			2.90	0.86		58
EXT1	58.27			47.50		3.80	7.00	46
EXT2	18.05	1.67	1.03	15.35				44
EXT3	16.40	16.40						50
EXT4	2.15	1.20			0.95			55
EXT5	0.76				0.76			61
EXT6	10.21	10.21						50
EXT7	2.79	2.79						50
EXT8	1.21	1.21						50
EXT9	0.42	0.42						50

Note: CN value is based solely on the pervious surfaces within the catchment area.

Table 9–5 Runoff curve numbers for urban areas 1/

Cover description cover type and hydrologic condition	Average percent impervious area 2/	-- CN for hydrologic soil group -- A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) 3/					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) 4/		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)		77	86	91	94

Soil Group AB - 50
Soil Group B- 61

The golf course can be said to be in good condition, refer to composite CN calculation.

1/ Average runoff condition, and $I_a = 0.2S$.

2/ The average percent impervious area shown was used to develop the composite CNs. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition.

3/ CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space type.

4/ Composite CNs for natural desert landscaping should be computed using figures 9–3 or 9–4 based on the impervious area percentage (CN=98) and the pervious area CN. The pervious area CNs are assumed equivalent to desert shrub in poor hydrologic condition.

Table 9–1 Runoff curve numbers for agricultural lands 1/ — Continued

Cover description			CN for hydrologic soil group			
cover type	treatment 2/	hydrologic condition 3/	A	B	C	D
Pasture, grassland, or range-continuous forage for grazing 4/		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
Meadow-continuous grass, protected from grazing and generally mowed for hay		Good	30	58	71	78
Brush-brush-forbs-grass mixture with brush the major element 5/		Poor	48	67	77	83
		Fair	35	56	70	77
		Good	30 6/	48	65	73
Woods-grass combination (orchard or tree farm) 7/		Poor	57	73	82	86
		Fair	43	65	76	82
		Good	32	58	72	79
Woods 8/		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	30	55	70	77
Farmstead–buildings, lanes, driveways, and surrounding lots		---	59	74	82	86
Roads (including right-of-way):						
Dirt		---	72	82	87	89
Gravel		---	76	85	89	91

Soil Group AB - 44
Soil Group B - 58

The external agricultural land can be said to be in good condition, refer to composite CN calculation. Refer to composite CN calculation.

Soil Group AB - 43
Soil Group B - 55

Woods areas are considered to be in good condition, protected from grazing. Refer to composite CN calculation.

1/ Average runoff condition, and I_a=0.2s.

2/ Crop residue cover applies only if residue is on at least 5 percent of the surface throughout the year.

3/ Hydrologic condition is based on combinations of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥20%), and (e) degree of surface toughness.
Poor: Factors impair infiltration and tend to increase runoff.
Good: Factors encourage average and better then average infiltration and tend to decrease runoff.
For conservation tillage poor hydrologic condition, 5 to 20 percent of the surface is covered with residue (less than 750 pounds per acre for row crops or 300 pounds per acre for small grain).
For conservation tillage good hydrologic condition, more than 20 percent of the surface is covered with residue (greater than 750 pounds per acre for row crops or 300 pounds per acre for small grain).

4/ Poor: < 50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

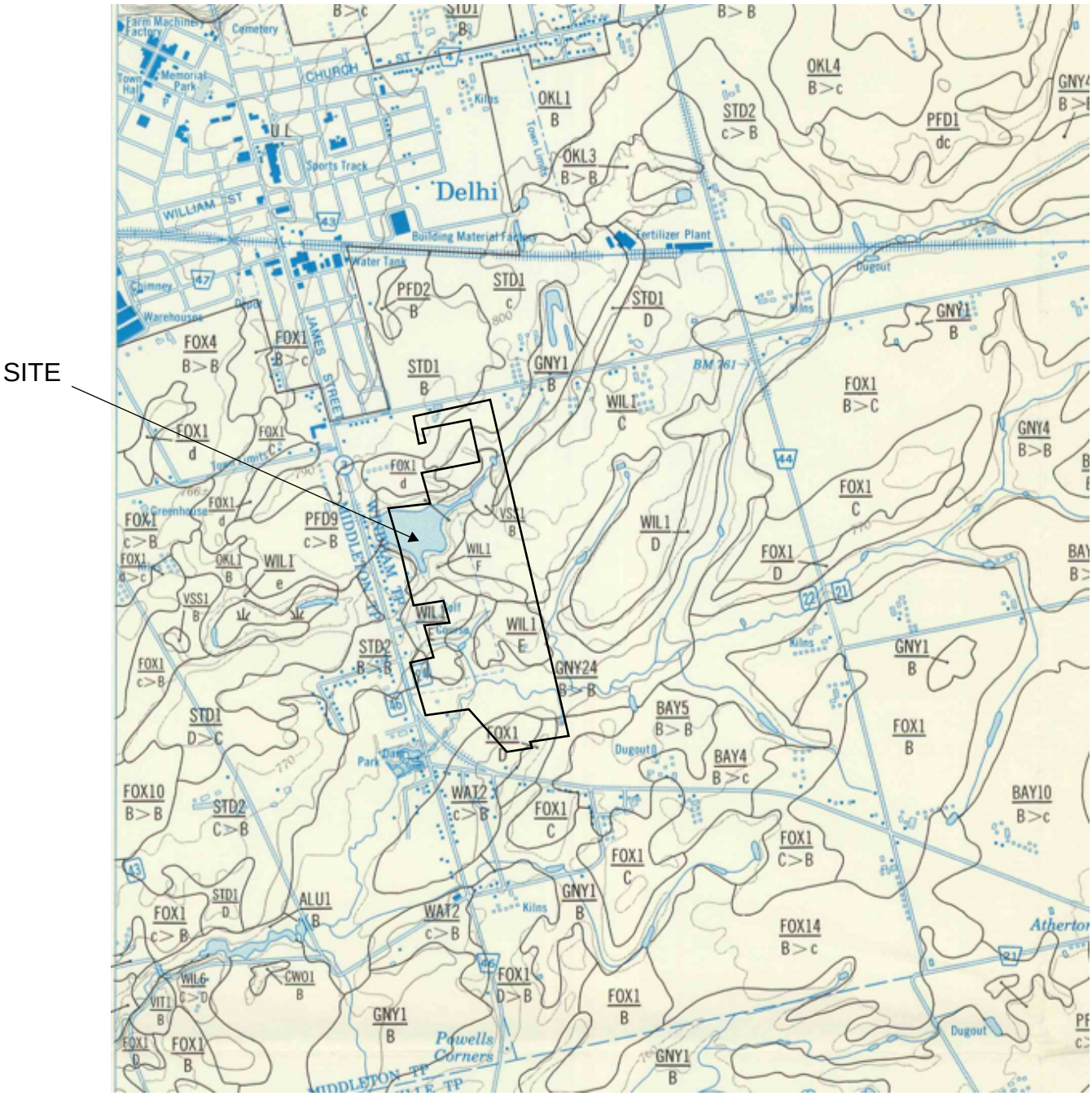
5/ Poor: < 50% ground cover.
Fair: 50 to 75% ground cover.
Good: > 75% ground cover.

6/ If actual curve number is less than 30, use CN = 30 for runoff computation.

7/ CNs shown were computed for areas with 50 percent woods and 50 percent grass (pasture) cover. Other combinations of conditions may be computed from the CNs for woods and pasture.

8/ Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed, but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Hydrologic Soil Group Mapping



Project: **Delhi Golf Club**
Project #: 300053741
Designed By: L.Garner
Date: 14-Mar-23

BURNSIDE

Composite Imperviousness Calculations - Pre-Development Conditions

Catchment	Land Use	Imperviousness	Area	Total Area	Weighted Average of Imperviousness
101	Parks 4 ha and under	7%	3.00	3.27	9%
	Single Family Residential	36%	0.27		
102	Parks 4 ha and under	7%	1.42	1.42	7%
103	Parks over 4 ha	0%	6.88	6.88	0%
104	Parks over 4 ha	0%	24.63	25.87	5%
	Standing Water	100%	0.30		
	Commercial	100%	0.13		
	Asphalt and Concrete Pavement	100%	0.81		
105	Parks 4 ha and under	7%	1.25	1.25	7%
106	Parks 4 ha and under	7%	0.58	0.58	7%
107	Standing Water	100%	0.27	5.47	5%
	Parks over 4 ha	0%	5.21		
WT1	Wetland	100%	6.84	6.84	100%
WT2	Wetland	100%	0.59	0.59	100%
WT3-1	Wetland	100%	3.21	3.21	100%
WT3-2	Wetland	100%	0.44	0.44	100%
EXT1	Rural Lawns - Flat 0-2% - Sandy Soil	0%	51.47	58.27	8%
	Single Family Residential	36%	3.18		
	Asphalt and Concrete Pavement	100%	0.83		
	Wetland	100%	2.80		
EXT2	Rural Lawns - Flat 0-2% - Sandy Soil	0%	15.69	17.78	10%
	Asphalt and Concrete Pavement	100%	0.78		
	Townhouses, Maisonette, Row Houses, etc.	79%	1.31		
EXT3	Single Family Residential	36%	14.34	16.40	44%
	Asphalt and Concrete Pavement	100%	2.06		
EXT4	Single Family Residential	36%	1.77	2.15	47%
	Asphalt and Concrete Pavement	100%	0.38		
EXT5	Single Family Residential	36%	0.76	0.76	36%
EXT6	Single Family Residential	36%	4.03	10.21	47%
	Rural Lawns - Flat 0-2% - Sandy Soil	0%	2.80		
	Commercial	100%	1.97		
	Asphalt and Concrete Pavement	100%	1.42		
EXT7	Single Family Residential	36%	2.09	2.79	52%
	Asphalt and Concrete Pavement	100%	0.69		
EXT8	Single Family Residential	36%	1.21	1.21	36%
EXT9	Single Family Residential	36%	0.42	0.42	36%

Project: **Delhi Golf Club**
Project #: 300053741
Designed By: L.Garner
Date: 14-Mar-23

Composite Imperviousness Calculations - Post-Development Conditions

Catchment	Land Use	Imperviousness	Area	Total Area	Weighted Average of Imperviousness
201	Townhouses, Maisonette, Row Houses, etc.	79%	3.27	3.27	79%
202	Single Family Residential (Lot size less than 12.2m)	57%	0.19	1.42	58%
	Single Family Residential	36%	0.79		
	Asphalt and Concrete Pavement	100%	0.43		
203	Townhouses, Maisonette, Row Houses, etc.	79%	9.34	23.72	66%
	Single Family Residential (Lot size less than 12.2m)	57%	3.10		
	Apartements	79%	1.22		
	Schools and Churches	79%	1.72		
	SWM Block	50%	1.83		
	Rural Lawns - Average 2%-7% - Sandy Soil	0%	3.10		
	Asphalt and Concrete Pavement	100%	3.42		
UNC-1	Parks 4 ha and under	7%	0.20	0.20	7%
UNC-2	Single Family Residential (Lot size less than 12.2m)	57%	0.17	6.34	2%
	Residential Lawn	7%	0.28		
	Parks over 4 ha	0%	5.89		
UNC-3	Residential Lawn	7%	0.19	0.32	36%
	Townhouses, Maisonette, Row Houses, etc.	79%	0.13		
UNC-4	Single Family Residential	36%	0.04	0.04	36%
UNC-5	Parks 4 ha and under	7%	0.06	4.97	4%
	Single Family Residential (Lot size less than 12.2m)	57%	0.23		
	Residential Lawn	7%	0.23		
	Asphalt and Concrete Pavement	100%	0.06		
	Parks over 4 ha	0%	4.39		
UNC-6	Parks over 4 ha	0%	3.92	4.46	8%
	Standing Water	100%	0.27		
	Single Family Residential	36%	0.27		
WT1	Wetland	100%	6.84	6.84	100%
WT2	Wetland	100%	0.59	0.59	100%
WT3-1	Wetland	100%	3.21	3.21	100%
WT3-2	Wetland	100%	0.44	0.44	100%
EXT1	Rural Lawns - Flat 0-2% - Sandy Soil	0%	51.47	58.27	8%
	Single Family Residential	36%	3.18		
	Asphalt and Concrete Pavement	100%	0.83		
	Wetland	100%	2.80		
EXT2	Rural Lawns - Flat 0-2% - Sandy Soil	0%	15.69	17.78	10%
	Asphalt and Concrete Pavement	100%	0.78		
	Townhouses, Maisonette, Row Houses, etc.	79%	1.31		
EXT3	Single Family Residential	36%	14.34	16.40	44%
	Asphalt and Concrete Pavement	100%	2.06		
EXT4	Single Family Residential	36%	1.77	2.15	47%
	Asphalt and Concrete Pavement	100%	0.38		
EXT5	Single Family Residential	36%	0.76	0.76	36%
EXT6	Single Family Residential	36%	4.03	10.21	47%
	Rural Lawns - Flat 0-2% - Sandy Soil	0%	2.80		
	Commercial	100%	1.97		
	Asphalt and Concrete Pavement	100%	1.42		
EXT7	Single Family Residential	36%	2.09	2.79	52%
	Asphalt and Concrete Pavement	100%	0.69		
EXT8	Single Family Residential	36%	1.21	1.21	36%
EXT9	Single Family Residential	36%	0.42	0.42	36%

Project:	**Delhi Golf Club**
Project #:	300053741
Designed By:	L.Garner
Date:	14-Mar-2023

Flow Length Overland flow length of pervious area (m) (Used for catchments <20% impervious)
LGI Overland flow length of impervious area (m) (Used for catchments with >20% impervious)

PRE-DEVELOPMENT				
Catchment	Area (ha)	Impervious	Flow Length (m)	LGI (m)
SITE				
101	3.27	9	300	
102	1.42	7	140	
103	6.88	0	130	
104	25.87	5	705	
105	1.25	7	90	
106	0.58	7	50	
107	5.47	5	260	
EXTERNAL				
EXT1	58.27	8	957	
EXT2	17.78	10	612	
EXT3	16.40	44		270
EXT4	2.15	47		98
EXT5	0.76	36		58
EXT6	10.21	47		213
EXT7	2.79	52		111
EXT8	1.21	36		73
EXT9	0.42	36		43
WETLAND				
WETLAND1	6.84	100		174
WETLAND2	0.59	100		52
WETLAND3-1	3.21	100		120
WETLAND3-2	0.44	100		44

POST-DEVELOPMENT				
Catchment	Area (ha)	Impervious	Flow Length (m)	LGI (m)
SITE				
201	3.27	79		120
202	1.42	58		79
203	23.72	66		321
UNC-1	0.20	7	300	
UNC-2	6.34	0	55	
UNC-3	0.32	36		38
UNC-4	0.04	36		13
UNC-5	4.97	4	156	
UNC-6	4.46	8	230	
EXTERNAL				
EXT1	58.27	8	957	
EXT2	17.78	10	612	
EXT3	16.40	44		270
EXT4	2.15	47		98
EXT5	0.76	36		58
EXT6	10.21	47		213
EXT7	2.79	52		111
EXT8	1.21	36		73
EXT9	0.42	36		43
WETLAND				
WETLAND1	6.84	100		174
WETLAND2	0.59	100		52
WETLAND3-1	3.21	100		120
WETLAND3-2	0.44	100		44

BURNSIDE

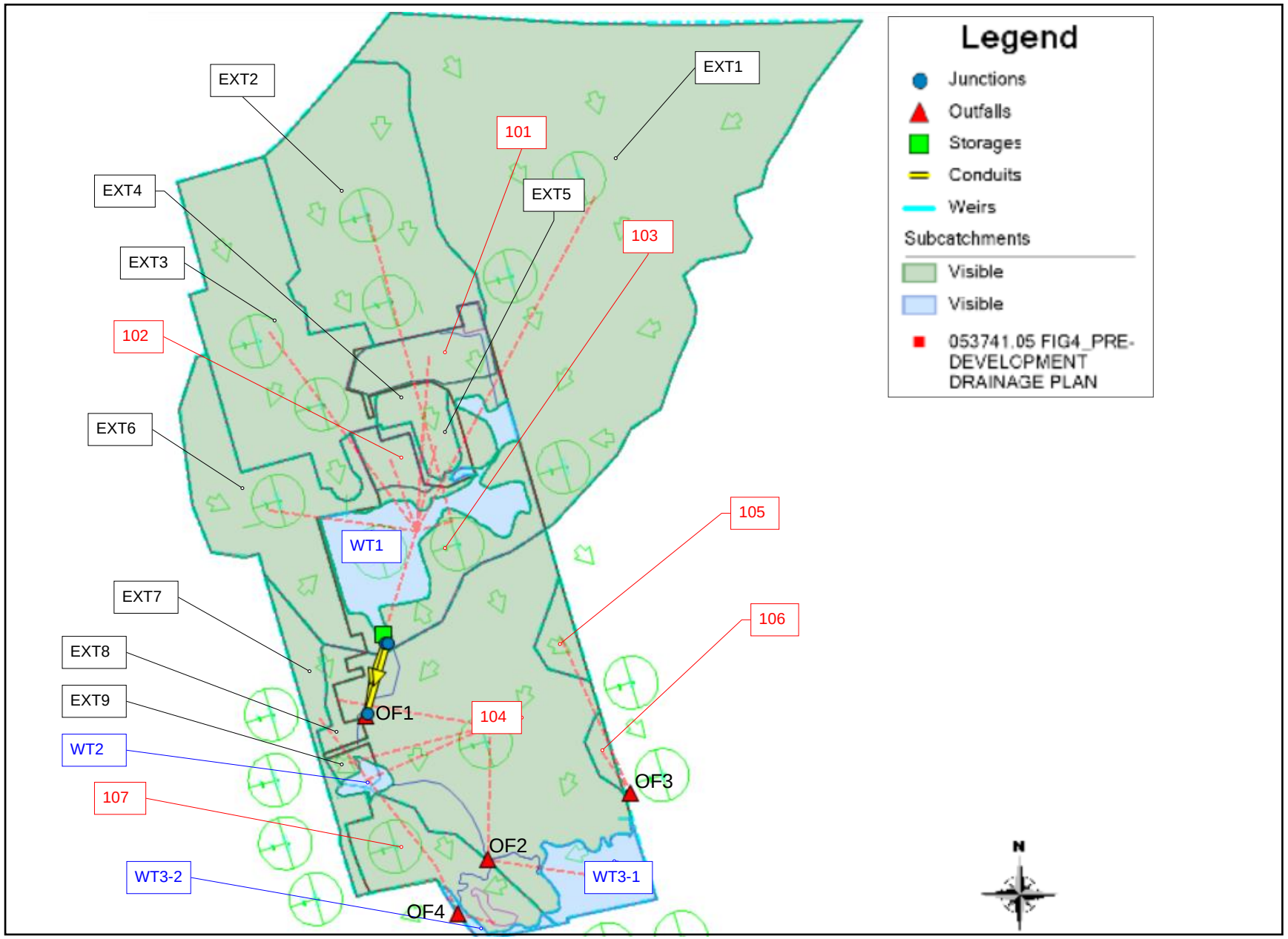
[THE DIFFERENCE IS OUR PEOPLE]

Appendix C

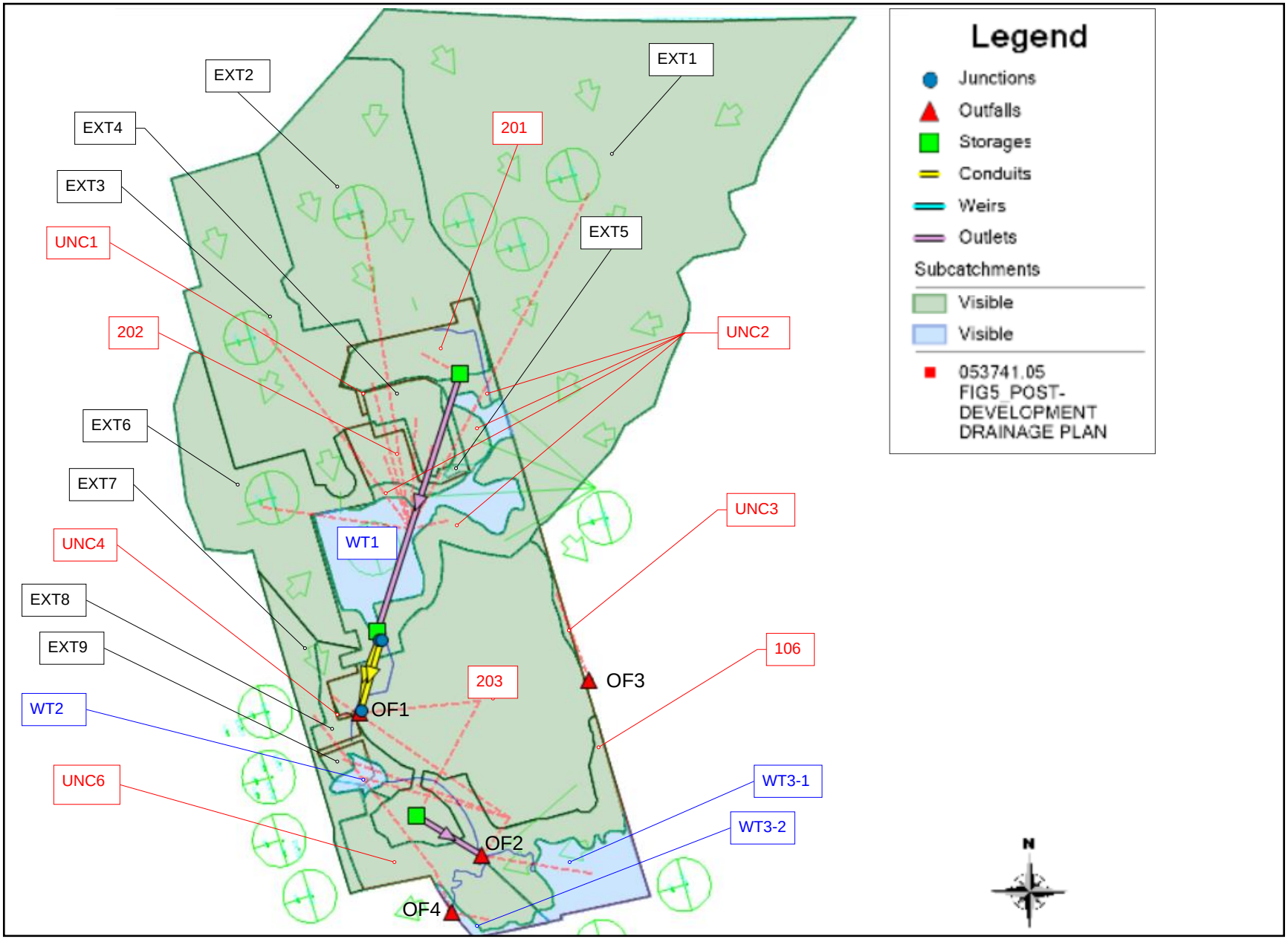
PCSWMM Model Output

Pre-Development Model
Post-Development Model

Pre-Development Model



Post-Development Model



EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.015)

WARNING 03: negative offset ignored for Link C1
WARNING 04: minimum elevation drop used for Conduit C3
WARNING 03: negative offset ignored for Link OL2
WARNING 02: maximum depth increased for Node J2
WARNING 02: maximum depth increased for Node J3
WARNING 02: maximum depth increased for Node WETLAND1

****
Element Count
****
Number of rain gages 12
Number of subcatchments ... 22
Number of nodes 10
Number of links 7
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
Chicago_3h-100yr	Chicago_3h-100yr	INTENSITY	5 min.
Chicago_3h-10yr	Chicago_3h-10yr	INTENSITY	5 min.
Chicago_3h-25yr	Chicago_3h-25yr	INTENSITY	5 min.
Chicago_3h-2yr	Chicago_3h-2yr	INTENSITY	5 min.
Chicago_3h-50yr	Chicago_3h-50yr	INTENSITY	5 min.
Chicago_3h-5yr	Chicago_3h-5yr	INTENSITY	5 min.
SCS_Type_II_100.31mm-10Year	SCS_Type_II_100.31mm-10Year	INTENSITY	6 min.
SCS_Type_II_124.02mm-25Year	SCS_Type_II_124.02mm-25Year	INTENSITY	6 min.
SCS_Type_II_142.66mm-50Year	SCS_Type_II_142.66mm-50Year	INTENSITY	6 min.
SCS_Type_II_161.63mm-100Year	SCS_Type_II_161.63mm-100Year	INTENSITY	6 min.
SCS_Type_II_56.27mm-2Year	SCS_Type_II_56.27mm-2Year	INTENSITY	6 min.
SCS_Type_II_84.13mm-5Year	SCS_Type_II_84.13mm-5Year	INTENSITY	6 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet

201	3.27	272.59	79.00	0.5000	SCS_Type_II_161.63mm-100Year SU1
202	1.42	179.35	58.00	0.5000	SCS_Type_II_161.63mm-100Year WT1
203	23.72	738.81	66.00	0.5000	SCS_Type_II_161.63mm-100Year SWMF
EXT1	58.27	608.88	8.00	0.6000	SCS_Type_II_161.63mm-100Year WT1
EXT2	17.78	290.53	10.00	0.6600	SCS_Type_II_161.63mm-100Year WT1
EXT3	16.40	607.35	44.00	0.5000	SCS_Type_II_161.63mm-100Year WT1
EXT4	2.15	219.33	47.00	0.5000	SCS_Type_II_161.63mm-100Year WT1
EXT5	0.76	131.60	36.00	0.5000	SCS_Type_II_161.63mm-100Year WT1
EXT6	10.21	479.54	47.00	0.5000	SCS_Type_II_161.63mm-100Year WT1
EXT7	2.79	251.08	52.00	0.5000	SCS_Type_II_161.63mm-100Year UNC6
EXT8	1.21	165.90	36.00	0.5000	SCS_Type_II_161.63mm-100Year UNC5
EXT9	0.42	98.00	36.00	0.5000	SCS_Type_II_161.63mm-100Year UNC5
UNC1	0.20	6.66	7.00	0.5000	SCS_Type_II_161.63mm-100Year WT1
UNC2	6.34	1152.84	2.00	0.5000	SCS_Type_II_161.63mm-100Year WT1
UNC3	0.32	84.21	36.00	0.5000	SCS_Type_II_161.63mm-100Year OF3
UNC4	0.04	28.15	36.00	0.5000	SCS_Type_II_161.63mm-100Year 203
UNC5	4.97	319.22	4.00	0.5000	SCS_Type_II_161.63mm-100Year OF2
UNC6	4.46	193.90	8.00	0.5000	SCS_Type_II_161.63mm-100Year OF4
WT1	6.84	395.28	100.00	0.5000	SCS_Type_II_161.63mm-100Year WETLAND1
WT2	0.59	115.96	100.00	0.5000	SCS_Type_II_161.63mm-100Year UNC5
WT3_1	3.21	267.21	100.00	0.5000	SCS_Type_II_161.63mm-100Year OF2
WT3_2	0.44	100.77	100.00	0.5000	SCS_Type_II_161.63mm-100Year OF4

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
J1	JUNCTION	233.42	1.85	0.0	
J2	JUNCTION	234.20	1.07	0.0	
J3	JUNCTION	230.54	1.25	0.0	
OF1	OUTFALL	230.54	1.00	0.0	
OF2	OUTFALL	0.00	0.00	0.0	
OF3	OUTFALL	0.00	0.00	0.0	
OF4	OUTFALL	0.00	0.00	0.0	
SU1	STORAGE	234.50	0.80	0.0	
SWMF	STORAGE	0.00	1.90	0.0	
WETLAND1	STORAGE	233.97	0.60	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C1	J1	J3	CONDUIT	158.9	1.8126	0.0100
C2	J2	J3	CONDUIT	158.7	2.1927	0.0100
C3	J3	OF1	CONDUIT	5.0	0.0061	0.0100
W1	WETLAND1	J1	WEIR			
W2	WETLAND1	J2	WEIR			
OL1	SWMF	OF2	OUTLET			
OL2	SU1	WETLAND1	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1	CIRCULAR	1.00	0.79	0.25	1.00	1	4.20
C2	TRAPEZOIDAL	1.00	6.00	0.64	9.00	1	66.23
C3	TRAPEZOIDAL	1.00	6.00	0.64	9.00	1	3.49

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... NO
  Water Quality ..... NO
Infiltration Method ..... HORTON
Flow Routing Method ..... DYNWAVE
Surcharge Method ..... EXTRAN
Starting Date 11/03/2022 00:00:00
Ending Date 11/04/2022 00:00:00

```
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 5.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.001524 m
```

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	26.799	161.630
Evaporation Loss	0.000	0.000
Infiltration Loss	11.468	69.165
Surface Runoff	12.770	77.017
Final Storage	2.595	15.650
Continuity Error (%)	-0.125	

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	12.757	127.572
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	8.683	86.836
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	4.073	40.735
Continuity Error (%)	0.002	

```
**************************
Time-Step Critical Elements
**************************
Link C3 (84.08%)

*******************************
```

Highest Flow Instability Indexes
****
All links are stable.

****
Routing Time Step Summary
****
Minimum Time Step   :   0.78 sec
Average Time Step   :   2.15 sec
Maximum Time Step   :   5.00 sec
Percent in Steady State   :   -0.00
Average Iterations per Step :   2.00
Percent Not Converging   :   0.00
Time Step Frequencies   :
    5.000 - 3.155 sec   :   22.23 %
    3.155 - 1.991 sec   :   0.94 %
    1.991 - 1.256 sec   :   58.99 %
    1.256 - 0.792 sec   :   17.83 %
    0.792 - 0.500 sec   :   0.00 %

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
201	161.63	0.00	0.00	20.09	126.58	12.42	139.00	4.55	1.56	0.860
202	161.63	0.00	0.00	41.49	93.14	23.39	116.53	1.65	0.55	0.721
203	161.63	0.15	0.00	33.06	105.39	18.62	124.00	29.41	8.17	0.767
EXT1	161.63	0.00	0.00	96.43	12.83	25.97	38.81	22.61	2.86	0.240
EXT2	161.63	0.00	0.00	96.98	16.05	27.93	43.99	7.82	1.11	0.272
EXT3	161.63	0.00	0.00	55.31	70.43	29.07	99.50	16.32	4.26	0.616
EXT4	161.63	0.00	0.00	48.19	75.47	33.22	108.69	2.34	0.70	0.672
EXT5	161.63	0.00	0.00	51.84	57.84	43.57	101.41	0.77	0.22	0.627
EXT6	161.63	0.00	0.00	52.35	75.29	25.45	100.74	10.29	2.85	0.623
EXT7	161.63	0.00	0.00	47.41	83.46	23.97	107.43	2.99	0.92	0.665
EXT8	161.63	0.00	0.00	63.22	57.84	32.11	89.95	1.09	0.30	0.557
EXT9	161.63	0.00	0.00	63.22	57.83	32.62	90.45	0.38	0.11	0.560
UNC1	161.63	0.00	0.00	91.86	11.25	45.12	56.36	0.11	0.01	0.349
UNC2	161.63	0.00	0.00	92.22	3.21	58.29	61.50	3.90	0.69	0.381
UNC3	161.63	0.00	0.00	63.22	57.83	35.90	93.73	0.30	0.09	0.580

UNC4	161.63	0.00	0.00	63.22	57.81	36.49	94.30	0.03	0.01	0.583
UNC5	161.63	48.67	0.00	82.59	8.37	102.03	110.40	5.49	0.61	0.525
UNC6	161.63	67.11	0.00	80.66	18.21	110.56	128.77	5.74	0.60	0.563
WT1	161.63	961.12	0.00	0.00	1116.77	0.00	1116.77	76.37	15.55	0.995
WT2	161.63	0.00	0.00	0.00	160.55	0.00	160.55	0.95	0.36	0.993
WT3_1	161.63	0.00	0.00	0.00	160.06	0.00	160.06	5.13	1.79	0.990
WT3_2	161.63	0.00	0.00	0.00	160.59	0.00	160.59	0.71	0.27	0.994

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J1	JUNCTION	0.09	0.11	233.53	0 11:54	0.11
J2	JUNCTION	0.14	0.21	234.41	0 13:38	0.21
J3	JUNCTION	0.19	0.31	230.85	0 13:38	0.31
OF1	OUTFALL	0.18	0.31	230.85	0 13:38	0.31
OF2	OUTFALL	0.00	0.00	0.00	0 00:00	0.00
OF3	OUTFALL	0.00	0.00	0.00	0 00:00	0.00
OF4	OUTFALL	0.00	0.00	0.00	0 00:00	0.00
SU1	STORAGE	0.33	0.79	235.29	0 12:33	0.79
SWMF	STORAGE	1.23	1.68	1.68	0 14:45	1.68
WETLAND1	STORAGE	0.33	0.45	234.42	0 13:38	0.45

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
J1	JUNCTION	0.000	0.086	0 11:50	0	4.32	0.068
J2	JUNCTION	0.000	1.795	0 13:38	0	46.7	0.077
J3	JUNCTION	0.000	1.881	0 13:38	0	51	0.017
OF1	OUTFALL	0.000	1.881	0 13:38	0	51	0.000
OF2	OUTFALL	2.251	2.477	0 11:54	10.6	29.1	0.000
OF3	OUTFALL	0.093	0.093	0 11:54	0.3	0.3	0.000

OF4	OUTFALL	0.793	0.793	0	12:00	6.45	6.45	0.000
SU1	STORAGE	1.563	1.563	0	11:54	4.55	4.55	-0.000
SWMF	STORAGE	8.171	8.171	0	11:54	29.4	29.4	0.004
WETLAND1	STORAGE	15.552	15.683	0	11:59	76.3	80.4	0.004

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
SU1	0.924	41	0	0	2.205	98	0 12:33	0.154
SWMF	11.397	60	0	0	16.364	86	0 14:45	0.360
WETLAND1	26.024	55	0	0	35.751	75	0 13:38	1.881

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	97.40	0.961	1.881	50.959
OF2	98.92	0.444	2.477	29.126
OF3	98.89	0.004	0.093	0.300

OF4	98.92	0.106	0.793	6.450
System	98.53	1.515	3.436	86.835

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	0.089	0 12:04	2.85	0.02	0.21
C2	CONDUIT	1.795	0 13:38	3.70	0.03	0.14
C3	CONDUIT	1.881	0 13:38	1.54	0.54	0.31
W1	WEIR	0.086	0 11:50			1.00
W2	WEIR	1.795	0 13:38			0.52
OL1	DUMMY	0.360	0 12:29			
OL2	DUMMY	0.154	0 12:33			

****
Flow Classification Summary
****

	Adjusted	Fraction of Time in Flow Class								
Conduit	/Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
C1	1.00	0.02	0.00	0.00	0.45	0.54	0.00	0.00	0.52	0.00
C2	1.00	0.23	0.00	0.00	0.00	0.00	0.00	0.77	0.00	0.00
C3	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Tue Mar 14 13:17:08 2023
Analysis ended on: Tue Mar 14 13:17:09 2023

```
Total elapsed time: 00:00:01
```

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.015)

WARNING 04: minimum elevation drop used for Conduit C3
WARNING 02: maximum depth increased for Node J2
WARNING 02: maximum depth increased for Node J3
WARNING 02: maximum depth increased for Node WETLAND1

****
Element Count
****
Number of rain gages 12
Number of subcatchments ... 20
Number of nodes 8
Number of links 5
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
Chicago_3h-100yr	Chicago_3h-100yr	INTENSITY	5 min.
Chicago_3h-10yr	Chicago_3h-10yr	INTENSITY	5 min.
Chicago_3h-25yr	Chicago_3h-25yr	INTENSITY	5 min.
Chicago_3h-2yr	Chicago_3h-2yr	INTENSITY	5 min.
Chicago_3h-50yr	Chicago_3h-50yr	INTENSITY	5 min.
Chicago_3h-5yr	Chicago_3h-5yr	INTENSITY	5 min.
SCS_Type_II_100Yr	SCS_Type_II_100Yr	INTENSITY	6 min.
SCS_Type_II_10Yr	SCS_Type_II_10Yr	INTENSITY	6 min.
SCS_Type_II_25Yr	SCS_Type_II_25Yr	INTENSITY	6 min.
SCS_Type_II_2Yr	SCS_Type_II_2Yr	INTENSITY	6 min.
SCS_Type_II_50Yr	SCS_Type_II_50Yr	INTENSITY	6 min.
SCS_Type_II_5Yr	SCS_Type_II_5Yr	INTENSITY	6 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
101	3.27	109.04	9.00	0.5000	SCS_Type_II_100Yr	WT1

102	1.42	101.09	7.00	0.5000	SCS_Type_II_100Yr	WT1
103	6.88	529.04	0.00	0.5000	SCS_Type_II_100Yr	WT1
104	25.87	366.99	5.00	0.5000	SCS_Type_II_100Yr	OF2
105	1.25	139.33	7.00	0.5000	SCS_Type_II_100Yr	OF3
106	0.58	116.70	7.00	0.5000	SCS_Type_II_100Yr	OF3
107	5.47	210.53	5.00	0.5000	SCS_Type_II_100Yr	OF4
EXT1	58.27	608.88	8.00	0.6000	SCS_Type_II_100Yr	WT1
EXT2	17.78	290.53	10.00	0.6600	SCS_Type_II_100Yr	103
EXT3	16.40	607.35	44.00	0.5000	SCS_Type_II_100Yr	WT1
EXT4	2.15	219.33	47.00	0.5000	SCS_Type_II_100Yr	WT1
EXT5	0.76	131.60	36.00	0.5000	SCS_Type_II_100Yr	WT1
EXT6	10.21	479.54	47.00	0.5000	SCS_Type_II_100Yr	WT1
EXT7	2.79	251.08	52.00	0.5000	SCS_Type_II_100Yr	107
EXT8	1.21	165.90	36.00	0.5000	SCS_Type_II_100Yr	104
EXT9	0.42	98.00	36.00	0.5000	SCS_Type_II_100Yr	104
WT1	6.84	393.01	100.00	0.5000	SCS_Type_II_100Yr	WETLAND1
WT2	0.59	113.73	100.00	0.5000	SCS_Type_II_100Yr	104
WT3_1	3.21	267.21	100.00	0.5000	SCS_Type_II_100Yr	OF2
WT3_2	0.44	100.77	100.00	0.5000	SCS_Type_II_100Yr	OF4

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
J1	JUNCTION	233.42	1.85	0.0	
J2	JUNCTION	230.54	1.25	0.0	
J3	JUNCTION	234.20	1.07	0.0	
OF1	OUTFALL	230.54	1.00	0.0	
OF2	OUTFALL	0.00	0.00	0.0	
OF3	OUTFALL	0.00	0.00	0.0	
OF4	OUTFALL	0.00	0.00	0.0	
WETLAND1	STORAGE	233.97	0.60	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C1	J1	J2	CONDUIT	158.3	1.8194	0.0130
C2	J3	J2	CONDUIT	159.0	2.1891	0.0100
C3	J2	OF1	CONDUIT	5.1	0.0060	0.0100
W1	WETLAND1	J1	WEIR			

W2 WETLAND1 J3 WEIR

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1	CIRCULAR	0.25	0.05	0.06	0.25	1	0.08
C2	TRAPEZOIDAL	1.00	6.00	0.64	9.00	1	66.18
C3	TRAPEZOIDAL	1.00	6.00	0.64	9.00	1	3.45

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... NO
  Water Quality ..... NO
Infiltration Method ..... CURVE_NUMBER
Flow Routing Method ..... DYNWAVE
Surcharge Method ..... EXTRAN
Starting Date 01/01/1991 00:00:00
Ending Date 01/02/1991 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:00:05
Wet Time Step 00:00:05
Dry Time Step 00:00:05
Routing Time Step ..... 0.50 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 1

Head Tolerance ..... 0.001500 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	26.802	161.630
Evaporation Loss	0.000	0.000
Infiltration Loss	13.166	79.397
Surface Runoff	10.249	61.809
Final Storage	3.387	20.424
Continuity Error (%)	-0.000	

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	10.249	102.493
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	7.305	73.047
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	2.944	29.443
Continuity Error (%)	0.002	

Time-Step Critical Elements

None

Highest Flow Instability Indexes

All links are stable.

Routing Time Step Summary

```
Minimum Time Step           :     0.50 sec
Average Time Step           :     0.50 sec
Maximum Time Step           :     0.50 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00
Time Step Frequencies       :
    0.500 -  0.500 sec      :   100.00 %
    0.500 -  0.500 sec      :     0.00 %
    0.500 -  0.500 sec      :     0.00 %
    0.500 -  0.500 sec      :     0.00 %
    0.500 -  0.500 sec      :     0.00 %
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
101	161.63	0.00	0.00	88.48	14.42	41.04	55.46	1.81	0.21	0.343
102	161.63	0.00	0.00	90.43	11.23	45.52	56.74	0.80	0.09	0.351
103	161.63	113.44	0.00	94.10	0.00	157.95	157.95	10.86	0.78	0.574
104	161.63	9.33	0.00	89.40	8.47	44.97	53.44	13.83	0.98	0.313
105	161.63	0.00	0.00	91.86	11.23	45.43	56.66	0.71	0.10	0.351
106	161.63	0.00	0.00	91.86	11.24	46.60	57.83	0.34	0.06	0.358
107	161.63	54.53	0.00	83.29	10.74	101.39	112.13	6.14	0.55	0.519
EXT1	161.63	0.00	0.00	96.43	12.79	25.92	38.71	22.55	2.86	0.239
EXT2	161.63	0.00	0.00	96.98	16.00	27.88	43.88	7.80	1.11	0.271
EXT3	161.63	0.00	0.00	55.31	70.21	26.24	96.45	15.82	4.17	0.597
EXT4	161.63	0.00	0.00	48.19	75.22	30.53	105.75	2.27	0.68	0.654
EXT5	161.63	0.00	0.00	51.84	57.69	43.50	101.20	0.77	0.22	0.626
EXT6	161.63	0.00	0.00	52.35	75.05	25.42	100.47	10.26	2.85	0.622
EXT7	161.63	0.00	0.00	47.41	83.17	23.93	107.11	2.99	0.92	0.663
EXT8	161.63	0.00	0.00	63.22	57.67	32.06	89.74	1.09	0.30	0.555
EXT9	161.63	0.00	0.00	63.22	57.72	32.56	90.27	0.38	0.11	0.559
WT1	161.63	952.80	0.00	0.00	1106.34	0.00	1106.34	75.66	13.90	0.993
WT2	161.63	0.00	0.00	0.00	159.99	0.00	159.99	0.95	0.36	0.990
WT3_1	161.63	0.00	0.00	0.00	159.57	0.00	159.57	5.12	1.79	0.987
WT3_2	161.63	0.00	0.00	0.00	160.05	0.00	160.05	0.71	0.27	0.990

****

Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J1	JUNCTION	0.33	0.72	234.14	0 12:04	0.72
J2	JUNCTION	0.12	0.29	230.83	0 14:03	0.29
J3	JUNCTION	0.08	0.20	234.40	0 14:03	0.20
OF1	OUTFALL	0.11	0.28	230.82	0 14:03	0.28
OF2	OUTFALL	0.00	0.00	0.00	0 00:00	0.00
OF3	OUTFALL	0.00	0.00	0.00	0 00:00	0.00
OF4	OUTFALL	0.00	0.00	0.00	0 00:00	0.00
WETLAND1	STORAGE	0.22	0.44	234.41	0 14:02	0.44

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
J1	JUNCTION	0.000	0.086	0 12:43	0	4.12	0.100
J2	JUNCTION	0.000	1.611	0 14:03	0	46.2	0.009
J3	JUNCTION	0.000	1.526	0 14:02	0	42.1	0.087
OF1	OUTFALL	0.000	1.611	0 14:03	0	46.2	0.000
OF2	OUTFALL	2.771	2.771	0 11:54	18.9	18.9	0.000
OF3	OUTFALL	0.155	0.155	0 12:00	1.05	1.05	0.000
OF4	OUTFALL	0.742	0.742	0 12:00	6.85	6.85	0.000
WETLAND1	STORAGE	13.900	13.900	0 11:54	75.7	75.7	0.004

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Hours	Max. Height Above Crown	Min. Depth Below Rim

Node	Type	Surcharged	Meters	Meters
J1	JUNCTION	12.17	0.470	1.130

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
WETLAND1	17.518	37	0	0	34.581	72	0 14:02	1.611

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	93.59	0.572	1.611	46.210
OF2	97.46	0.225	2.771	18.942
OF3	97.44	0.012	0.155	1.048
OF4	97.45	0.081	0.742	6.847
System	96.48	0.890	3.711	73.047

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days	hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	0.086	0	12:44	2.54	1.07	1.00
C2	CONDUIT	1.526	0	14:03	3.49	0.02	0.13
C3	CONDUIT	1.611	0	14:03	1.47	0.47	0.28
W1	WEIR	0.086	0	12:43			1.00
W2	WEIR	1.526	0	14:02			0.47

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
C1	1.00	0.04	0.00	0.00	0.31	0.65	0.00	0.00	0.00	0.00
C2	1.00	0.50	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00
C3	1.00	0.04	0.00	0.00	0.96	0.00	0.00	0.00	0.00	0.00

****
Conduit Surcharge Summary
****

Conduit	Hours Full: Both Ends	Upstream	Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
C1	3.71	12.17	3.71	11.69	3.71

Analysis begun on: Tue Mar 14 13:13:45 2023
Analysis ended on: Tue Mar 14 13:13:48 2023
Total elapsed time: 00:00:03

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix D

Stormwater Management Facility Design Calculations

Project: Delhi Golf & Country Club Redevelopment
File: 300053471
Designed by: L.Garner
Date: 9-Nov-22

BURNSIDE

IDF Parameters

7.8.02 RAINFALL INTENSITY

For stormwater management design and modelling, rainfall IDF curves shall be based on the following local rainfall data for Norfolk County:

$$i = \frac{a}{(t + b)^c} \text{ mm/hr}$$

Return	A	B	C
2	529.711	4.501	0.745
5	583.017	3.007	0.703
10	670.324	3.007	0.698
25	721.533	2.253	0.679
50	766.038	1.898	0.668
100	801.041	1.501	0.657

For normal residential development storm sewer pipe design, the rainfall intensity shall be determined from the **5-Year IDF Curve** as per the formula listed above.

24-hour Rainfall Depths

2 year – 56.27mm
5 year – 84.13mm
10 year – 100.31mm
25 year – 124.02mm
50 year – 142.66mm
100 year – 161.63mm

Project: Delhi Golf & Country Club Redevelopment
File: 300053471
Designed by: L.Garner
Date: 10-Mar-23

SWMF1 - Wet Pond Permament Pool Requirement

MOE Table 3.2 Water Quality Storage Requirements Based on Receiving Waters.

DRAINAGE AREA	23.72	ha	(Catchment 203)
IMPERVIOUSNESS	66.00	%	
Protection Level (1, 2, or 3)	1		

NOTE - 40 cu.m/ha has been removed from MOE table values for Ex. Detention Portion

Enhanced (Level 1) Protection

x	y	Known (x)	Calc (y)	
Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Total Permanent Pool Required (cu.m)
35	100	**66.00**	**171.82**	**4075.67**
55	150			
70	185			
85	210			
95.0	**236**	**Extrapolated**		

Normal (Level 2) Protection

x	y	Known (x)	Calc (y)	
Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Total Permanent Pool Required (cu.m)
35	50	**66.00**	**84.67**	**2008.29**
55	70			
70	90			
85	110			
95.0	**121**	**Extrapolated**		

Basic (Level 3) Protection

x	y	Known (x)	Calc (y)	
Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Total Permanent Pool Required (cu.m)
35	20	**66.00**	**42.33**	**1004.15**
55	35			
70	45			
85	55			
95.0	**62**	**Extrapolated**		

SEDIMENT FOREBAY SIZING

Project: Delhi Golf & Country Club Redevelopment
File: 300053471
Designed by: L.Garner
Date: 10-Mar-23

SWMF1 Forebay
Forebay Length: Two calculations (per MOE SWMP Manual, 2003)

1) Settling Calculations **Dist = SQRT(r * Qp / Vs)**
(Equation 4.5, MOE 2003)

where:
Dist = Forebay length (m)
r = Length to width ratio of forebay
Qp = Peak flowrate from the pond during quality design storm (cms)
Vs = Settling velocity (m/s)

given:
r = 2
Qp = 0.0906 cms *see below
Vs = 0.0003 m/s

therefore:
Dist = 24.6 metres
Width= 12.3 metres

Peak quality flowrate (Qp) from pond based on release rate and volume of extended detention multiplied by a factor of 2.0 for peaking

Extended Detention Vol 3914 cu.m (extended det. volume)
Release Rate 24 hrs (typically 24 or 48)
Qp 0.0906 cms

2) Dispersion Length **Dist = (8 * Q) / (d * Vf)**
(Equation 4.6,MOE 2003)

where:
Dist = Forebay length (m)
Q = inlet flowrate (cms)
d = depth of permanent pool in forebay (m)
Vf = desired forebay velocity (m/s)

given:
Q = 3.32 cms *see below
d = 1.2 m
Vf = 0.5 m/s

therefore:
Dist = 44.3 metres
Width= 22.1 metres
Min Bottom Width= 5.5 metres *MOE equation 4.6
Pond Side Slopes: 5
Calc. Top Width= 17.533 metres
Calc. Top Length= 35.067 meters

Peak inflow rate calculated based on PCSWMM output for 5 year storm (based of IDF parameters)

Minimum Forebay Dimension:

Length= 44.3 meters
Width= 22.1 meters

Actual Forebay Design:

Length= 51.2 meters
Width= 25.6 meters

Check Average velocity in forebay <= 0.15 m/s
Pond Side Slopes: 5 H : 1 V
Q = V x A Q = 3.32 A = 24 sq.metres

therefore: V = 0.1412 m/s
Design: **OK**

Location:	Delhi Golf & Country Club Redevelopment
Project #:	300053471
Designed by:	L.Garner
Date:	10-Mar-23

BURNSIDE

Extended Detention

25mm over 24 hours

SWMF1

Drainage Area:	23.72 ha		
Approximate ED:		3913.8	m³
DA x imp x 25mm x 10	23.72 ha x 66% x 25 mm x 10		
ED Release Rate:	3886 m³/24/3600 x 1.5 =	0.068	m³/s

Location:	Delhi Golf & Country Club Redevelopment
Project #:	300053471
Designed by:	L.Garner
Date:	14-Mar-23

BURNSIDE

SWMF1 Storage Calculations

INPUT AREA

Drainage Area:	23.72	ha
Percent Impervious:	66%	
Base of Pond:	226.00	
N.W.L.:	227.20	masl
Required Permanent Pool Volume:	4076	m^3
Permanent Pool Volume Provided:	8503	m^3

ELEVATION / STORAGE INFORMATION

	Elevation	Stage	Total Area	Cumulative Storage	Cumulative Storage above Permanent Pool
	(m)	(m)	(m2)	(m3)	(m3)
Base of Pond :	226.00	0.00	2421	0.00	0.00
	226.50	0.50	6845	3156.91	0.00
	227.00	1.00	7974	6860.11	0.00
NWL :	227.20	1.20	8456	8503.25	0.00
	227.50	1.50	9220	11152.98	2649.73
	227.80	1.80	10021	14040.38	5537.13
	228.10	2.10	10652	17141.83	8638.58
	228.40	2.40	11277	20431.23	11927.98
	228.70	2.70	11919	23909.70	15406.45
HWL:	228.90	2.90	12343	26336.10	17832.85
Top of Pond:	229.10	3.10	12677	27580.72	19077.47

1.90 Active Storage Depth Available

DELHI GOLF & COUNTRY CLUB REDEVELOPMENT

SERVICING STUDY TECHNICAL MEMORANDUM

MARCH 2023

REPORT PREPARED FOR

GERANIUM
From the ground up™

Delhi Redevelopment Inc. c/o Geranium
3190 Steeles Avenue East, Suite 300
Markham, ON L3R 1G9

REPORT PREPARED BY

TYLin

T.Y. LIN INTERNATIONAL
8800 DUFFERIN STREET, SUITE 200,
VAUGHAN, ON L4K 0C5
905-738-5700

TYLIN PROJECT NUMBER 10478

Signature Page

Report prepared by:

Mateusz Lewandowski, P.Eng.
Project Manager

Report reviewed by:

Ian Parkinson, P. Eng.
Senior Design Manager

Brian Edwards
Vice President, Water and Wastewater

CONTENTS

1 SUMMARY 1
2 INTRODUCTION 3
2.1 Purpose 3
3 INTERNAL SANITARY SERVICING 6
3.1 Design Criteria 6
3.2 Servicing Approach 6
3.3 Gravity Sewer Servicing 6
3.4 Sewage Pumping Station Servicing 7
3.4.1 Design Flow 7
3.4.2 SPS Design Guidelines 8
3.5 Force Main 8
3.5.1 Sizing 8
3.5.1 Horizontal Alignment 9
3.5.2 Vertical Alignment 10
4 EXTERNAL SANITARY SERVICING 11
4.1 Existing Sanitary Collection System 11
4.1.1 Overview 11
4.1.2 Sanitary Sewer Network 11
4.1.3 Sewage Pumping Stations 11
4.2 Existing Sewage Treatment Plant 13
4.2.1 Delhi Wastewater Treatment Facility 13
4.2.2 Annual Wastewater Treatment System Summary Reports 14
5 WATER SERVICING 16
5.1 Design Criteria 16
5.2 Water Demand and Supply 17
5.2.1 Daily Water Demands 17
5.2.2 Fire Flows 17
5.3 Water Storage 17
5.4 Water Main Network 18
5.5 Level of Service 18
5.6 Modelling Scenarios 18
6 EXTERNAL WATER SERVICING 20
6.1 Existing Infrastructure 20
6.1.1 Overview 20
6.1.1 Groundwater Wells 20
6.1.2 Standpipe 20
6.2 Future System Infrastructure 21

6.2.1 Booster Pump Station 21
7 NEXT STEPS 21
8 REFERENCES 22

APPENDICES

APPENDIX A: DRAINAGE AREAS (R.J. BURNSIDE, 2022)
APPENDIX B: WATER AND WASTEWATER CALCULATIONS
APPENDIX C: PERMITS AND APPROVALS
APPENDIX D: MODELLING SCENARIOS (ISMP)

FIGURES

Figure 2-1: Delhi Redevelopment Concept Completed by GSP Group 4
Figure 2-2: Water and Wastewater Servicing Concept for the Proposed Delhi Redevelopment 5
Figure 3-1: Existing Sanitary Sewer Network 7
Figure 3-2: Vertical Profile Alternatives of the Proposed Force Main Alignment Using Google Earth 10
Figure 4-1: St. Michael's Sewage Pumping Station from Google Earth 12
Figure 4-2: Main Street Pump Station from Google Earth 13
Figure 4-3: Image of the Delhi WWTF from the R.V. Anderson Facebook Page 13

TABLES

Table 3-1: Design Criteria 6
Table 3-2: Sanitary Design Flows from Drainage Areas SAN1 and SAN2 7
Table 3-3: Sewage Pumping Station Design Flows 8
Table 3-4: Calculated Flow Velocities Using the Peak Instantaneous Flow for Force Mains with an Interior Diameter of 150 mm or 200 mm 9
Table 4-1: Delhi Wastewater Treatment Facility Annual Wastewater Treatment System Reports 14
Table 5-1: Water System Design Criteria 16
Table 5-2: Projected Water Demands for Delhi redevelopment 17
Table 6-1: Rated Capacities for Groundwater Wells 20

ACRONYMS

BPS	Booster pumping station
EA	Environmental Assessment
ECA	Environmental Compliance Approval
GUDI	groundwater under the direct influence of surface water
ISMP	Integrated Sustainable Master Plan
LPCD	Litres per capita per day
MECP	Ontario Ministry of the Environment, Conservation, and Parks
SPS	Sewage pumping station
WWTF	Wastewater treatment facility

DEFINITIONS

Average daily flow	The average daily flow is the average of the daily volumes received in a calendar year expressed as a volume per unit of time (MECP, 2008).
Employment growth	The increase in employment (commercial) areas within the urban boundary between 2021 to 2041 as identified in the Integrated Sustainable Master Plan.
Firm pumping capacity	The capacity of a station that is capable of handling at least the 10-year design peak hourly flow when one unit is out of service (MECP, 2008).
Groundwater under direct influence of surface water (GUDI)	Groundwater that has incomplete or undependable subsurface filtration of surface water and infiltrating precipitation (MECP, 2008).
Maximum daily demand	The largest amount of water delivered to a system in a single day expressed as a volume per unit of time.
Dry weather flow	The sewage flow resulting from sanitary wastewater and infiltration and inflows from sewer joints and service connections during periods with an absence of rainfall or snowmelt (MECP, 2008).
Overflow	The discharge to the environment from a sewage treatment works at a location other than the final effluent outfall or downstream of the sampling point in the final effluent outfall (MECP, 2008).
Peak hour flow	The largest volume of flow to be received during a one-hour period expressed as a volume per unit of time (MECP, 2008).
Peak instantaneous flow	The instantaneous maximum flow rate as measured by a metering device. This flow is used to size sewage pump stations (MECP, 2008).
Residential growth	The increase in population within the urban boundary from 2021 to 2041 as identified in the Integrated Sustainable Master Plan.
Sewage treatment plant design capacity	This capacity should be such that the treated effluent would continuously meet the established quality criteria in terms of concentrations and loadings during the design period.
Sewage treatment plant rated capacity	To meet the requirements of a Municipal Engineers Association Class Environmental Assessment (MEA Class EA), this capacity generally means the design average daily flow for the limiting process stage.

Standpipe	A high vertical pipe or reservoir that is used to secure a uniform pressure in a water-supply system.
Wet weather flow	The sewage flow resulting from sanitary wastewater, infiltration and inflows from sewer joints and service connections during periods of rainfall or snowmelt, or the stormwater generated by either rainfall or snowmelt that enters the sanitary sewer system (MECP, 2008).

1 SUMMARY

The key findings of this servicing report are described below.

Overall Serviceability

- The former Township of Delhi appears to have sufficient capacity within the existing water and wastewater systems to service the new Delhi development. It should be noted that additional evaluation is recommended to confirm any limitations to the sewage collection, pumping stations, water distribution system, water storage and include evaluation of plant performance characteristics.
- Key servicing parameters include:
    - The new Delhi redevelopment would require 1,267 m^3/day of water (max day demand) and a 200 L/s fire flow when using the Fire Underwriter Survey (FUS) calculation based on the updated Delhi Development Inc. Homes Development Concept, dated February 23, 2023 – Figure 2-1. The Information Memo – Water and Wastewater EIS -22 -077 (Released September 2022) notes an available capacity after pending development application within Delhi to be 2,768 m^3/day. The additional flows from the new Delhi redevelopment appear to be within the available capacity limits based on review of proposed max day demands against the available capacity.
    - The new Delhi redevelopment would discharge 545 m^3/day of wastewater daily to the Delhi wastewater treatment plant. The Information Memo – Water and Wastewater EIS -22 -077 (Released September 2022) notes an available capacity after pending development application within Delhi to be 1,636 m^3/day. The additional flows from the new Delhi redevelopment appear to be within the available capacity limits and would not trigger any reserve capacity upgrade.

Integrated Sustainable Master Plan

- The County of Norfolk's 2016 Integrated Sustainable Master Plan (ISMP) identifies the projected water and wastewater servicing requirement for Delhi based on the growth in the residential population that was expected to occur between 2021 and 2041. The ISMP omits the need to service the redevelopment of 150 hectares of employment (commercial) lands in Delhi that is projected to occur over that same period.
- The County has acknowledged that the ISMP will be updated to reflect the latest information from the servicing capacity report once it is released in 2023.
- Once the updated ISMP is available and the Delhi redevelopment project technical work continues to advance, additional impact cross-checks can be completed.

Design Criteria

- Revised design criteria (versus what was identified in the County of Norfolk ISMP) have been used to project the water and wastewater servicing needs for the Delhi redevelopment. See Section 3.1 and 5.1.
- Reviews information from the Information Memo – Servicing Monitoring Report – Water and Wastewater EIS-22-077 released on Sept 20, 2022 that identifies the historical water and wastewater demands and remaining reserve capacities for water and wastewater.

Wastewater Servicing

- The north portion of the Delhi redevelopment would be serviced by gravity sewers conveying flow to the existing St. Michael sewage pumping station (SPS) sanitary drainage area. It is expected that the north portion of the redevelopment would produce a peak wet weather flow of 6 L/s.
- The southern portion of the redevelopment would be serviced by new gravity sewers draining to a new SPS located at the southwest corner of the Delhi redevelopment. The new SPS would require a 200 mm diameter force main to convey flows (approximately 36 L/s) into the sanitary drainage area of the Main Street SPS.
- As technical work continues, a hydraulic modelling exercise will confirm the operational requirements of increased flows to the receiving sanitary sewers, the new SPS, and the Delhi wastewater treatment facility (WWTF).

Water Servicing

- The Delhi redevelopment would require a water main connection along Wilson Avenue, where an existing 300 mm diameter water main is installed. A new 300 mm diameter water main connection would extend throughout the redevelopment and loop back along James Street (Highway 3).
- Based on preliminary design calculations, the new residential streets within the redevelopment would require a 300 mm diameter water main to provide sufficient levels of service, in accordance with the Ontario Ministry of the Environment, Conservation, and Parks (MECP) guidelines.
- The average water daily demand for the redevelopment will be approximately 597 m^3/day, with a maximum daily demand of 1,267 m^3/day. It is expected that the peak hour flow demand will be approximately 20.7 L/s.
- The fire flows based on the proposed building types, private condo block (worst case), will require 200 L/s based on the Fire Underwriters Survey (FUS). It appears that fire flows can be provided to the Delhi redevelopment exceeding 200 L/s, based on fire hydrant testing completed on Wilson Avenue.
- The existing standpipe within Delhi has a total storage volume of 3,955 m^3 and a useable storage volume of 947 m^3 when using a fire storage requirement of 159 L/s for a duration of 3 hours. The ISMP identified the need to construct a booster pumping station (BPS) in 2025 to provide fire flows for 159 L/s. The BPS would convert the total storage volume within the standpipe into useable storage.
- With the proposed Delhi redevelopment, a review of the water storage capacity within the Delhi standpipe would be required. Also, the BPS would need to be designed to provide maximum day demands and a larger fire flow due to the increased overall population of Delhi. Based on the MECP design guidelines this storage volume would need to be increased to accommodate a fire storage requirement of 189 L/s for a duration of 3 hours.
- It is assumed that the fire flows can be supplemented by the Delhi wells, as the firm capacity of the wells exceed the total water demands of the current Delhi/Courtland population, pending development applications and the Delhi redevelopment.
- The excess well capacity of 17 L/s would reduce the water storage requirement within the Delhi standpipe to 172 L/s for a duration of 3 hours.
- Based on a fire flow of 172 L/s at a duration of 3 hours, approximately 96% of the available storage capacity within the tank would be required. As such, the existing standpipe appears to have sufficient capacity to service Delhi including the Delhi redevelopment.
- As future planning proceeds via the inter urban water supply program, an overall review of fire flows and storage requirements for Delhi will be needed to be discussed with the County of Norfolk.

2 INTRODUCTION

T.Y. Lin International (TYLin) has been retained by Delhi Redevelopment Inc. c/o Geranium ('owners', 'owner') to prepare a servicing study technical memorandum for the redevelopment of the Delhi Golf & Country Club located in the former Township of Delhi in Norfolk County. This technical memorandum sets out the anticipated servicing requirements for the proposed redevelopment of the Delhi Golf & Country Club lands as part of the urban boundary expansion.

The site plan (Figure 2-1) proposes a redevelopment of the Delhi Golf & Country Club with residential properties and a retirement home. The area for redevelopment has an approximate area of 55.32 ha, where 29.73 ha of the land is considered developable. The current draft plan will house a new 874-unit redevelopment comprising 604 townhouses and lots of varying sizes, including 57 thirty-foot lots, 50 thirty-six-foot lots, 10 forty-four-foot lots, 3 sixty-foot lots and 150 retirement units. The proposed site plan may evolve as the overall redevelopment moves through the design process and environmental constraints are confirmed with the Conservation Authority.

The proposed servicing plan (Figure 2-2) will include a new SPS and force main that is expected to service the southern portion of the provincially significant wetland (PSW) and ultimately discharge to the Delhi WWTF. A proposed northern portion of the PSW will be serviced via the existing gravity sanitary sewers located along Wilson Avenue and St. Michael's Street.

It is proposed that the redeveloped site be serviced by a 300 mm diameter water main that will connect to the Delhi water supply at two locations. One municipal water connection location will be along Wilson Avenue at the proposed northeast block of the Delhi redevelopment where a 300 mm diameter water main is currently installed. The second municipal water connection will be at James Street near Tisdale Drive, which will require a water main extension south along James Street from the intersection of Wilson Avenue and James Street to the subject site.

To plan for future growth in Delhi and to comply with the County of Norfolk's growth management requirements, Delhi Redevelopment Inc. will work with the County to determine the operational requirements and determine preferred solutions for providing water and wastewater servicing for the Delhi redevelopment.

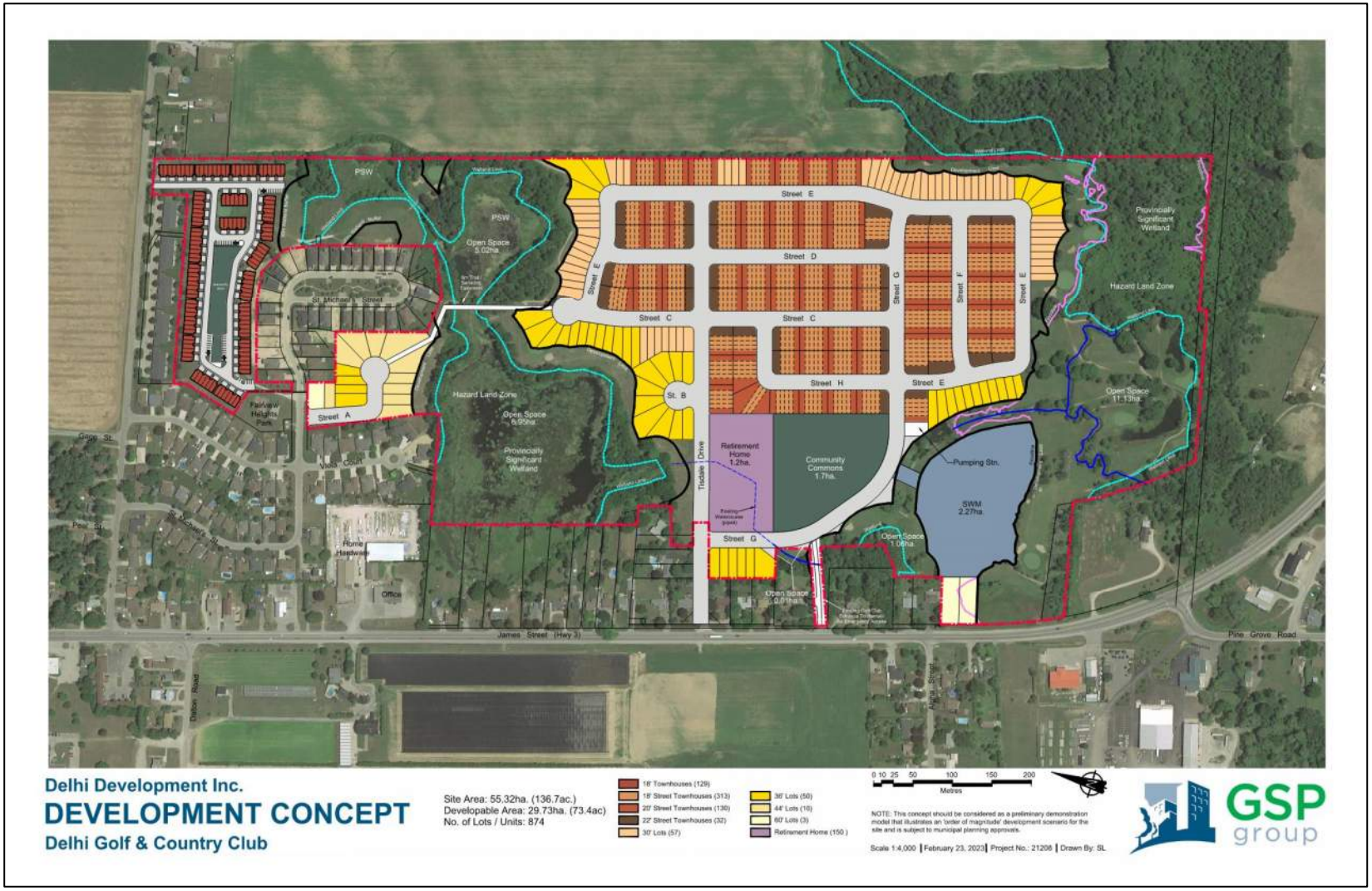
2.1 Purpose

This servicing study identifies the water and wastewater servicing options for the Delhi redevelopment.

R.J. Burnside will be developing a functional servicing report to identify the preferred means of providing water, wastewater servicing, stormwater management, stormwater drainage, and transportation planning for the proposed redevelopment, in accordance with the County's current official plan and adopted.

The final servicing concept will be confirmed as solutions are confirmed and the required technical work is completed.

Figure 2-1: Delhi Redevelopment Concept Completed by GSP Group



PSW = provincially significant wetland; SWM = stormwater management.

Figure 2-2: Water and Wastewater Servicing Concept for the Proposed Delhi Redevelopment

Delhi WWTF has a current rated capacity of 3,182 m³/day

Confirm if Delhi WWTF has available capacity to receive added flows from proposed Delhi Golf & Country Club redevelopment.

Hydraulic Modelling required to assess capacity of existing gravity mains, pump stations and forcemains upstream of alternative discharge locations.

Trenchless crossing required for traintracks. (Discharge Alternative #3 only)

PS6 - Main Street has a current firm capacity of 45 L/s

Discharge Alternative #3

Manhole, T/G = 232 m. Inverts and depths to be confirmed in detailed design.

Discharge Alternative #2

Main Street PS (PS6), T/G = 231 m. Inverts and depths to be confirmed in detailed design.

Reduce Impacts of construction along Main Street for Alternatives 2 and 3.

Discharge Alternative #1

Manhole, T/G = 230 m. Inverts and depths to be confirmed in detailed design.

Delhi Standpipe

Delhi Standpipe that has a total storage volume of 3,955 m³ and a useful storage volume of 947 m³

Source water coming from the Delhi Municipal Well Field located at intersection of Windham Rd 14 and Windham West Quarter Line Rd

300 mm watermain connection to existing

Wilson Ave.

200 mm HDPE Forcemain recommended, DR rating to be confirmed. Minimum proposed Length of 2640 m.

Existing St Michaels SPS (PS4) discharges into the existing sanitary sewer and capacities will need to be confirmed with RJ Burnside.

300 mm watermain looping through Delhi Golf & Country Club redevelopment. Use 6 m trail/servicing easement as a utility corridor.

Updated Delhi Golf & Country Club redevelopment concept plan.

Transient Analysis is recommended due to downhill pumping.

High point of Forcemain profile.

MTO Corridor

James St. (Highway 3)

Extension of 300 mm watermain from Wilson Ave. to Tisdale Drive.

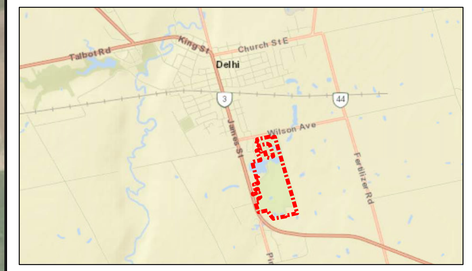
Proposed Delhi PS rated at 36 L/s. Current T/G elevation of site is 226 m, possible regrading by development to be confirmed and assessed in detailed design.

Confirmation with Long Point Region Authority (LPRA) on flood levels required as part of detailed design.

Regulatory flood datum would dictate minimum sub grade structure elevation.

N

TYLin



LEGEND

- POINTS OF INTEREST
- PROPOSED FORCEMAIN
- EXISTING FORCEMAIN
- PROPOSED SANITARY SEWER
- EXISTING MAIN STREET SPS (PS6)
- PROPOSED SEWAGE PUMP STATION
- DELHI WWTF
- EXISTING ST MICHAELS SPS (PS4)
- EXISTING SANITARY MANHOLE
- EXISTING STANDPIPE
- PROPOSED 300 mm WATERMAIN
- EXISTING 200 mm WATERMAIN
- EXISTING 300 mm WATERMAIN
- RAILROAD TRACKS

0 0.125 0.25 0.5 0.75 1 Kilometers

PROJECT NUMBER: 10478

DELHI GOLF & COUNTRY CLUB REDEVELOPMENT

GERANIUM
From the ground up™

Norfolk COUNTY

FIGURE 2-2

WATER AND WASTEWATER SERVICING OF DELHI GOLF & COUNTRY CLUB REDEVEOPMENT

DRAWN BY: RR	DATE: MARCH 2023
CHECKED BY: ML	

3 INTERNAL SANITARY SERVICING

3.1 Design Criteria

The design criteria that apply to this redevelopment were obtained from discussions (May 2022) with the County of Norfolk and in accordance with MECP design guidelines.

The residential redevelopment average per-capital flow was recently updated in the Information Memo – Servicing Monitoring Report – Water and Wastewater EIS-22-077 dated September 20, 2022.

Table 3-1: Design Criteria

Criteria	Value	Source
Site area (gross)	55.32 ha	Delhi Development Inc. Homes Development Concept, dated December 16, 2022 – Figure 2-1
Residential development population density	2.75 persons per lot	ISMP, Figure 4-54 – Norfolk County Sanitary Design Criteria
Retirement home development population density	1.70 persons per lot	As per discussion with RJ Burnside
Residential development average per-capita flow	239 LPCD	Information Memo – Servicing Monitoring Report – Water and Wastewater EIS-22-077 (2022)
Retirement home development average per-capita flow	266 LPCD	As per discussion with RJ Burnside
Residential area peak hour factor	3.7	Harmon peaking factor formula
Infiltration allowance	0.26 L/s/ha	Discussed with County of Norfolk (May 2022)
Peak instantaneous factor	1.5	MECP guidelines (2008)

LPCD = litres per capita per day; MECP = Ontario Ministry of the Environment, Conservation, and Parks.

Source: County of Norfolk Integrated Sustainable Master Plan and MECP Design Guidelines for Sewage Works 2008.

3.2 Servicing Approach

The Delhi redevelopment will be split into two drainage areas separated by the naturalized area. The sanitary drainage areas completed by R.J. Burnside can be found in Figure 2-2 and Appendix A.

The northern areas are intended to service 144 units along Street A and the block of townhomes by connecting to the existing gravity sewers that drain to the St. Michael's Street SPS. The south area is intended to discharge to a new Delhi SPS. These service areas are further described in the following sections of this technical memorandum.

A sanitary sewer design sheet will be completed by R.J. Burnside to establish the final design flows that will be serviced either by gravity sewers or the new Delhi SPS.

The current design flows noted within this technical memorandum are preliminary flow estimates.

3.3 Gravity Sewer Servicing

The gravity sewer design servicing the north area of the redevelopment would be coordinated with the depths of the existing sewers along Wilson Avenue, St. Michael's Street, and Viola Court. A review of the as-built drawings of the existing sewer system shown in Figure 3-1 will establish a suitable tie-in point within the existing development.

A request for as-built drawings and geographic information system (GIS) data for this area has been made to the County of Norfolk A subsurface utility investigation and topographic survey can also be carried out to confirm the sanitary sewer sizes and invert elevations for the proposed tie-in points.

A hydraulic analysis will confirm the receiving sewers and St. Michael's Street SPS operational requirements. The County has requested that the modelling analysis be completed by the County's consulting engineer.

Table 3-2: Sanitary Design Flows from Drainage Areas SAN1 and SAN2

Criteria	Area SAN1	Area SAN2
Average daily flow	85 m^3/d	10 m^3/d
Peak hour dry weather flow	302 m^3/d	36 m^3/d
Infiltration flow rate	83 m^3/d	32 m^3/d
Peak hour wet weather flow	385 m^3/d (~5 L/s)	68 m^3/d (~1 L/s)

Figure 3-1: Existing Sanitary Sewer Network

Source: Image taken from County of Norfolk website (arcgis.com).

3.4 Sewage Pumping Station Servicing

3.4.1 Design Flow

A new Delhi SPS will need to be constructed to service the south block of the Delhi redevelopment. A preliminary SPS design flow has been calculated and is noted in Table 3-3.

The design flow calculations can be found in Appendix B.

Table 3-3: Sewage Pumping Station Design Flows

Criteria	Value
Average daily flow(1)	450 m^3/d
Peak dry weather flow	1,597 m^3/d
Infiltration flowrate	710 m^3/d
Peak wet weather flow	28 L/s
Peak instantaneous flow(2)	36 L/s

Notes:
(1) Assumes 730 units.
(2) Peak instantaneous flow is the criteria used to size pumping station requirements in accordance with MECP design guidelines. Pump station can be sized for peak wet weather flow (hourly) as opposed to peak instantaneous flow if sufficient emergency storage is provided within the wet well to buffer a peak instantaneous flow rate.

3.4.2 SPS Design Guidelines

The required features for an SPS are typically identified within the municipality's design guidelines. In discussions with Norfolk County, it was ascertained that no SPS design guidelines are available. Therefore, for this servicing study, the SPS design features will be developed in accordance with MECP design guidelines and previously constructed pump stations within Delhi.

As such, the following design features are proposed:

- An upstream sanitary maintenance hole that will house an isolation valve.
- A subgrade concrete wet well with required emergency storage volume (approximately 1 hour of storage)[1] that will house a trash screen and pumps (duty and standby), controls (floats and level transmitter), and discharge piping.
- A separate subgrade valve chamber that will house all the valving and instrumentation.
- A control building that will house the electrical equipment and controls (e.g., motor control centres, automatic transfer switch) as opposed to an outdoor control panel.
- An outdoor emergency standby generator (fuel type to be confirmed based on availability).
- An odour control unit.

3.5 Force Main

3.5.1 Sizing

The force main pipe sizes shown in comply with MECP design guidelines, which recommend that the flow velocity within a force main range from 0.6 m/s to 2.0 m/s. A 200 mm diameter force main is recommended, as it will allow for a velocity of 1.15 m/s which is within the recommended range.

Also, the 200 mm diameter pipe size will provide future flexibility for the County of Norfolk to accommodate any growth that may occur within the surrounding area.

[1] TYLin will review the new sanitary sewer capacities to evaluate the emergency storage volume necessary for the system when compared with the lowest sanitary basement servicing elevation.

3.5.1 Horizontal Alignment

The preferred horizontal alignment for the force mains is identified in Figure 2-2. This alignment (alternative 1) was identified by Burnside for wastewater servicing.

Approval from the Ministry of Transportation (MTO) will be required to confirm the permitting and technical requirements of constructing a 300 mm watermain and forcemain required along James Street (Hwy 3) to service the Delhi redevelopment.

A hydraulic analysis will need to be completed by the County of Norfolk to confirm the operational requirements of the existing sanitary system. This analysis will identify system constraints and the infrastructure upgrades required to accommodate the Delhi redevelopment.

TYLin proposes to review two additional force main discharge locations aimed at minimizing upgrades to existing infrastructure.

- Alternative 1 (Figure 2-2) will discharge sewage into a maintenance hole in Delhi at the intersection of Main Street and First Avenue which, in turn, will drain sewage by gravity to the Main Street SPS (noted as the preferred alternative). This alternative will be preferred if:
    - The existing sanitary sewers that receive sewage from the Delhi development will not require upsizing.
    - The existing force main can be reused.
    - A key advantage of alternative 1 is that upgrades to the Main Street SPS will be needed to support the 2041 growth, as indicated in the ISMP, independent of the Delhi redevelopment. As such, upgrade work for the Main Street SPS should be coordinated with the sanitary servicing requirements for the Delhi redevelopment.
- Alternative 2 (Figure 2-2) will discharge sewage directly to Main Street SPS. This alternative will be preferred if:
    - Upgrades to the existing sanitary sewer system are required.
    - The existing force main can be reused.
    - A key advantage of alternative 2 is that upgrades to the Main Street SPS will be needed to support the forecast growth for 2041, as indicated in the ISMP, independent of the Delhi redevelopment. As such, upgrade work for the Main Street SPS should be coordinated with the sanitary servicing requirements for the Delhi redevelopment.
- Alternative 3 (Figure 2-2) will discharge sewage into the maintenance hole downstream of the Main Street SPS, which then drains sewage by gravity to the Delhi WWTF. Currently, the Main Street SPS also discharges to this maintenance hole. This alternative will be preferred if:
    - Upgrades to the existing sanitary sewer system are required.
    - Replacement of the Main Street SPS is required. The force main size requires replacement to accommodate an increased design flow.
    - A key advantage of alternative 3 is that a second force main crossing the railway would be available that could be used as a backup if Main Street SPS force main fails. Thus, the County could, via real-time control, coordinate the pump starts and stops at the existing Main Street SPS with the Delhi SPS as a secondary means to pump sewage across the railway when the existing force main is not available. This alternative would provide the County with a redundant force main across the railway crossing and increase the reliability of the operation of the Main Street SPS.

A secondary horizontal alternative may also be considered once the hydraulic analysis of the County sanitary sewer system is completed.

3.5.2 Vertical Alignment

The current force main alignment and general profile, based on topographic information extracted from Google Earth, are identified in Figure 3-2.

A transient analysis is recommended for the selected preferred alternative. The hydraulic transient analysis will assess the transients that may result if a system high point is located along the midpoint of the alignment. This analysis will provide recommendations for the preferred design at the discharge location and the vertical alignment of the preferred horizontal alignment (e.g., install an upstream pressuring sustaining valve at the discharge maintenance hole, and raise the discharge location) to prevent a vacuum or siphoning effect for the force main from occurring during pump cycles.

Alternatively, a deeper force main can be constructed along the high point to limit the severity of the hydraulic transients.

Figure 3-2: Vertical Profile Alternatives of the Proposed Force Main Alignment Using Google Earth

4 EXTERNAL SANITARY SERVICING

4.1 Existing Sanitary Collection System

4.1.1 Overview

The existing sanitary system servicing Delhi comprises a gravity sewer system and four SPSs that collect flow and convey sewage to the Delhi WWTF.

The alignment of the Delhi redevelopment force main is intended to enable discharge into the Delhi gravity sanitary sewer systems upstream of the Main Street SPS.

The portion of the Delhi redevelopment that is serviced by gravity sewers will be conveyed to the St. Michael's SPS.

These two SPSs, the downstream gravity sewers, and the Delhi WWTF will be assessed to confirm the operational requirements for accepting flows from the Delhi redevelopment.

4.1.2 Sanitary Sewer Network

Any sewers that will accept sanitary flows from the Delhi redevelopment will need to be reviewed by hydraulic analysis to confirm capacity and any surcharging conditions. This exercise will confirm the constraints and infrastructure upgrades needed as a result of the Delhi redevelopment.

4.1.3 Sewage Pumping Stations

4.1.3.1 St. Michael's SPS

The St. Michael's SPS is located at approximately 68 St. Michael's Street (Figure 4-1). This SPS consists of a wet well, above-ground control panel, and an emergency standby generator. The firm capacity for this SPS is 14 L/s, with a total capacity of 20 L/s, based on the County of Norfolk's ISMP.

The St. Michael's SPS will be reviewed to confirm it can accommodate an approximate 6 L/s peak wet weather flow from the Delhi redevelopment.

The St. Michael's SPS pumps flow through a force main to a gravity maintenance hole north of Wilson Avenue that then ultimately drains to the Main Street SPS.

A background review of the sanitary sewer design sheet, design brief, design drawings, incoming flow data, and historical condition assessment information of the facility have been requested. The review of these documents will confirm whether the SPS can accommodate the additional flows from the Delhi redevelopment or if upgrades are required.

Figure 4-1: St. Michael's Sewage Pumping Station from Google Earth

4.1.3.2 Main Street Sewage Pumping Station

The Main Street SPS is located at approximately 445 Main Street South (Figure 4-2). This SPS consists of a wet well (5 m long × 5 m wide × 8 m deep), an above-grade control panel, and an emergency standby generator. This SPS pumps through a 200 mm diameter sanitary sewer force main. The firm capacity for this SPS is 45 L/s based on the County of Norfolk's ISMP. It will need to be upgraded to satisfy the 2041 predicted peak flow of 62 L/s for Delhi future growth.

The Main Street SPS will need to be reviewed to confirm whether the SPS can accommodate an increased peak instantaneous flow of approximately 36 L/s from the new Delhi SPS.

The Environmental Compliance Approval (ECA) for the Main Street SPS can be found in Appendix C.

A background review of the design brief, design drawings, incoming flow data, and a historical condition assessment of the facility have been requested.

The review of these documents will assist in confirming the operational upgrades that may be required to accommodate the additional design flow required for the Delhi redevelopment. A condition assessment should be completed to confirm the working condition of the SPS.

Figure 4-2: Main Street Pump Station from Google Earth

4.2 Existing Sewage Treatment Plant

4.2.1 Delhi Wastewater Treatment Facility

The Delhi WWTF has a rated capacity of 3,182 m^3/day (37 L/s). It treats sanitary sewage and disposes of effluent to Big Creek. The plant treats all wastewater generated within Delhi. The plant is designed to handle a peak flow of 92 L/s, as noted within amended ECA 5168-AHCJ3G.

The ECA for the Delhi WWTF can be found in Appendix C (MECP, 2017).

Figure 4-3: Image of the Delhi WWTF from the R.V. Anderson Facebook Page

4.2.2 Annual Wastewater Treatment System Summary Reports

A summary of the Delhi WWTF average daily flow, maximum daily flow, and process upset conditions can be found in the table below.

Table 4-1: Delhi Wastewater Treatment Facility Annual Wastewater Treatment System Reports

Year	Average Daily Flow (m^3/day)	Maximum Daily Flow (m^3/day)	Process Upsets (Operational Upsets and Bypasses, Effluent Exceedances)[1]
2018	1,239	2,019	▪ The effluent criteria objectives and limits outlined in the ECA, specifically, total phosphorus, are not achievable. The MECP was notified and indicated its willingness to open up the criteria for review upon the filing of an amendment application by the County (currently under review). ▪ The maximum daily peak flow was recorded at 2,018.93 m^3/d, which occurred on October 6 during a heavy rain event. ▪ There was a small plant bypass of 31 m^3 that occurred on June 18 during an intense thunderstorm. This caused a temporary surge in the incoming flow that exceeded the design flow limit of the headworks. This was reported to the MECP's Spills Action Centre. ▪ There were some minor process upsets encountered in 2018 due to the processing of vegetables by a local business during the fall months, which increased organic loading. At the same time, process-tankage availability was limited to accommodate the construction of the new tertiary treatment building; however, effluent compliance was still met. ▪ Odour complaints were made by a neighbour of the treatment plant throughout 2018; these were found by operations staff and MECP staff to be unsubstantiated. The MECP installed a wind-monitoring station on the roof of the headworks building to correlate the odour complaints with the current wind speed and direction at the time of the complaints.
2019	1,343	2,085	▪ In 2019, the review remained pending and the Delhi WWTP performed well, with no operational issues, and the effluent criteria were well within the interim ECA compliance criteria. ▪ There were some minor process upsets encountered in 2019 due to the processing of vegetables by a local business during the late summer and fall months. This activity led to increased organic loading, but effluent compliance was still met. ▪ Odour complaints remained.
2020	1,316	1,936	▪ The County and Veolia Water Canada, along with the facility's design engineering firm, R.V. Anderson, met with the MECP in January to discuss the pending application to amend the ECA to increase the total phosphorus objective and change the limits for some concentration settings. ▪ The maximum daily peak flow was recorded at 1,936 m^3/d. This occurred on May 5 as a result of heavy precipitation. ▪ There were some minor process upsets encountered in 2020 in the spring and fall due to incoming wastewater strengths increasing rapidly and then quickly dropping down. This short-term increase was attributed to industrial contributors to the collection system. ▪ Odour complaints remained.
2021	1,219	NA	▪ 1,000 metres of sanitary sewer main was replaced to help reduce infiltration that could contribute to bypass and/or overflows. ▪ There were no bypasses or spills at the Delhi WWTP in 2021. ▪ An odour control system was put in place to abate the emission of foul odours; however, odour complaints remained.

ECA = Environmental Compliance Approval; MECP = Ontario Ministry of the Environment, Conservation, and Parks; NA = not applicable; WWTP = wastewater treatment plant.

[1] Source: Annual Wastewater Treatment System Report (Veolia Water/Norfolk County, 2020).

The key findings from the annual wastewater treatment reports are as follows:

- Although the Delhi WWTF plant upgrades completed in 2017 comply with the interim ECA requirements regarding total phosphorous removal, they do not meet the final ECA requirements. A yearly review by the County and MECP is being undertaken to amend the ECA to accommodate a revised phosphorous removal requirement.
- Between 2018 and 2021, the average daily flows operated at around 40% (1,300 m^3/day) of the plant's rated capacity.
- The maximum daily flow operated well within the plant peak flow capacity between 2018 to 2020. The maximum daily flow was not provided in the 2021 report.
- A plant bypass occurred on June 18, 2018, where 31 m^3 of flow during a severe thunderstorm.
- Industrial contributor's wastewater discharge creates process upsets during the spring and fall.
- Ongoing odour complaints between 2018 to 2021. In 2021, an odour control system was provided to abate the emission of foul odours.

A hydraulic and process review of the plant is recommended to determine the source of the odour, as this appears to be a reoccurring issue with the plant.

5 WATER SERVICING

5.1 Design Criteria

The design criteria used to project the water servicing requirements for the Delhi redevelopment were obtained from the MECP design guidelines, ISMP and the Information Memo – Servicing Monitoring Report for Water and Wastewater EIS 22-077.

Table 5-1: Water System Design Criteria

Criteria	Value	Source
Number of lots	874	Delhi Development Inc. Homes Development Concept, dated February 10, 2023 – Figure 2-1
Number of residential lots	724	Delhi Development Inc. Homes Development Concept, dated February 10, 2023 – Figure 2-1
Number of retirement home lots	150	Delhi Development Inc. Homes Development Concept, dated February 10, 2023 – Figure 2-1
Population density per lot (residential)	2.75	ISMP, Figure 4-54 – Norfolk County Sanitary Design Criteria
Population density per lot (retirement home)	1.70	
Residential population	1991	Calculated
Retirement home population	255	
Delhi redevelopment population (1)	2,246	
Residential Litres per capita per day	266	Information Memo – Servicing Monitoring Report for Water and Wastewater EIS 22-077(Sept 2022)
Maximum day factor	2.12	
Retirement Home Litres per capita per day	266	As per discussion with R.J. Burnside
Peak hour factor	3	MECP 2008 water design guidelines (included in County of Norfolk's 2016 ISMP)
Fire duration	3	
Design fire-flow requirement (2)	189	MECP water design guidelines (2008)
Delhi redevelopment design fire-flow requirement	200	As per Fire Underwriters Survey (FUS) completed by R.J. Burnside
Delhi Well Supply - Firm capacity (m^3/day)	6,894	Information Memo – Servicing Monitoring Report for Water and Wastewater EIS 22-077(Sept 2022)
Delhi Well Supply - Firm capacity (L/s)	79.8	Information Memo – Servicing Monitoring Report for Water and Wastewater EIS 22-077(Sept 2022)
Excess capacity (m^3/day) (3)	1,501	Calculated
Excess capacity (L/s)	17	Calculated

ISMP = Integrated Sustainable Master Plan; MECP = Ontario Ministry of the Environment, Conservation, and Parks; NA = not applicable.

Notes:

(1) Delhi redevelopment population = Number of lots × population density.

(2) The fire duration and design fire-flow requirements are based on the Delhi population forecast for 2041 plus the population of the Delhi redevelopment (for a total population of 6,795). The addition of the Delhi redevelopment would increase the design fire-flow requirement from 159 L/s to 189 L/s for the same fire duration.

(3) Excess well capacity = Delhi well firm capacity – max day demand [existing Delhi/Courtland (3,722 m^3/day) + Committed/Pending Applications (404 m^3/day) + Delhi redevelopment (1,267 m^3/day)]

5.2 Water Demand and Supply

5.2.1 Daily Water Demands

The projected daily water demands that must be met to service the Delhi redevelopment are summarized below.

Table 5-2: Projected Water Demands for Delhi redevelopment

Development Type	Average Water Demand		Maximum Daily Flow		Peak Hour (L/s)
	m^3/day	L/s	m^3/day	L/s	
Residential	530	6.1	1,123	13.0	18.4
Retirement Home	68	0.8	144	1.7	2.4
Total	597	6.9	1,267	14.7	20.7

Based on the Servicing Monitoring Report – Water and Wastewater EIS 22-07, the average daily demand within Delhi/Courtland is 1,756 m^3/day, with a maximum day demand of 3,722 m^3/day and a current servicing level upgrade capacity of 5,870 m^3/day (85% of Existing Firm Capacity 6,894 m^3/day). The report also identifies that there is 2,768 m^3/day capacity beyond the committed developments and pending developments within the County for Delhi/Courtland. Based on the additional water demands noted in Table 5-2, the Delhi redevelopment could be serviced by the existing water supply without triggering any servicing level upgrades.

5.2.2 Fire Flows

Based on the FUS calculations, the proposed building type, private condo block, within the Delhi redevelopment would require a fire flow of 200 L/s. Fire hydrant testing was completed which identified a theoretical flow that exceeded 200 L/s along Wilson Avenue. A hydraulic modelling exercise should be completed to review sufficient fire flows can be provided to Delhi and the proposed Delhi redevelopment. The supporting FUS calculations and fire flow testing results can be found in Appendix B.

5.3 Water Storage

Storage capacity is based on the requirement to meet water demands that exceed the capacity of the available water supply and to satisfy fire-flow demands. The storage requirements for Delhi and Courtland is determined using the following formula from the MECP guidelines (MECP, 2008):

$$Storage = A + B + C$$

Where:

A = Fire storage. Fire storage is the product of the fire flow and fire duration based on FUS requirements.

B = Equalization storage = 25% of maximum daily demand.

C = Emergency storage = 25% of (A + B).

Delhi requires 854 m^3 of equalization storage, 1,717 m^3 of fire storage, and 643 m^3 of emergency storage within the existing standpipe based on a population of 5,344 people (Source: 2021 population census). The existing usable storage volume within the Delhi standpipe is 947 m^3. A BPS was recommended in the ISMP to provide fire flows in accordance with MECP design guidelines (MECP, 2008). The BPS would convert the total storage volume, 3,955 m^3, within the standpipe into useable storage volume.

Including the Delhi redevelopment, an additional 317 m^3 of equalization storage volume would be required within the standpipe. The fire storage would need to be increased by an additional 140 m^3 and an emergency storage volume of 114 m^3 for a total additional storage volume of 571 m^3.

Due to the excess capacity of the Delhi well supply, a reduction in the fire flow requirement can be considered. The revised fire flow would equal to 172 L/s (189 L/s – 17 L/s) for evaluating the storage requirements within the Delhi standpipe.

The total usable storage required to service the current population of Delhi and the Delhi redevelopment would be 3,786 m^3 with the addition of a BPS that includes pumps sized for max day demand and fire flows.

Further discussion with the County is required to identify the servicing level upgrade requirements, if any, related to the storage volume within the Delhi standpipe to service the Delhi redevelopment.

5.4 Water Main Network

The water servicing for the Delhi redevelopment will be provided by connecting to an existing 300 mm diameter water main along Wilson Avenue. A proposed water main extension along James Street to Tisdale Drive would also be required. This water main extension would provide a second connection point to the proposed redevelopment from the municipal water supply.

This water main would extend south to Tisdale Drive (Figure 2-2). A 300 mm diameter water main would be installed within the redevelopment, connecting Wilson Avenue and James Street, to provide the primary water-supply loop for the Delhi redevelopment. The 300 mm diameter water main is proposed to connect the north and south redevelopment areas within the limits of the proposed recreational trail to minimize the impacts on the naturalized area.

Local 150 mm diameter water mains branched off the proposed 300 mm diameter water main will be required to service local roads within the Delhi redevelopment.

A hydraulic modelling exercise to assess the increased water demand will be completed for the existing water-distribution system as a result of the Delhi redevelopment. The County has requested that all hydraulic modelling be completed by the County's consulting engineer.

5.5 Level of Service

The water-system evaluation involves assessing the system performance under various demand scenarios. The water-distribution system is required to operate within pressures of 345 kPa (50 psi) to 552 kPa (80 psi) under normal operating conditions (average day and maximum daily demands), and a slightly expanded pressure range of 275 kPa (40 psi) during peak hour demands. A minimum of 140 kPa (20 psi) is required under the maximum daily demand plus fire-flow condition.

Preliminary calculations were completed by R.J. Burnside (Appendix B) to assess the anticipated level of service for the Delhi redevelopment based on the current water-distribution system pressure noted within the ISMP.

Based on the calculations, it is estimated that, under normal operating and peak hour demand, the Delhi redevelopment water-system pressures would operate at approximately 340 kPa (approximately 50 psi). During a maximum daily flow plus fire-flow scenario, the system water pressure is expected to operate at approximately 224 kPa (approximately 32 psi).

Additionally, hydrant flow testing will be carried out in the Spring 2023 to confirm the residual system pressure at the proposed 300 mm diameter municipal water main service connection at the nearest hydrant.

5.6 Modelling Scenarios

The following modelling scenarios will be considered as part of the water-distribution system assessment:

- average daily demand
- maximum daily demand
- peak hour demand
- maximum daily demand plus fire flow

The existing modelling scenarios for Delhi can be found in Appendix D. The County has requested that all water modelling for the redevelopment be completed by the County's engineering consultant.

TYLin and R.J. Burnside will coordinate with the County's engineering consultant to assist in providing design information for the Delhi redevelopment for the purposes of completing the modelling exercise.

6 EXTERNAL WATER SERVICING

6.1 Existing Infrastructure

6.1.1 Overview

The Delhi water-system Drinking Water Works Permit (DWWP) (permit 070-201 dated June 4, 2021) notes that the system is currently supplied by four groundwater wells.

The water from each well is pumped and monitored using a magnetic flow meter that measures the flow. Primary treatment is provided via two UV disinfection units, and secondary treatment is provided through the addition of sodium hypochlorite (chlorine) as described on the County of Norfolk website (Norfolk County, n.d.).

The treated water is transported from the four groundwater wells into Delhi via two transmission mains. One of the transmission mains is fairly new (commissioned in 2020).

The water-distribution system also includes a standpipe where treated water is stored to provide a defined level of service (section 5.5) for a portion of Delhi's daily water demand (Norfolk County, 2021).

A single transmission main also transfers water from Delhi to Courtland where it is stored in the Courtland Reservoir.

6.1.1 Groundwater Wells

Wells 1 and 2 cannot supply the total demand of the system. Both are GUDI wells with in-situ filtration. For each well, the water is drawn by separate vertical turbine pumps, each with a rated capacity of 2,300 m^3/day.

The two new wells (3A and 3B) are non-GUDI and provide necessary redundancy and source security. Water from each well is pumped by a submersible pump; the well 3A pump has a rated capacity of 942 m^3/day, and the pump for well 3B has a rated capacity of 2,264 m^3/day.

DWWP 070-201 lists the rated capacity for the four well pumps, as shown in the table below.

Table 6-1: Rated Capacities for Groundwater Wells

Well Number	Rated Capacity	
	Flow (L/s)	TDH (m)
1	26.7	88.7
2	26.7	88.7
3A	10.9	117.7
3B	26.2	113.7

TDH = total dynamic head.

Note: The total capacity of the four groundwater wells is 7,805 m^3/day. The firm capacity of the four groundwater wells is 6,894 m^3/day.

6.1.2 Standpipe

The water-distribution system includes a 3,955 m^3 standpipe located at 116 Argyle Avenue that acts as a reservoir when the system requires larger amounts of water than the water sources can supply (such as fire flows) and helps to maintain a constant system pressure. The usable storage volume of the tank is 947 m^3, as noted within the DWWP (Appendix C).

The unusable storage volume can be used within Delhi but at reduced pressures compared with what is typically required within MECP level of service guidelines.

6.2 Future System Infrastructure

6.2.1 Booster Pump Station

The ISMP identified the installation of a BPS to provide sufficient water pressure for fire-flow scenarios to support the former Township of Delhi. The construction of the BPS would convert the unusable storage volume to usable storage volume for a total usable storage volume of 3,955 m^3.

The ISMP indicated that the BPS design would include one duty and one standby pump at the base of the standpipe. The ISMP identified that each pump would be sized for a fire flow of 159 L/s at a total dynamic head (TDH) of 45 m, including some reworking of the valves to prevent depressurization of the system during the refilling of the tank following a high-flow event for the existing Delhi water distribution system.

It is anticipated that the construction of the BPS will be completed in 2025.

As additional development proceeds, an overall review of maximum day demands and fire flows in the former Township of Delhi will be needed in order to comply with the MECP guidelines and the ISMP.

7 NEXT STEPS

The next steps are as follows:

1. Expansion of the settlement boundary followed by an amendment to the former Township of Delhi's official plan to establish a secondary plan for the Delhi redevelopment.
2. Confirm the operations requirements of the sanitary collection system receiving sewage flows from the Delhi redevelopment.
3. Confirm the operational requirements for the external water servicing of the Delhi redevelopment.

8 REFERENCES

MECP. (2008). *Design Guidelines for Drinking-Water Systems.* https://www.ontario.ca/document/design-guidelines-drinking-water-systems-0

MECP. (2008). *Design Guidelines for Sewage Works.* https://www.ontario.ca/document/design-guidelines-sewage-works-0

MECP. (2017). *Delhi Wastewater Treatment Facility: Amended Environmental Compliance Approval (5168-AHCJ3G).*

Norfolk County. (2016). *Integrated Sustainable Master Plan (ISMP).* https://www.norfolkcounty.ca/download/government/public_works/The-ISMP.pdf

Norfolk County. (2021). *Final 2022–2031 Capital Plan.* https://www.norfolkcounty.ca/wp-content/uploads/2021/11/Final-2022-2031-Capital-Plan.pdf

Norfolk County. (2021, December 20). *Water Treatment in Norfolk County*. https://www.norfolkcounty.ca/living/roads-water-wastewater/water-treatment/

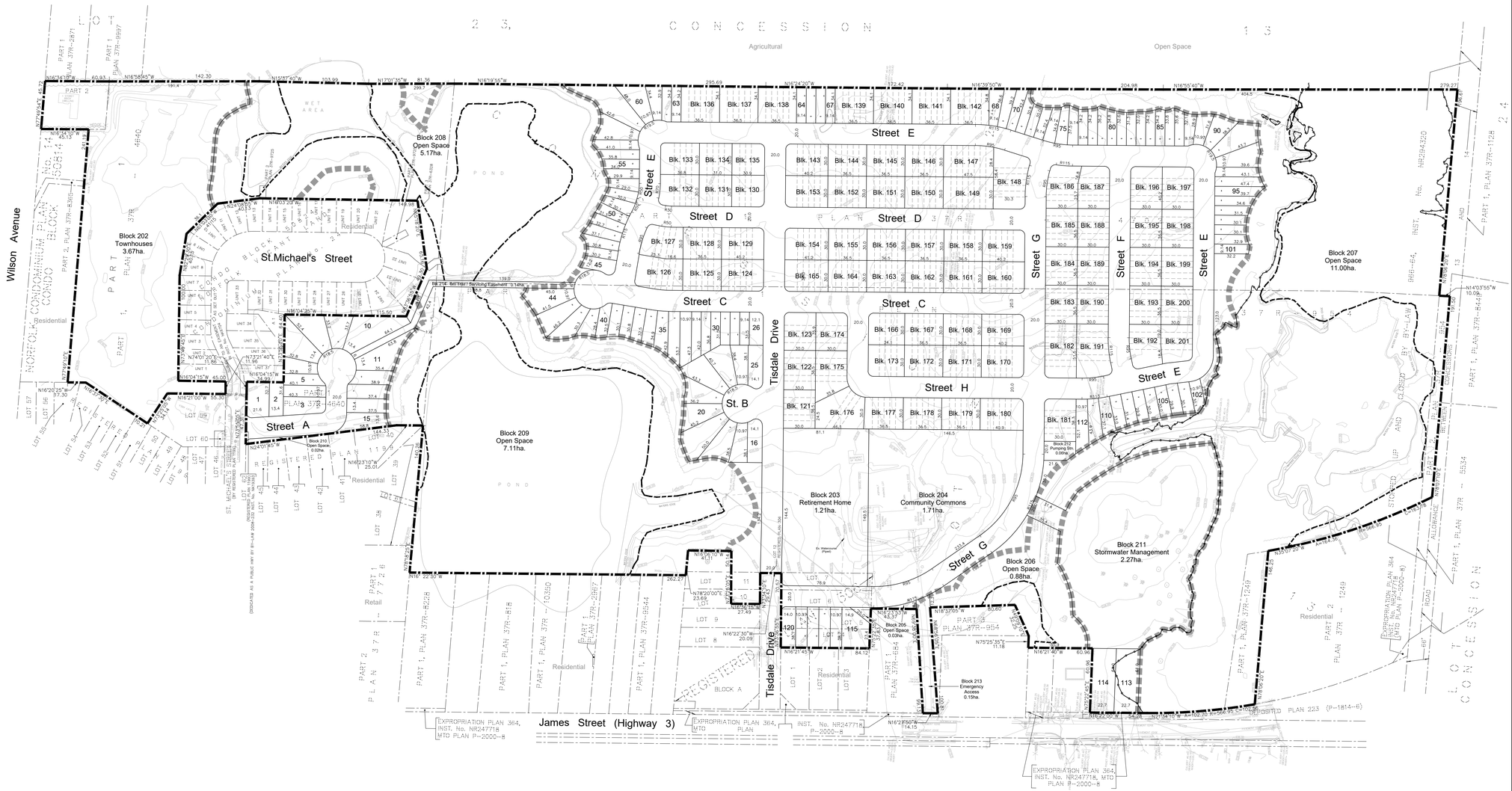
Norfolk County. (n.d.). *Water and Wastewater*. https://www.norfolkcounty.ca/living/roads-water-wastewater/

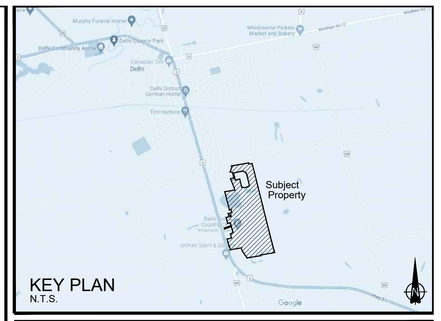
R.V. Anderson Associates Limited. (2018, February 6). *The Delhi Wastewater Treatment Facility project* [post]. Facebook. Retrieved August 2, 2022, from https://www.facebook.com/RVAndersonAssociates/photos/the-delhi-wastewater-treatment-facility-project-delivered-out-of-rvas-london-off/10157417840076164/

Veolia Water/Norfolk County. (2020). *2020 Annual Wastewater Treatment System Summary Report: Delhi Wastewater Treatment Plant.*

APPENDIX A

Drainage Areas (R.J. Burnside, 2022)





DRAFT PLAN OF SUBDIVISION

Lots 4,5,6,7 and 12, Part of Lots 10 and 11,
Registered Plan 306,
Part of Lot 24, Concession 13,
Part of the Road Allowance Between
Concessions 12 and 13,
(STOPPED UP AND CLOSED BY BY-LAW 966-64, INST. No.NR294320)
(GEOGRAPHIC TOWNSHIP OF WINDHAM)
Township of Delhi
County of Norfolk

LAND USE SCHEDULE

DESCRIPTION	LOTS/BLKS.	UNITS	AREA (ha.)
Residential	1-120	120	5.45
Street Townhouses	121-201	475	9.34
Townhouses	202	129	3.67
Retirement Home	203	150	1.21
Community Commons	204		1.71
Open Space	205-210		24.21
Stormwater Management	211		2.27
Pumping Station	212		0.06
Emergency Access	213		0.15
Trail / Servicing Easement	214		0.14
Roads			7.11
TOTAL		874	55.32

LEGEND

- Outermost Constraint Line
- Wetland Boundary
- Floodline

ADDITIONAL INFORMATION

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

INFORMATION REQUIRED BY CLAUSES a,b,c,d,e,f,g,j and l ARE AS SHOWN ON THE DRAFT PLAN.
h) Municipal water supply
i) Silt, sand, sand and gravel, clayey silt, sandy silt, silty sand and silty clay
k) All sanitary and storm sewers as required

OWNER'S CERTIFICATE

I AUTHORIZE THE GSP GROUP INC. TO PREPARE AND SUBMIT THIS DRAFT PLAN OF SUBDIVISION TO NORFOLK COUNTY.

MARIO GIAMPIETRI, ASO
Delhi Land Holdings Limited
January 20, 2023
DATE

SHAWN EVANS, ASO
Delhi Land Holdings Limited
JAN. 20, 2023
DATE

SURVEYOR'S CERTIFICATE

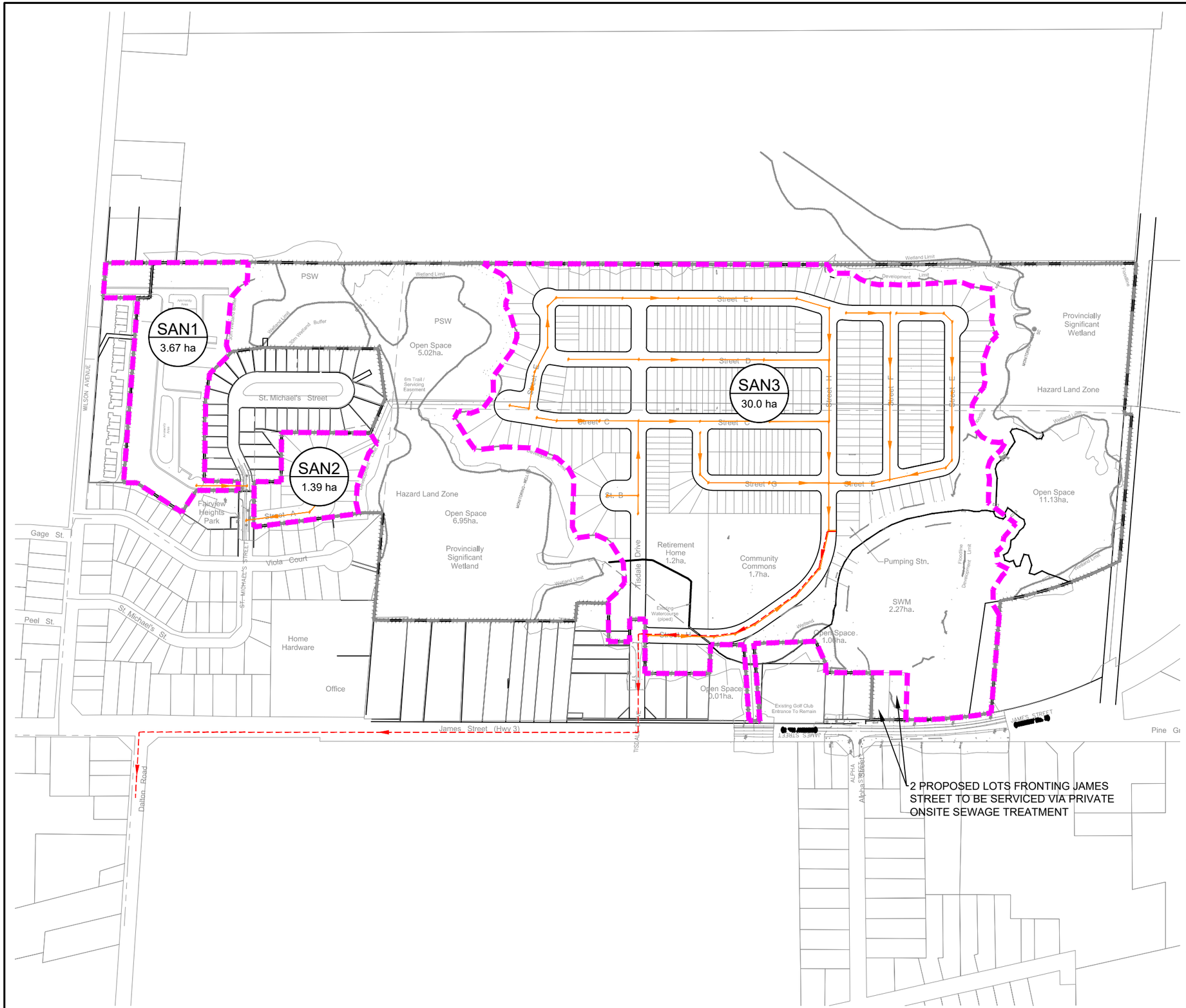
I CERTIFY THAT THE BOUNDARIES OF THE LAND TO BE SUBDIVIDED AND THEIR RELATIONSHIP TO THE ADJACENT LANDS ARE CORRECTLY SHOWN.

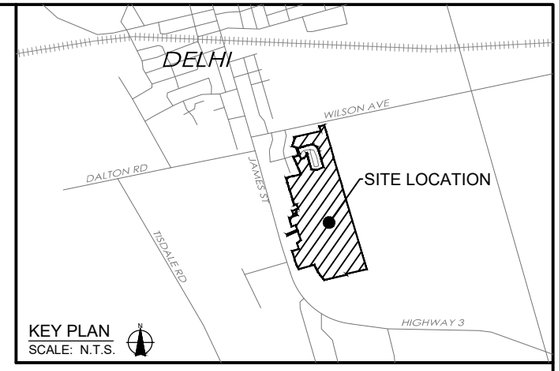
C.P. EDWARD, O.L.S.
R-PE Surveying Ltd.
January 23, 2023
DATE

GSP group
PLANNING I URBAN DESIGN I LANDSCAPE ARCHITECTURE
gspgroup.ca

REVISIONS
March 9, 2023

Date: January 30, 2023	Drawn By: S.L.	Dwg. File Name:dp21208c.dwg
Scale: 1:2,000 metric	Project No.: 21208	





LEGEND

- PROPERTY BOUNDARY
- SANITARY DRAINAGE BOUNDARY
- PROPOSED SANITARY SEWER
- PROPOSED SANITARY FORCEMAIN

SAN1 / 20.0 ha — CATCHMENT No. / CATCHMENT AREA

N

0 50 100 200 300 400

Metres

BURNSIDE

Client

DELHI DEVELOPMENT INC.

Figure Title

DELHI GOLF COURSE

SANITARY DRAINAGE AREA

Drawn	Checked	Date	Figure No.
FR	FG	22/11/16	6
Scale		Project No.	
1:5000		053741.05	

File: \\sherlock\Shared Work Areas\053741 Delhi GC\053741.05 FSR\07_Figures\FSR FIGURES\053741.05 FIG6_SANITARY DRAINAGE.dwg Date Plotted: November 16, 2022 - 9:36 AM

APPENDIX B

Water and Wastewater Calculations

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Water Demand Calculations - Private Condo Block		Date:	23/03/15

I. Fire Flow Calculation

**Based on Fire Underwriters Survey*

Table 8: Simplified Method for One and Two Family Dwellings Exceeding 450 sq.m, and Row Housing Exposure distances

Exposure Distances	Suggested Fire Flow (L/min)	
	Wood Frame	Masonry
< 3m	12000	9000
3 to 10m	8000	8000
10.1 to 30m	6000	6000
> 30m	4000	4000

F = 12,000 L/min
200.00 L/s
F = 3,170 US GPM

Fire Flow Required = 200.00 L/s
Fire Flow Required = 12,000 L/min 3,170 US GPM

II. Domestic Flow Calculations

Type	Quantity	P/Unit	Population
Townhouse	129	2.75	355
Single/Semi Detached	0	2.75	0
Total	129		355

Average Day Demand = 266 L/cap/day
= 1.1 L/s
= 17 US GPM

Max. Daily Demand Peaking Factor = 2.12
Max. Daily Demand = 2.32 L/s
= 37 US GPM

or

Max. Hourly Demand Peaking Factor = 3.00
Max. Hourly Demand = 3.28 L/s
= 52 US GPM

Domestic Flow = 3.28 L/s 52 US GPM

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Water Demand Calculations - Private Condo Block		Date:	23/03/15

Peak Domestic Flow =	**3.28**	**L/s**
Fire Flow =	**200.00**	**L/s**
Max Day Domestic + Fire Demand =	**202.32**	**L/s**
	12138.92	**L/min**

Pressure Loss Calculations

$$h_f = \frac{10.7L}{C^{1.852}D^{4.87}}Q^{1.852}$$

Scenario 1: Peak Domestic Demand (Min. 275 kPa)

Watermain (Section 1)

Length, L =	360	m
C =	150	
Diameter, D =	250	mm
Flow, Q =	3.28	L/s
Velocity, V =	0.07	m/s
Pressure Loss, h_f =	0.01	m
=	0.01	psi
=	0.08	kPa

Pressure at Connection =	420.55	kPa	*from hydrant test results
Total Pressure Loss =	0.08	kPa	
Service Pressure =	**420.48**	**kPa**	> 275 kPa

Scenario 2: Fire Flow + Max Day (Min. 140 kPa)

Watermain (Section 1)

Length, L =	360	m
C =	150	
Diameter, D =	300	mm
Flow, Q =	202.32	L/s
Velocity, V =	2.86	m/s
Pressure Loss, h_f =	6.56	m
=	9.33	psi
=	64.33	kPa

Pressure at Connection =	331.80	kPa	*Calculated Residual Pressure at Wilson Ave Hydrant
Total Pressure Loss =	64.33	kPa	
Service Pressure =	**267.47**	**kPa**	> 140 kPa

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Water Demand Calculations - Private Condo Block		Date:	23/03/15

IV. Flow Test Results - Test 1

** As per fire flow test completed on fire hydrant ID #178 located on Wilson Ave*

Static Pressure = 61 psi
= 42.90 m head

Pressure (psi)	*Pressure (m)*	*Flow (GPM)*	*Flow (L/s)*
59	41.49	1186	74.82
55	38.68	2069	130.53

Pump Head Equation

$Head(m) = A - B(Q^C)$

A =	42.90
B =	0.0004907
C =	1.85

Theoretical Flow @ 20.3 psi = 377 L/s
= 22611 L/min
= 5973 US GPM

Anticipated Residual Pressures

Scenario	Flow (L/s)	Pressure (psi)		
		Estimated	Required	
Peak Domestic	3.3	***61.0***	39.9	** Minimum pressure of 275 kpa (39.9 psi)*
Fire + Max Day	202.3	***48.1***	20.3	** Minimum pressure of 140 kpa (20.3 psi)*

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Water Demand Calculations - South Site		Date:	23/03/15

I. Fire Flow Calculation

**Based on Fire Underwriters Survey*

Row Townhouses

Table 8: Simplified Method for One and Two Family Dwellings Exceeding 450 sq.m, and Row Housing Exposure distances

Exposure Distances	Suggested Fire Flow (L/min) Wood Frame	Masonry
< 3m	12000	9000
3 to 10m	8000	8000
10.1 to 30m	6000	6000
> 30m	4000	4000

F = 12,000.00 L/min
200.00 L/s
F = 3170 US GPM

Retirement Facility

$F = 220\ C\ (A)^{1/2}$

Where F= Fire flow in Lpm
C= construction type coefficient
= 0.6 For fire-resistive construction (fully protected frame, floors, roof)
A = total floor area in sq.m. excluding basements, includes garage*

Floor	Area (sq.m)	%
2nd Floor	3400 m^2	100%
3rd Floor	3400 m^2	25%
1st Floor	3400 m^2	25%

Largest Area = 5,100 sq.m.
F = 9,426.69 L/min

Round to nearest 1000 l/min
F = 9,000 L/min

Occupancy Reduction
15% reduction for limited combustible occupancy
F = 7650 L/min

Sprinkler Reduction
30% Reduction for NFPA Sprinkler System
F = 5355 l/min

Separation Charge		Distance
0%	North	>30m
0%	West	>30m
0%	South	>30m
10%	East	10.1-20m

10% Total Separation Charge 765 L/min
75% MAX Separation Charge

F = 6,000.00 L/min
100.00 L/s
F = 1585 US GPM

Row Townhouse Fire Flow > Retirement Facility Fire Flow, Therefore Fire Flow = 200.00 L/s

Fire Flow Required = 200.00 L/s
Fire Flow Required = 12,000 L/min 3,170 US GPM

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
	Delhi GC Development	Checked by:	FG
	Delhi, ON	Project No:	300053741
	Water Demand Calculations - South Site	Date:	23/03/15

II. Domestic Flow Calculations

Type	Quantity	P/Unit	Population
Retirement Unit	150	1.7	255
Single/Semi Detached	595	2.75	1636
Total	745		1891

Average Day Demand =	266	L/cap/day	
=	5.8	L/s	
=	92	US GPM	
Max. Daily Demand Peaking Factor =	2.12		
Max. Daily Demand =	12.34	L/s	
=	196	US GPM	
or			
Max. Hourly Demand Peaking Factor =	3.00		
Max. Hourly Demand =	17.47	L/s	
=	277	US GPM	

Domestic Flow =	**17.47**	**L/s**	**277**	**US GPM**

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Water Demand Calculations - South Site		Date:	23/03/15

Peak Domestic Flow =	**17.47**	**L/s**
Fire Flow =	**200.00**	**L/s**
Max Day Domestic + Fire Demand =	**212.34**	**L/s**
	12740.63	**L/min**

Pressure Loss Calculations

$$h_f = \frac{10.7L}{C^{1.852}D^{4.87}}Q^{1.852}$$

Scenario 1: Peak Hour Domestic Demand (Min. 275 kPa)

Watermain (Section 1)			**Watermain (Section 2)**			**Watermain (Section 3)**		
Length, L =	650	m	Length, L =	600	m	Length, L =	280	m
C =	150		C =	150		C =	150	
Diameter, D =	300	mm	Diameter, D =	300	mm	Diameter, D =	150	mm
Flow, Q =	17.47	L/s	Flow, Q =	17.47	L/s	Flow, Q =	17.47	L/s
Velocity, V =	0.25	m/s	Velocity, V =	0.25	m/s	Velocity, V =	0.99	m/s
Pressure Loss, h_f =	0.13	m	Pressure Loss, I	0.12	m	Pressure Loss, h_f =	1.60	m
=	0.18	psi	=	0.17	psi	=	2.27	psi
=	1.24	kPa	=	1.15	kPa	=	15.67	kPa

Pressure at Connection =	397.73	kPa
Total Pressure Loss =	18.07	kPa
Service Pressure =	**379.66**	**kPa**

*Calculated Residual Pressure at Dalton Road Hydrant

> 275 kPa

Scenario 2: Fire Flow + Max Day Domestic Demand (Min. 140 kPa)

Watermain (Section 1)			**Watermain (Section 2)**			**Watermain (Section 3)**		
Length, L =	1250	m	Length, L =	0	m	Length, L =	0	m
C =	150		C =	150		C =	150	
Diameter, D =	300	mm	Diameter, D =	300	mm	Diameter, D =	300	mm
Flow, Q =	212.34	L/s	Flow, Q =	212.34	L/s	Flow, Q =	212.34	L/s
Velocity, V =	3.00	m/s	Velocity, V =	3.00	m/s	Velocity, V =	3.00	m/s
Pressure Loss, h_f =	24.90	m	Pressure Loss, I	0.00	m	Pressure Loss, h_f =	0.00	m
=	35.43	psi	=	0.00	psi	=	0.00	psi
=	244.31	kPa	=	0.00	kPa	=	0.00	kPa

Pressure at Connection =	309.78	kPa
Total Pressure Loss =	244.31	kPa
Service Pressure =	**65.47**	**kPa**

*Calculated Residual Pressure at St. Michaels Hydrant

> 140 kPa

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Water Demand Calculations - South Site		Date:	23/03/15

IV. Flow Test Results - Test 1

** As per fire flow test completed on fire hydrant ID #188 located on St. Michaels St*

Static Pressure = 60 psi
= 42.19 m head

Pressure (psi)	*Pressure (m)*	*Flow (GPM)*	*Flow (L/s)*
58	40.79	1126	71.04
50	35.16	1957	123.47

Pump Head Equation

$Head(m) = A - B(Q^C)$

A =	42.19
B =	0.000524800
C =	1.85

Theoretical Flow @ 20.3 psi = 359 L/s
= 21511 L/min
= 5683 US GPM

Anticipated Residual Pressures

Scenario	Flow (L/s)	Pressure (psi)		
		Estimated	Required	
Peak Domestic	17.5	***59.8***	39.9	** Minimum pressure of 275 kpa (39.9 psi)*
Fire + Max Day	212.3	***44.9***	20.3	** Minimum pressure of 140 kpa (20.3 psi)*

V. Flow Test Results - Test 2

** As per fire flow test completed on fire hydrant ID #75 located on Dalton Road*

Static Pressure = 58 psi
= 40.8 m head

Pressure (psi)	*Pressure (m)*	*Flow (GPM)*	*Flow (L/s)*
54	37.98	1061	67
42	29.54	1898	120

Pump Head Equation

$Head(m) = A - B(Q^C)$

A =	40.80
B =	0.0012060
C =	1.84

Theoretical Flow @ 20.3 psi = 229 L/s
= 13743 L/min
= 3631 US GPM

Anticipated Residual Pressures

Scenario	Flow (L/s)	Pressure (psi)		
		Estimated	Required	
Domestic	17.5	***57.7***	39.9	** Minimum pressure of 275 kpa (39.9 psi)*
Fire + Domestic	212.3	***25.2***	20.3	** Minimum pressure of 140 kpa (20.3 psi)*

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Water Demand Calculations - South Site		Date:	22/11/08

I. Fire Flow Calculation

**Based on Fire Underwriters Survey*

Table 7: Simplified Method for One and Two Family Dwellings up to 450 sq.m

Exposure Distances	Suggested Fire Flow (L/min) Wood Frame	Masonry
< 3m	8000	6000
3 to 10m	4000	4000
10.1 to 30m	3000	3000
> 30m	2000	2000

F = 4,000 L/min
66.67 L/s
F = 1,057 US GPM

Retirement Facility

$F = 220\ C\ (A)^{1/2}$

Where F= Fire flow in Lpm
C= construction type coefficient
= 0.6 For fire-resistive construction (fully protected frame, floors, roof)
A = total floor area in sq.m. excluding basements, includes garage*

Floor	Area (sq.m)	%
2nd Floor	3400 m^2	100%
3rd Floor	3400 m^2	25%
1st Floor	3400 m^2	25%

Largest Area = 5,100 sq.m.
F = 9,426.69 L/min

Round to nearest 1000 l/min
F = 9,000 L/min

Occupancy Reduction
15% reduction for limited combustible occupancy
F = 7650 L/min

Sprinkler Reduction
30% Reduction for NFPA Sprinkler System
F = 5355 l/min

Separation Charge		Distance
0%	North	>30m
0%	West	>30m
0%	South	>30m
10%	East	10.1-20m

10% Total Separation Charge 765 L/min
75% MAX Separation Charge

F = 6,000.00 L/min
100.00 L/s
F = 1585 US GPM

Retirement Facility Fire Flow > Single Family Fire Flow Requirement Therefore Fire Flow = 89.25 L/s

Fire Flow Required = 100.00 L/s
Fire Flow Required = 6,000 L/min 1,585 US GPM

DRAFT

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
	Delhi GC Development	Checked by:	FG
	Delhi, ON	Project No:	300053741
	Water Demand Calculations - South Site	Date:	22/11/08

II. Domestic Flow Calculations

Type	Quantity	P/Unit	Population
Retirement Unit	150	1.7	255
Single/Semi Detached	389	2.75	1070
Total	539		1325

Average Day Demand =	266	L/cap/day	
=	4.1	L/s	
=	65	US GPM	
Max. Daily Demand Peaking Factor =	2.12		
Max. Daily Demand =	8.65	L/s	
=	137	US GPM	
or			
Max. Hourly Demand Peaking Factor =	3.00		
Max. Hourly Demand =	12.24	L/s	
=	194	US GPM	

Domestic Flow =	**12.24**	**L/s**	**194**	**US GPM**

DRAFT

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Water Demand Calculations - South Site		Date:	22/11/08

Peak Domestic Flow =	**12.24**	**L/s**
Fire Flow =	**100.00**	**L/s**
Max Day Domestic + Fire Demand =	**108.65**	**L/s**
	6518.79	**L/min**

Pressure Loss Calculations

$$h_f = \frac{10.7L}{C^{1.852}D^{4.87}}Q^{1.852}$$

Scenario 1: Peak Domestic Demand (Min. 275 kPa)

Watermain (Section 1)			**Watermain (Section 2)**			**Watermain (Section 3)**		
Length, L =	650	m	Length, L =	750	m	Length, L =	250	m
C =	150		C =	150		C =	150	
Diameter, D =	300	mm	Diameter, D =	300	mm	Diameter, D =	150	mm
Flow, Q =	12.24	L/s	Flow, Q =	12.24	L/s	Flow, Q =	12.24	L/s
Velocity, V =	0.17	m/s	Velocity, V =	0.17	m/s	Velocity, V =	0.69	m/s
Pressure Loss, h_f =	0.07	m	Pressure Loss, I	0.08	m	Pressure Loss, h_f =	0.74	m
=	0.09	psi	=	0.11	psi	=	1.05	psi
=	0.64	kPa	=	0.74	kPa	=	7.24	kPa

Pressure at Connection =	398.82	kPa
Total Pressure Loss =	8.62	kPa
Service Pressure =	**390.20**	**kPa**

*Calculated Residual Pressure at Dalton Road Hydrant

> 275 kPa

Scenario 2: Fire Flow + Domestic Demand (Min. 140 kPa)

Watermain (Section 1)			**Watermain (Section 2)**			**Watermain (Section 3)**		
Length, L =	650	m	Length, L =	750	m	Length, L =	250	m
C =	150		C =	150		C =	150	
Diameter, D =	300	mm	Diameter, D =	300	mm	Diameter, D =	200	mm
Flow, Q =	108.65	L/s	Flow, Q =	108.65	L/s	Flow, Q =	108.65	L/s
Velocity, V =	1.54	m/s	Velocity, V =	1.54	m/s	Velocity, V =	3.46	m/s
Pressure Loss, h_f =	3.74	m	Pressure Loss, I	4.32	m	Pressure Loss, h_f =	10.37	m
=	5.33	psi	=	6.15	psi	=	14.76	psi
=	36.73	kPa	=	42.38	kPa	=	101.76	kPa

Pressure at Connection =	334.09	kPa
Total Pressure Loss =	180.86	kPa
Service Pressure =	**153.23**	**kPa**

*Calculated Residual Pressure at Dalton Road Hydrant

> 140 kPa

DRAFT

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Water Demand Calculations - South Site		Date:	22/11/08

IV. Flow Test Results - Test 1

** As per fire flow test completed on fire hydrant ID #188 located on St. Michaels St*

Static Pressure = 60 psi
= 42.19 m head

Pressure (psi)	*Pressure (m)*	*Flow (GPM)*	*Flow (L/s)*
58	40.79	1126	71.04
50	35.16	1957	123.47

Pump Head Equation

$Head(m) = A - B(Q^C)$

A =	42.19
B =	0.000524800
C =	1.85

Theoretical Flow @ 20.3 psi = 359 L/s
= 21511 L/min
= 5683 US GPM

Anticipated Residual Pressures

Scenario	Flow (L/s)	Pressure (psi)		
		Estimated	Required	
Peak Domestic	12.2	***59.9***	39.9	** Minimum pressure of 275 kpa (39.9 psi)*
Fire + Max Day	108.6	***55.6***	20.3	** Minimum pressure of 140 kpa (20.3 psi)*

V. Flow Test Results - Test 2

** As per fire flow test completed on fire hydrant ID #75 located on Dalton Road*

Static Pressure = 58 psi
= 40.8 m head

Pressure (psi)	*Pressure (m)*	*Flow (GPM)*	*Flow (L/s)*
54	37.98	1061	67
42	29.54	1898	120

Pump Head Equation

$Head(m) = A - B(Q^C)$

A =	40.80
B =	0.0012060
C =	1.84

Theoretical Flow @ 20.3 psi = 229 L/s
= 13743 L/min
= 3631 US GPM

Anticipated Residual Pressures

Scenario	Flow (L/s)	Pressure (psi)		
		Estimated	Required	
Domestic	12.2	***57.8***	39.9	** Minimum pressure of 275 kpa (39.9 psi)*
Fire + Domestic	108.6	***48.5***	20.3	** Minimum pressure of 140 kpa (20.3 psi)*

DRAFT

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Sanitary Servicing Calculations		Date:	22/05/27

Proposed Site Flows (Cul de sac)

Residential

Type	Quantity	P/Unit	Population
Townhouse	0	2.75	0
Single/Semi Detached	15	2.75	41
Total	15		41

Daily Design Flows = 266 L/cap/day *Norfolk County design standards
Population, P = 0.041

Peaking Factor, M = 4.33 $M = 1 + \frac{14}{4 + P^{0.5}}$

Peak Flow, Q = 0.55 L/s $Q = \frac{P\ x\ Q\ x\ M}{86400} + (A\ x\ I)$

Infiltration

Infiltration Allowance= 0.26 L/s/ha
Site Area = 1.39 ha
$Q_{infiltration}$= 0.36 L/s

$Q_{proposed\ total}$= 0.91 L/s

Service Connection					
Diameter (mm)	Slope (%)	Full Flow Velocity (m/s)	Capacity (L/s)	Spare Capacity (L/s)	Percent Full (%)
200	0.50	0.74	23.19	22.28	3.93%

Proposed Site Flows (Townhouses)

Residential

Type	Quantity	P/Unit	Population
Townhouse	88	2.75	242
Single/Semi Detached	0	2.75	0
Total	88		242

Daily Design Flows = 266 L/cap/day *Norfolk County design standards
Population, P = 0.242 *In Thousands

Peaking Factor, M = 4.12 $M = 1 + \frac{14}{4 + P^{0.5}}$

Peak Flow, Q = 3.07 L/s $Q = \frac{P\ x\ Q\ x\ M}{86400} + (A\ x\ I)$

Infiltration

Infiltration Allowance= 0.26 L/s/ha
Site Area = 3.67 ha
$Q_{infiltration}$= 0.95 L/s

$Q_{proposed\ total}$= 4.02 L/s

Service Connection					
Diameter (mm)	Slope (%)	Full Flow Velocity (m/s)	Capacity (L/s)	Spare Capacity (L/s)	Percent Full (%)
200	0.50	0.74	23.19	19.17	17.34%

BURNSIDE

CALCULATION SHEET

Project:	Prepared by:	BF
Delhi GC Development	Checked by:	FG
Delhi, ON	Project No:	300053741
Sanitary Servicing Calculations	Date:	22/05/27

Proposed Site Flows (Main Development Area)

Residential

Type	Quantity	P/Unit	Population
Townhouse	0	2.75	0
Single/Semi Detached	432	2.75	1188
Total	432		1188

Daily Design Flows = 266 L/cap/day *Norfolk County design standards

Population, P = 1.188 *In Thousands

Peaking Factor, M = 3.75 $M = 1 + \frac{14}{4 + P^{0.5}}$

Peak Flow, Q = 13.72 L/s $Q = \frac{P\ x\ Q\ x\ M}{86400} + (A\ x\ I)$

Infiltration

Infiltration Allowance= 0.26 L/s/ha

Site Area = 30.30 ha

$Q_{infiltration}$= 7.88 L/s

$Q_{proposed\ total}$= 21.60 L/s

Service Connection					
Diameter (mm)	Slope (%)	Full Flow Velocity (m/s)	Capacity (L/s)	Spare Capacity (L/s)	Percent Full (%)
200	0.50	0.74	23.19	1.60	93.12%

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Water Demand Calculations - South Site		Date:	22/11/08

I. Fire Flow Calculation

**Based on Fire Underwriters Survey*

Table 7: Simplified Method for One and Two Family Dwellings up to 450 sq.m

Exposure Distances	Suggested Fire Flow (L/min) Wood Frame	Masonry
< 3m	8000	6000
3 to 10m	4000	4000
10.1 to 30m	3000	3000
> 30m	2000	2000

F = 4,000 L/min
66.67 L/s
F = 1,057 US GPM

Retirement Facility

$F = 220\ C\ (A)^{1/2}$

Where F= Fire flow in Lpm
C= construction type coefficient
= 0.6 For fire-resistive construction (fully protected frame, floors, roof)
A = total floor area in sq.m. excluding basements, includes garage*

Floor	Area (sq.m)	%
2nd Floor	3400 m^2	100%
3rd Floor	3400 m^2	25%
1st Floor	3400 m^2	25%

Largest Area = 5,100 sq.m.
F = 9,426.69 L/min

Round to nearest 1000 l/min
F = 9,000 L/min

Occupancy Reduction
15% reduction for limited combustible occupancy
F = 7650 L/min

Sprinkler Reduction
30% Reduction for NFPA Sprinkler System
F = 5355 l/min

Separation Charge		Distance
0%	North	>30m
0%	West	>30m
0%	South	>30m
10%	East	10.1-20m

10% Total Separation Charge 765 L/min
75% MAX Separation Charge

F = 6,000.00 L/min
100.00 L/s
F = 1585 US GPM

Retirement Facility Fire Flow > Single Family Fire Flow Requirement Therefore Fire Flow = 89.25 L/s

Fire Flow Required = 100.00 L/s
Fire Flow Required = 6,000 L/min 1,585 US GPM

DRAFT

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
	Delhi GC Development	Checked by:	FG
	Delhi, ON	Project No:	300053741
	Water Demand Calculations - South Site	Date:	22/11/08

II. Domestic Flow Calculations

Type	Quantity	P/Unit	Population
Retirement Unit	150	1.7	255
Single/Semi Detached	389	2.75	1070
Total	539		1325

Average Day Demand =	266	L/cap/day	
=	4.1	L/s	
=	65	US GPM	
Max. Daily Demand Peaking Factor =	2.12		
Max. Daily Demand =	8.65	L/s	
=	137	US GPM	
or			
Max. Hourly Demand Peaking Factor =	3.00		
Max. Hourly Demand =	12.24	L/s	
=	194	US GPM	

Domestic Flow =	**12.24**	**L/s**	**194**	**US GPM**

DRAFT

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Water Demand Calculations - South Site		Date:	22/11/08

Peak Domestic Flow =	**12.24**	**L/s**
Fire Flow =	**100.00**	**L/s**
Max Day Domestic + Fire Demand =	**108.65**	**L/s**
	6518.79	**L/min**

Pressure Loss Calculations

$$h_f = \frac{10.7L}{C^{1.852}D^{4.87}}Q^{1.852}$$

Scenario 1: Peak Domestic Demand (Min. 275 kPa)

Watermain (Section 1)			**Watermain (Section 2)**			**Watermain (Section 3)**		
Length, L =	650	m	Length, L =	750	m	Length, L =	250	m
C =	150		C =	150		C =	150	
Diameter, D =	300	mm	Diameter, D =	300	mm	Diameter, D =	150	mm
Flow, Q =	12.24	L/s	Flow, Q =	12.24	L/s	Flow, Q =	12.24	L/s
Velocity, V =	0.17	m/s	Velocity, V =	0.17	m/s	Velocity, V =	0.69	m/s
Pressure Loss, h_f =	0.07	m	Pressure Loss, I	0.08	m	Pressure Loss, h_f =	0.74	m
=	0.09	psi	=	0.11	psi	=	1.05	psi
=	0.64	kPa	=	0.74	kPa	=	7.24	kPa

Pressure at Connection =	398.82	kPa
Total Pressure Loss =	8.62	kPa
Service Pressure =	**390.20**	**kPa**

*Calculated Residual Pressure at Dalton Road Hydrant

> 275 kPa

Scenario 2: Fire Flow + Domestic Demand (Min. 140 kPa)

Watermain (Section 1)			**Watermain (Section 2)**			**Watermain (Section 3)**		
Length, L =	650	m	Length, L =	750	m	Length, L =	250	m
C =	150		C =	150		C =	150	
Diameter, D =	300	mm	Diameter, D =	300	mm	Diameter, D =	200	mm
Flow, Q =	108.65	L/s	Flow, Q =	108.65	L/s	Flow, Q =	108.65	L/s
Velocity, V =	1.54	m/s	Velocity, V =	1.54	m/s	Velocity, V =	3.46	m/s
Pressure Loss, h_f =	3.74	m	Pressure Loss, I	4.32	m	Pressure Loss, h_f =	10.37	m
=	5.33	psi	=	6.15	psi	=	14.76	psi
=	36.73	kPa	=	42.38	kPa	=	101.76	kPa

Pressure at Connection =	334.09	kPa
Total Pressure Loss =	180.86	kPa
Service Pressure =	**153.23**	**kPa**

*Calculated Residual Pressure at Dalton Road Hydrant

> 140 kPa

DRAFT

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Water Demand Calculations - South Site		Date:	22/11/08

IV. Flow Test Results - Test 1

** As per fire flow test completed on fire hydrant ID #188 located on St. Michaels St*

Static Pressure = 60 psi
= 42.19 m head

Pressure (psi)	*Pressure (m)*	*Flow (GPM)*	*Flow (L/s)*
58	40.79	1126	71.04
50	35.16	1957	123.47

Pump Head Equation

$Head(m) = A - B(Q^C)$

A =	42.19
B =	0.000524800
C =	1.85

Theoretical Flow @ 20.3 psi = 359 L/s
= 21511 L/min
= 5683 US GPM

Anticipated Residual Pressures

Scenario	Flow (L/s)	Pressure (psi)		
		Estimated	Required	
Peak Domestic	12.2	***59.9***	39.9	** Minimum pressure of 275 kpa (39.9 psi)*
Fire + Max Day	108.6	***55.6***	20.3	** Minimum pressure of 140 kpa (20.3 psi)*

V. Flow Test Results - Test 2

** As per fire flow test completed on fire hydrant ID #75 located on Dalton Road*

Static Pressure = 58 psi
= 40.8 m head

Pressure (psi)	*Pressure (m)*	*Flow (GPM)*	*Flow (L/s)*
54	37.98	1061	67
42	29.54	1898	120

Pump Head Equation

$Head(m) = A - B(Q^C)$

A =	40.80
B =	0.0012060
C =	1.84

Theoretical Flow @ 20.3 psi = 229 L/s
= 13743 L/min
= 3631 US GPM

Anticipated Residual Pressures

Scenario	Flow (L/s)	Pressure (psi)		
		Estimated	Required	
Domestic	12.2	***57.8***	39.9	** Minimum pressure of 275 kpa (39.9 psi)*
Fire + Domestic	108.6	***48.5***	20.3	** Minimum pressure of 140 kpa (20.3 psi)*

DRAFT

TYLin

Project Name		
Project Number		
Originator	Mateusz L.	2023-03-22
Reviewer	Ian P.	2023-03-22

Water Design Criteria					
Identifier	**Delhi Residential**	**Delhi - Retirement Homes**			
Description	**A**	**B**			**Reference**
Number of Units	**724**	**150**			**From Development Concept, July 2021**
People per unit	**2.75**	**1.70**			Geranium Homes Development, Dated Feb 1 2022
Total Population	1991	255	2246		Calculated
LCPD	**266**	**266**			Information Memo - Servicing Monitoring Report - Water and Wastewater EIS-22-077
Max Day Demand	**2.12**	**2.12**			Information Memo - Servicing Monitoring Report - Water and Wastewater EIS-22-077
Peak Hour Factor	**3**	**3**			**Norfolk Master Plan 2016, Figure 4-13**
Fire Duration (Delhi)	3	3			MECP Water Design Guidelines, 2008
Fire Flow Requirement (Delhi)	189	189			MECP Water Design Guidelines based on a population up to 10,000 people
Excess Well Capacity Greater than Max Day Demand	17	17			Calculated
Revised Design Fire Flow Requirement (Delhi)	172	172			Calculated
Note: That Delhi and Courtland are treated separately for fire protection calculations, since the transmission connection is not designed to carry peak flows necessary for a fire supply.					

2. Water Demand					
Description	**Values**				**Reference**
	Delhi Residential	**Delhi - Retirement Homes**	**Total**		
Average Daily Demand	530	68	597		Calculated
	6.1	0.8	6.9		
Max Day Demand	1123	144	1267		
	13.0	1.7	14.7		
Peak Hour Demand	1589	203	1792		
	18.4	2.4	20.7		
Fire Flow			14861		
			172		

TYLin

Project Name		
Project Number		
Originator	Mateusz L.	2023-03-22
Reviewer	Ian P.	2023-03-22

Storage Requirement			
Description	Values		**Notes/Assumptions**
Existing Condition (Delhi + Committed Development + Pending Development)			
Delhi and Courtland Existing Max Day Demand	3722		Information Memo - Servicing Monitoring Report - Water and Wastewater EIS-22-077
Delhi Only Existing Max Day Demand	3014		5344 people based on 2021 population Census
Delhi Existing Committed Development	301		Information Memo - Servicing Monitoring Report - Water and Wastewater EIS-22-077
Delhi Pending Development	103		Information Memo - Servicing Monitoring Report - Water and Wastewater EIS-22-077
Total Delhi Existing Max Day Demand + Committed Development + Pending Development	3418		Calculated
Ex. Equalization Storage allocated to Delhi	854		Information Memo - Servicing Monitoring Report - Water and Wastewater EIS-22-077
Ex. Fire Storage allocated to Delhi	1717		Calculated using 159 L/s @ 3 hr MECP Design Guideline Flow
Ex. Emergency Storage allocated to Delhi	643		Calculated
Ex. Total Storage allocated to Existing Condition	**3214**		Calculated
Proposed Delhi Development	**Scenerio**		
	Fire Flow of 172 L/s	**Fire Flow of 189 L/s**	
Additional Max Day Demand	1267	1267	Calculated
Additional Equalization Storage Required	317	317	Calculated
Additional Fire Storage Required	140	324	Calculated
Additional Emergency Storage Required	114	160	Calculated
Total Additional Storage Required	**571**	**801**	Calculated
Total Storage Requirement for Delhi and Delhi Development	3786	4015	Calculated
Existing Total Storage	3955	3955	Inter-Urban Water System Study 2020
Storage (Available/Deficit)	169	-60	Calculated

TYLin

Project Name	Delhi Golf & Country Club Development		
Project Number	10478		
Originator	Mateusz L.	**Date**	2023-03-22
Reviewer	Ian P.	**Date**	2023-03-22

Sanitary Flows from Delhi Development (TYLin)

Description	SAN1 (Gravity)	SAN2 (Gravity)	North Sanitary (SAN 1 + SAN 2)	Retirement Home (Gravity to SPS)	SAN3 (SPS, without retirement home)	SAN3 (SPS, with retirement home)	Total Delhi Development	Unit	Reference
Number of Units	**129.0**	**15.0**		**150.0**	**580.0**		874.0		From Development Concept, January 2023
People per unit	2.75	2.75		1.70	**2.75**			ppu	From Development Concept, January 2023
Total Population	354.8	41.3		255.0	1595.0		2246.0	persons	
LCPD	239.0	239.0		**266.0**	**239.0**				Service Monitoring Report - Water and Wastewater
Harmon Peaking Factor	3.5	3.5		3.5	3.5				MECP Design Guidelines
I	0.26	0.26		0.26	**0.26**			L/ha/s	Discussed with the County of Norfolk (2022)
Gross Area	3.7	1.4		1.2	30.4			ha	From Sanitary Drainage Area Figure, November 2022
Peak Instantaneous Factor					**1.5**				Typical Value
Average Daily Flow	85.00	10.00	95.00	68.00	382.00	450.00	545.00	m3/d	Calculated
Peak Hour Dry Weather Flow	302.00	36.00	338.00	242.00	1355.00	1597.00	1935.00	m3/d	
Infiltration Flow Rate	83.00	32.00	115.00	27.00	683.00	710.00	825.00	m3/day	
Peak Hour Wet Weather Flow	385.00	68.00	453.00	269.00	2038.00	2307.00	2760.00	m3/day	
	5.00	**1.00**	**6.00**	**4.00**	24.00	28.00	34.00	L/s	
Peak Instantaneous Flow	536.00	86.00				3077.00		m3/day	
	7.00	**1.00**				**36.00**		L/s	

APPENDIX C

Permits and Approvals

Ontario

DRINKING WATER WORKS PERMIT

Permit Number: 070-201
Issue Number: 7

Pursuant to the *Safe Drinking Water Act*, 2002, S.O. 2002, c. 32, and the regulations made thereunder and subject to the limitations thereof, I hereby issue this drinking water works permit under Part V of the *Safe Drinking Water Act*, 2002, S.O. 2002, c. 32 to:

The Corporation of Norfolk County

185 Robinson Street
Simcoe, ON
N3Y 5L6

For the following municipal residential drinking water system:

Delhi Drinking Water System

This drinking water works permit includes the following:

Schedule	Description
Schedule A	Drinking Water System Description
Schedule B	General
Schedule C	All documents issued as Schedule C to this drinking water works permit which authorize alterations to the drinking water system
Schedule D	Process Flow Diagrams

Upon the effective date of this drinking water works permit # 070-201, all previously issued versions of permit # 070-201 are revoked and replaced by this permit.

DATED at TORONTO this 4th day of June, 2021

Signature

Aziz Ahmed, P.Eng.
Director
Part V, *Safe Drinking Water Act*, 2002

Schedule A: Drinking Water System Description

System Owner	**Norfolk County, The Corporation of**
Permit Number	**070-201**
Drinking Water System Name	**Delhi Drinking Water System**
Permit Effective Date	**June 4, 2021**

1.0 System Description

1.1 The following is a summary description of the works comprising the above drinking water system:

Overview

The **Delhi Drinking Water System** consists of Delhi Well Numbers 1, 2, 3a and 3b a standpipe, the Courtland Reservoir, which includes re-chlorination and booster pumping facilities, and a network of watermains in Delhi and Courtland.

Delhi Well Pumphouse No. 1

Well No. 1	39 m deep drilled production well
Location	2529 Windham West Quarter Line Road, Norfolk County
UTM Coordinates	NAD 83, UTM Zone 17: 545671 m E, 4742552 m N
Well Pump	Vertical turbine pump rated at 26.7 L/s at 88.7 m TDH
Notes	Classified as groundwater under the direct influence of surface water with effective in-situ filtration (GUDIWEF).

Chlorination

Storage	One (1) sodium hypochlorite day tank
Pumps	Two (2) metering pumps (duty/spare) rated to achieve disinfection requirements.
Injection Point	Prior to chlorine contact chamber
Chlorine Contact	Baffled, 24 m^3 chlorine contact chamber downstream of UV systems
Notes	Chlorine contact chamber equipped with bypass capability

Fluoridation

Storage	One (1) hydrofluorosilicic acid day tank
Pumps	Two (2) metering pumps (duty/spare)
Injection Point	Prior to chlorine contact chamber
Notes	

Iron and Manganese Sequestering

Storage	One (1) sodium silicate day tank
Pumps	Two (2) metering pumps (duty/ spare)
Injection Point	Downstream of UV units, prior to chlorine contact chamber
Notes	

Ultraviolet Disinfection

Description	Two (2) in-line UV reactors, duty/standby
Capacity	26.7 L/s each
Notes	

Instrumentation and Control

Instruments	Raw water flowmeter
	Treated water turbidimeter
	Two (2) treated water chlorine residual analyzers (one located in Well #1 used to calculated Well #2 CT)
Notes	

SCADA System

Description	Integrated with Norfolk County's water SCADA system
Notes	

Delhi Well Pumphouse No. 2

Well No. 2	41 m deep drilled production well
Location	2497 Windham West Quarter Line Road, Norfolk County
UTM Coordinates	NAD 83, UTM Zone 17: 545730 m E, 4742552 m N
Well Pump	Vertical turbine pump rated 26.7 L/s at 88.7 m TDH
Notes	Classified as groundwater under the direct influence of surface water with effective in-situ filtration (GUDIWEF).

Chlorination

Storage	One (1) sodium hypochlorite day tank
Pumps	Two (2) metering pumps (duty/ spare) rated to achieve disinfection requirements
Injection Point	Downstream of UV units
Notes	

Fluoridation

Storage	One (1) hydrofluorosilicic acid day tank
Pumps	Two (2) metering pumps (duty/ spare)
Injection Point	Downstream of UV units
Notes	

Iron and Manganese Sequestering

Storage	One (1) sodium silicate day tank
Pumps	Two (2) metering pumps (duty/ spare)
Injection Point	Downstream of UV units
Notes	

Ultraviolet Disinfection

Description	Two (2) in-line UV reactors (duty/standby)
Capacity	26.7 L/s each
Notes	

Instrumentation and Control

Instruments	Raw water flowmeter
	Treated water turbidimeter
	One (1) treated water chlorine residual analyzer
Notes	Treated water chlorine residual analyzer measures pre-contact residual. CT residual analyzer for Well#2 is located in Well #1.

SCADA System

Description	Integrated with Norfolk County's water SCADA system
Notes	

Fuel Oil Systems

Fuel Storage Locations

Location	Well #2 - NAD 83, UTM Zone 17: Easting 545730 m and Northing 4742552 m
Description	One (1) 1908 L indoor above-grade double walled storage tank
Fuel Type	Diesel
Source Protection Area	Delhi-Courtland Water Supply (Groundwater Wells)
Notes	Vulnerability Score: 10 Significant Risk Level

Standby Power

Description	One (1) trailer mounted diesel generator
Rating	230 kW
Notes	Also supplies standby power for Well # 1

Delhi Well Nos. 3A and 3B	
Well No. 3A	
Description	Drilled groundwater well
Location	2469 Windham West Quarter Line Road
UTM Coordinates	NAD 83, UTM Zone 17: 545806 m E, 4742280 m N
Dimensions	44.8 m deep, with a 200 mm nominal diameter casing.
Equipment	One (1) submersible well pump with a rated capacity of 10.9 L/s at 117.7 m TDH, with variable frequency drive complete with pitless adaptor and associated piping, fittings, valves, electrical and controls.
Notes	Groundwater - Non-GUDI
Well No. 3B	
Description	Drilled groundwater well
Location	2469 Windham West Quarter Line Road
UTM Coordinates	NAD 83, UTM Zone 17: 545796 m E, 4742295 m N
Dimensions	44.2 m deep, with a 300 mm nominal diameter casing.
Equipment	One (1) submersible well pump with a rated capacity of 26.2 L/s at 113.7 m TDH, with variable frequency drive complete with pitless adaptor and associated piping, fittings, valves, electrical and controls
Notes	Groundwater - Non-GUDI

Delhi Well Pumphouse No. 2	
Description	Prefabricated concrete building
Location	2469 Windham West Quarter Line Road
UTM Coordinates	NAD 83, UTM Zone 17: 545800 m E, 4742285 m N
Instrumentation and Controls	Hydrostatic pressure sensor/transmitter, flowmeter, discharge pressure transmitter, check valve position sensor and pump to waster piping for each well (Well 3A and Well 3B) and associated discharge piping.
SCADA	Controls, monitoring, recording, alarms, reporting and alarm annunciation via SCADA PLC and HMI
Notes	All associated piping, valves, electrical and mechanical equipment, instrumentation and operation control.

Delhi Standpipe

Location	116 Argyle Avenue
UTM Coordinates	NAD 83, UTM 17: 541910 m E, 4744125 m N
Total Volume	3,955 m^3
Useable Volume	1,978 m^3
Equipment	Mixing system
Notes	

Courtland Reservoir and Booster Pumping Station

Description	Two-celled treated water reservoir
Location	329 Main Street of Courtland -
UTM Coordinates	NAD 83, UTM 17: 531002 m E, 4743522 m N
Pumps	Two (2) vertical turbine high lift pumps rated at 6.8 L/s at 51 m TDH
	One (1) vertical turbine high lift pump rated at 4.9 L/s at 53.3 m TDH
	One (1) vertical turbine fire pump rated at 64.0 L/s at 51 m TDH
Re-Chlorination	Two (2) sodium hypochlorite solution day tanks
	Three (3) re-chlorination metering pumps (2 duty, 1 standby)
Instrumentation	One (1) inlet water flowmeter One (1) plant discharge water flowmeter One (1) plant discharge water flowmeter bypassing the turbidimeter
	One (1) outlet water turbidimeter
	One (1) inlet water chlorine residual analyzer One (1) plant discharge water chlorine residual analyzer
Control	Integrated with Norfolk County's water SCADA system
Standby Power	One (1) 125 kW generator
Notes	

Fuel Oil Systems

Fuel Storage Locations

Location	Courtland Reservoir- NAD 83, UTM 17: Easting 531002 m and Northing 4743522 m
Description	One (1) 1500 L outdoor above grade double walled storage tank
Fuel Type	Diesel
Source Protection Area	N/A
Notes	N/A

Watermains

1.2 Watermains within the distribution system comprise:

1.2.1 Watermains that have been set out in each document or file identified in column 1 of Table 1.

Table 1: Watermains

Column 1 Document or File Name	Column 2 Date
Delhi Courtland Water System 2019	August 2019

1.2.2 Watermains that have been added, modified, replaced or extended further to the provisions of Schedule C of this drinking water works permit on or after the date identified in column 2 of Table 1 for each document or file identified in column 1.

1.2.3 Watermains that have been added, modified, replaced or extended further to an authorization by the Director on or after the date identified in column 2 of Table 1 for each document or file identified in column 1.

Schedule B: General

System Owner	**Norfolk County, The Corporation of**
Permit Number	**070-201**
Drinking Water System Name	**Delhi Drinking Water System**
Permit Effective Date	**June 4, 2021**

1.0 Applicability

1.1 In addition to any other applicable legal requirements, the drinking water system identified above shall be altered and operated in accordance with the conditions of this drinking water works permit and the licence #070-101.

1.2 The definitions and conditions of licence #070-101 are incorporated into this permit and also apply to this drinking water system.

2.0 Alterations to the Drinking Water System

2.1 Any document issued by the Director to be incorporated into Schedule C to this drinking water works permit shall provide authority to alter the drinking water system in accordance with the applicable conditions of this drinking water works permit and licence #070-101.

2.2 All documents issued by the Director as described in condition 2.1 shall form part of this drinking water works permit.

2.3 All parts of the drinking water system in contact with drinking water that are added, modified, replaced, extended shall be disinfected in accordance with a procedure approved by the Director or in accordance with the applicable provisions of the following documents:

a) Until 6 months from the date of issue of this permit, the ministry's Watermain Disinfection Procedure, dated November 2015. Thereafter, the ministry's Watermain Disinfection Procedure, dated August 1, 2020;
b) Subject to condition 2.3.2, any updated version of the ministry's Watermain Disinfection Procedure;
c) AWWA C652 – Standard for Disinfection of Water-Storage Facilities;
d) AWWA C653 – Standard for Disinfection of Water Treatment Plants; and
a) AWWA C654 – Standard for Disinfection of Wells.

2.3.1 For greater clarity, where an activity has occurred that could introduce contamination, including but not limited to repair, maintenance, or physical / video inspection, all equipment that may come in contact with the drinking water system shall be disinfected in accordance with the requirements of condition 2.3. above.

2.3.2 Updated requirements described in condition 2.3 b) are effective six months from the date of publication of the updated Watermain Disinfection Procedure.

2.4 The owner shall notify the Director in writing within thirty (30) days of the placing into service or the completion of any addition, modification, replacement, removal or extension of the drinking water system which had been authorized through:

2.4.1 Schedule B to this drinking water works permit which would require an alteration of the description of a drinking water system component described in Schedule A of this drinking water works permit;

2.4.2 Any document to be incorporated in Schedule C to this drinking water works permit respecting works other than watermains; or

2.4.3 Any approval issued prior to the issue date of the first drinking water works permit respecting works other than watermains which were not in service at the time of the issuance of the first drinking water works permit.

2.5 The notification required in condition 2.4 shall be submitted using the "Director Notification Form" published by the Ministry.

2.6 For greater certainty, the notification requirements set out in condition 2.4 do not apply to any addition, modification, replacement, removal or extension in respect of the drinking water system which:

2.6.1 Is exempt from subsection 31(1) of the SDWA by subsection 9.(2) of O. Reg. 170/03;

2.6.2 Constitutes maintenance or repair of the drinking water system; or

2.6.3 Is a watermain authorized by condition 3.1 of Schedule B of this drinking water works permit.

2.7 The owner shall notify the legal owner of any part of the drinking water system that is prescribed as a municipal drinking water system by section 2 of O. Reg. 172/03 of the requirements of the licence and this drinking water works permit as applicable to the prescribed system.

2.8 For greater certainty, the owner may only carry out alterations to the drinking water system in accordance with this drinking water works permit after having satisfied other applicable legal obligations, including those arising from the *Environmental Assessment Act*, *Niagara Escarpment Planning and Development Act*, *Oak Ridges Moraine Conservation Act, 2001* and *Greenbelt Act, 2005*.

3.0 Watermain Additions, Modifications, Replacements and Extensions

3.1 The owner may alter the drinking water system, or permit it to be altered by a person acting on the owner's behalf, by adding, modifying, replacing or extending a watermain within the distribution system subject to the following conditions:

3.1.1 The design of the watermain addition, modification, replacement or extension:

a) Has been prepared by a licensed engineering practitioner;

b) Has been designed only to transmit water and has not been designed to treat water;

c) Satisfies the design criteria set out in the Ministry publication “Watermain Design Criteria for Future Alterations Authorized under a Drinking Water Works Permit – June 2012”, as amended from time to time; and

d) Is consistent with or otherwise addresses the design objectives contained within the Ministry publication “Design Guidelines for Drinking Water Systems, 2008”, as amended from time to time.

3.1.2 The maximum demand for water exerted by consumers who are serviced by the addition, modification, replacement or extension of the watermain will not result in an exceedance of the rated capacity of a treatment subsystem or the maximum flow rate for a treatment subsystem component as specified in the licence, or the creation of adverse conditions within the drinking water system.

3.1.3 The watermain addition, modification, replacement or extension will not adversely affect the distribution system’s ability to maintain a minimum pressure of 140 kPa at ground level at all points in the distribution system under maximum day demand plus fire flow conditions.

3.1.4 Secondary disinfection will be provided to water within the added, modified, replaced or extended watermain to meet the requirements of O. Reg. 170/03.

3.1.5 The watermain addition, modification, replacement or extension is wholly located within the municipal boundary over which the owner has jurisdiction.

3.1.6 The owner of the drinking water system consents in writing to the watermain addition, modification, replacement or extension.

3.1.7 A licensed engineering practitioner has verified in writing that the watermain addition, modification, replacement or extension meets the requirements of condition 3.1.1.

3.1.8 The owner of the drinking water system has verified in writing that the watermain addition, modification, replacement or extension meets the requirements of conditions 3.1.2 to 3.1.6.

3.2 The authorization for the addition, modification, replacement or extension of a watermain provided for in condition 3.1 does not include the addition, modification, replacement or extension of a watermain that:

3.2.1 Passes under or through a body of surface water, unless trenchless construction methods are used;

3.2.2 Has a nominal diameter greater than 750 mm;

3.2.3 Results in the fragmentation of the drinking water system; or

3.2.4 Connects to another drinking water system, unless:

a) Prior to construction, the owner of the drinking water system seeking the connection obtains written consent from the owner or owner’s delegate of the drinking water system being connected to; and

b) The owner of the drinking water system seeking the connection retains a copy of the written consent from the owner or owner's delegate of the drinking water system being connected to as part of the record that is recorded and retained under condition 3.3.

3.3 The verifications required in conditions 3.1.7 and 3.1.8 shall be:

3.3.1 Recorded on "Form 1 – Record of Watermains Authorized as a Future Alteration", as published by the Ministry, prior to the watermain addition, modification, replacement or extension being placed into service; and

3.3.2 Retained for a period of ten (10) years by the owner.

3.4 For greater certainty, the verification requirements set out in condition 3.3 do not apply to any addition, modification, replacement or extension in respect of the drinking water system which:

3.4.1 Is exempt from subsection 31(1) of the SDWA by subsection 9.(2) of O. Reg. 170/03; or

3.4.2 Constitutes maintenance or repair of the drinking water system.

3.5 The document or file referenced in Column 1 of Table 1 of Schedule A of this drinking water works permit that sets out watermains shall be retained by the owner and shall be updated to include watermain additions, modifications, replacements and extensions within 12 months of the addition, modification, replacement or extension.

3.6 The updates required by condition 3.5 shall include watermain location relative to named streets or easements and watermain diameter.

3.7 Despite clause (a) of condition 3.1.1 and condition 3.1.7, with respect to the replacement of an existing watermain or section of watermain that is 6.1 meters in length or less, if a licensed engineering practitioner has:

3.7.1 inspected the replacement prior to it being put into service;

3.7.2 prepared a reporting confirming that the replacement satisfies clauses (b), (c) and (d) of condition 3.1.1 (i.e. "Form 1 – Record of Watermains Authorized by a Future Alteration" (Form 1), Part 3, items No. 2, 3 and 4); and

3.7.3 appended the report referred to in condition 3.7.2 to the completed Form 1,

the replacement is exempt from the requirements that the design of the replacement be prepared by a licensed engineering practitioner and that a licensed engineering practitioner verify on Form 1, Part 3, item No. 1 that a licensed engineering practitioner prepared the design of the replacement.

3.8 For greater certainty, the exemption in condition 3.7 does not apply to the replacement of an existing watermain or section of watermain if two or more sections of pipe, each of which is 6.1 meters in length or less, are joined together, if the total length of replacement pipes joined together is greater than 6.1 meters.

4.0 Minor Modifications to the Drinking Water System

4.1 The drinking water system may be altered by adding, modifying or replacing the following components in the drinking water system:

4.1.1 Coagulant feed systems in the treatment system, including the location and number of dosing points:

a) Prior to making any alteration to the drinking water system under condition 4.1.1, the owner shall undertake a review of the impacts that the alteration might have on corrosion control or other treatment processes; and

b) The owner shall notify the Director in writing within thirty (30) days of any alteration made under condition 4.1.1 and shall provide the Director with a copy of the review.

c) The notification required in condition 4.1.1 b) shall be submitted using the “Director Notification Form” published by the Ministry

4.1.2 Instrumentation and controls, including new SCADA systems and upgrades to SCADA system hardware;

4.1.3 SCADA system software or programming that:

a) Measures, monitors or reports on a regulated parameter;
b) Measures, monitor or reports on a parameter that is used to calculate CT; or,
c) Calculates CT for the system or is part of the process algorithm that calculates log removal, where the impacts of addition, modification or replacement have been reviewed by a licensed engineering practitioner;

4.1.4 Filter media, backwashing equipment, filter troughs, and under-drains and associated equipment in the treatment system;

4.1.5 Spill containment works; or,

4.1.6 Coarse screens and fine screens

4.2 The drinking water system may be altered by adding, modifying, replacing or removing the following components in the drinking water system:

4.2.1 Treated water pumps, pressure tanks, and associated equipment;

4.2.2 Raw water pumps and process pumps in the treatment system;

4.2.3 Inline booster pumping stations that are not associated with distribution system storage facilities and are on a watermain with a nominal diameter not exceeding 200 mm;

4.2.4 Re-circulation devices within distribution system storage facilities;

4.2.5 In-line mixing equipment;

4.2.6 Chemical metering pumps and chemical handling pumps;

4.2.7 Chemical storage tanks (excluding fuel storage tanks) and associated equipment; or,

4.2.8 Measuring and monitoring devices that are not required by regulation, by a condition in the Drinking Water Works Permit, or by a condition otherwise imposed by the Ministry.

4.2.9 Chemical injection points.

4.2.10 Valves;

4.3 The drinking water system may be altered by replacing the following:

4.3.1 Raw water piping, treatment process piping or treated water piping within the treatment subsystem;

4.3.2 Measuring and monitoring devices that are required by regulation, by a condition in the Drinking Water Works Permit or by a condition otherwise imposed by the Ministry.

4.3.3 Coagulants and pH adjustment chemicals, where the replacement chemicals perform the same function;

a) Prior to making any alteration to the drinking water system under condition 4.3.3, the owner shall undertake a review of the impacts that the alteration might have on corrosion control or other treatment processes; and

b) The owner shall notify the Director in writing within thirty (30) days of any alteration made under condition 4.3.3 and shall provide the Director with a copy of the review.

c) The notification required in condition 4.3.3 b) shall be submitted using the "Director Notification Form" published by the Ministry

4.4 Any alteration of the drinking water system made under conditions 4.1, 4.2 or 4.3 shall not result in:

4.4.1 An exceedance of a treatment subsystem rated capacity or a treatment subsystem component maximum flow rate as specified in the licence;

4.4.2 The bypassing or removal of any unit process within a treatment subsystem;

4.4.3 The addition of any new unit process other than coagulation within a treatment subsystem;

4.4.4 A deterioration in the quality of drinking water provided to consumers;

4.4.5 A reduction in the reliability or redundancy of any component of the drinking water system;

4.4.6 A negative impact on the ability to undertake compliance and other monitoring necessary for the operation of the drinking water system; or

4.4.7 An adverse effect on the environment.

4.5 The owner shall verify in writing that any addition, modification, replacement or removal of drinking water system components in accordance with conditions 4.1, 4.2 or 4.3 has met the requirements of the conditions listed in condition 4.4.

4.6 The verifications and documentation required in condition 4.5 shall be:

4.6.1 Recorded on "Form 2 – Record of Minor Modifications or Replacements to the Drinking Water System" published by the Ministry, prior to the modified or replaced components being placed into service; and

4.6.2 Retained for a period of ten (10) years by the owner.

4.7 For greater certainty, the verification requirements set out in conditions 4.5 and 4.6 do not apply to any addition, modification, replacement or removal in respect of the drinking water system which:

4.7.1 Is exempt from subsection 31(1) of the SDWA by subsection 9.(2) of O. Reg. 170/03; or

4.7.2 Constitutes maintenance or repair of the drinking water system, including software changes to a SCADA system that are not listed in condition 4.1.3

4.8 The owner shall update any drawings maintained for the drinking water system to reflect the modification or replacement of the works, where applicable.

5.0 Equipment with Emissions to the Air

5.1 The drinking water system may be altered by adding, modifying or replacing any of the following drinking water system components that may discharge or alter the rate or manner of a discharge of a compound of concern to the air:

5.1.1 Any equipment, apparatus, mechanism or thing that is used for the transfer of outdoor air into a building or structure that is not a cooling tower;

5.1.2 Any equipment, apparatus, mechanism or thing that is used for the transfer of indoor air out of a space used for the production, processing, repair, maintenance or storage of goods or materials, including chemical storage;

5.1.3 Laboratory fume hoods used for drinking water testing, quality control and quality assurance purposes;

5.1.4 Low temperature handling of compounds with a vapor pressure of less than 1 kilopascal;

5.1.5 Maintenance welding stations;

5.1.6 Minor painting operations used for maintenance purposes;

5.1.7 Parts washers for maintenance shops;

5.1.8 Emergency chlorine and ammonia gas scrubbers and absorbers;

5.1.9 Venting for activated carbon units for drinking water taste and odour control;

5.1.10 Venting for a stripping unit for methane removal from a groundwater supply;

5.1.11 Venting for an ozone treatment unit;

5.1.12 Natural gas or propane fired boilers, water heaters, space heaters and make-up air units with a total facility-wide heat input rating of less than 20 million kilojoules per hour, and with an individual fuel energy input of less than or equal to 10.5 gigajoules per hour; or

5.1.13 Emergency generators that fire No. 2 fuel oil (diesel fuel) with a sulphur content of 0.5 per cent or less measured by weight, natural gas, propane, gasoline or biofuel, and that are used for emergency duty only with periodic testing.

5.2 The owner shall not make an addition, modification, or replacement described in condition 5.1 in relation to an activity that is not related to the treatment and/or distribution of drinking water.

5.3 The emergency generators identified in condition 5.1.13 shall not be used for non-emergency purposes including the generation of electricity for sale or for peak shaving purposes.

5.4 The owner shall prepare an emission summary table for nitrogen oxides emissions only, for each addition, modification or replacement of emergency generators identified in condition 5.1.13.

Performance Limits

5.5 The owner shall ensure that a drinking water system component identified in conditions 5.1.1 to 5.1.13 is operated at all times to comply with the following limits:

5.5.1 For equipment other than emergency generators, the maximum concentration of any compound of concern at a point of impingement shall not exceed the corresponding point of impingement limit;

5.5.2 For emergency generators, the maximum concentration of nitrogen oxides at sensitive receptors shall not exceed the applicable point of impingement limit, and at non-sensitive receptors shall not exceed the Ministry half-hourly screening level of 1880 ug/m^3 as amended; and

5.5.3 The noise emissions comply at all times with the limits set out in publication NPC-300, as applicable.

5.6 The owner shall verify in writing that any addition, modification or replacement of works in accordance with condition 5.1 has met the requirements of the conditions listed in condition 5.5.

5.7 The owner shall document how compliance with the performance limits outlined in condition 5.5.3 is being achieved, through noise abatement equipment and/or operational procedures.

5.8 The verifications and documentation required in conditions 5.6 and 5.7 shall be:

5.8.1 Recorded on “Form 3 – Record of Addition, Modification or Replacement of Equipment Discharging a Contaminant of Concern to the Atmosphere”, as published by the Ministry, prior to the additional, modified or replacement equipment being placed into service; and

5.8.2 Retained for a period of ten (10) years by the owner.

5.9 For greater certainty, the verification and documentation requirements set out in conditions 5.6 and 5.8 do not apply to any addition, modification or replacement in respect of the drinking water system which:

5.9.1 Is exempt from subsection 31(1) of the SDWA by subsection 9.(2) of O. Reg. 170/03; or

5.9.2 Constitutes maintenance or repair of the drinking water system.

5.10 The owner shall update any drawings maintained for the works to reflect the addition, modification or replacement of the works, where applicable.

6.0 Previously Approved Works

6.1 The owner may add, modify, replace or extend, and operate part of a municipal drinking water system if:

6.1.1 An approval was issued after January 1, 2004 under section 36 of the SDWA in respect of the addition, modification, replacement or extension and operation of that part of the municipal drinking water system;

6.1.2 The approval expired by virtue of subsection 36(4) of the SDWA; and

6.1.3 The addition, modification, replacement or extension commenced within five years of the date that activity was approved by the expired approval.

7.0 System-Specific Conditions

7.1 Not Applicable

8.0 Source Protection

8.1 Not Applicable

Schedule C: Authorization to Alter the Drinking Water System

System Owner	**Norfolk County, The Corporation of**
Permit Number	**070-201**
Drinking Water System Name	**Delhi Drinking Water System**
Permit Effective Date	**June 4, 2021**

1.0 General

1.1 Table 2 provides a reference list of all documents to be incorporated into Schedule C that have been issued as of the date that this permit was issued.

1.1.1 Table 2 is not intended to be a comprehensive list of all documents that are part of Schedule C. For clarity, any document issued by the Director to be incorporated into Schedule C after this permit has been issued is considered part of this drinking water works permit.

Table 2: Schedule C Documents

Column 1 Issue #	Column 2 Issued Date	Column 3 Description	Column 4 Status	Column 5 DN#
1	2019/10/30	Addition of New Wells 3A & 3B	Archived	5

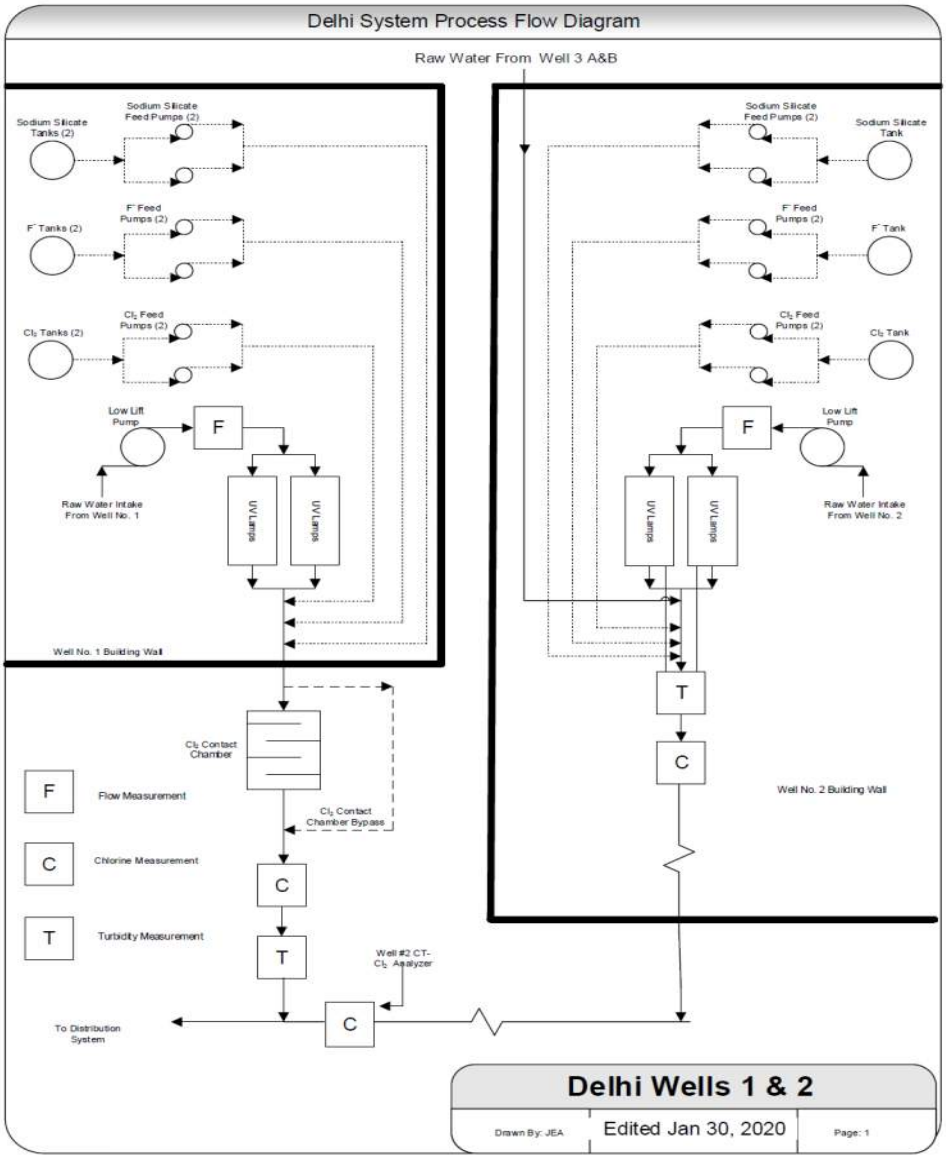
1.2 For each document described in columns 1, 2 and 3 of Table 2, the status of the document is indicated in column 4. Where this status is listed as 'Archived', the approved alterations have been completed and relevant portions of this permit have been updated to reflect the altered works. These 'Archived' Schedule C documents remain as a record of the alterations.

Schedule D: Process Flow Diagrams

System Owner	**Norfolk County, The Corporation of**
Permit Number	**070-201**
Drinking Water System Name	**Delhi Drinking Water System**
Permit Effective Date	**June 4, 2021**

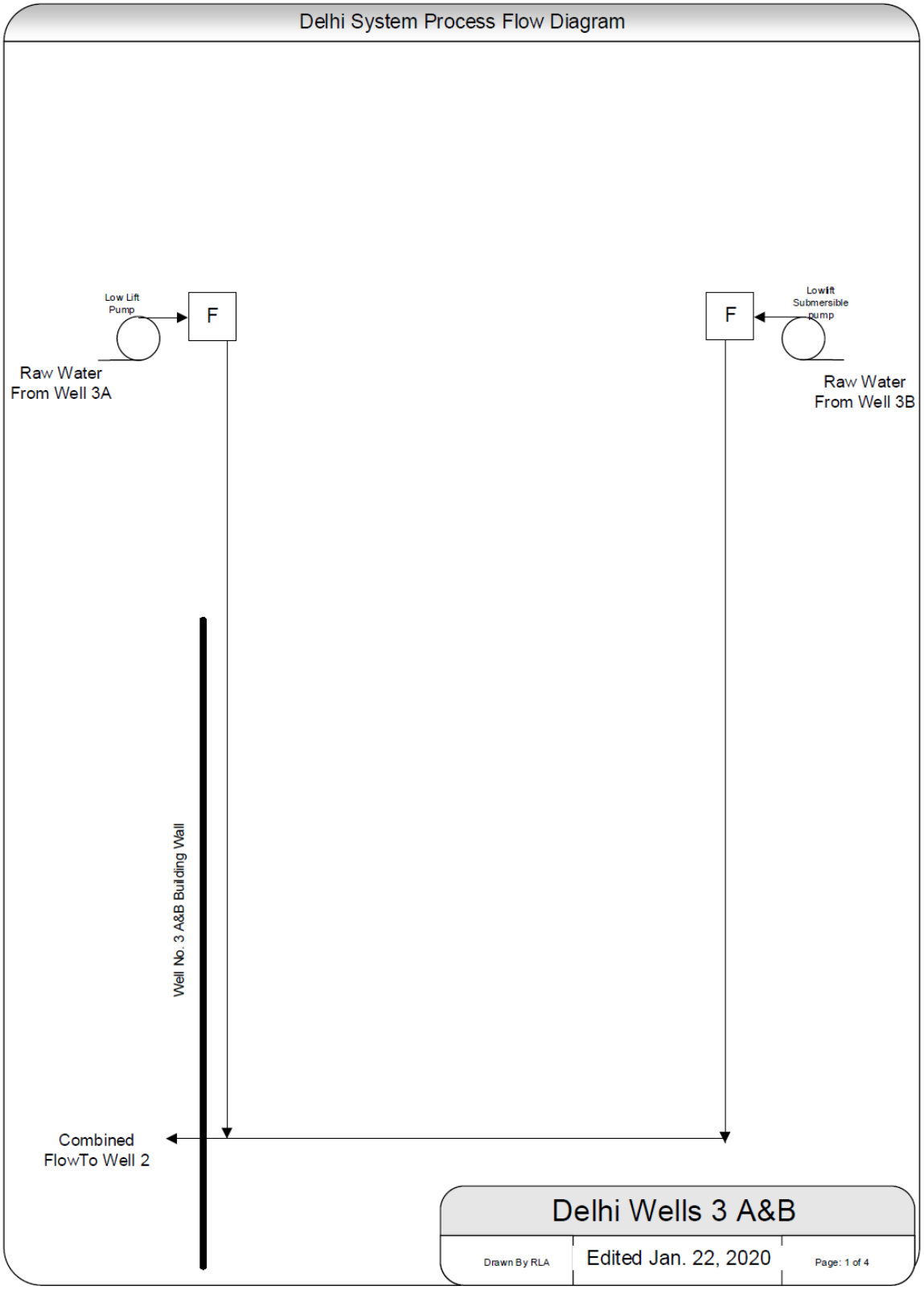
1.0 Process Flow Diagrams

Delhi Wells 1 & 2

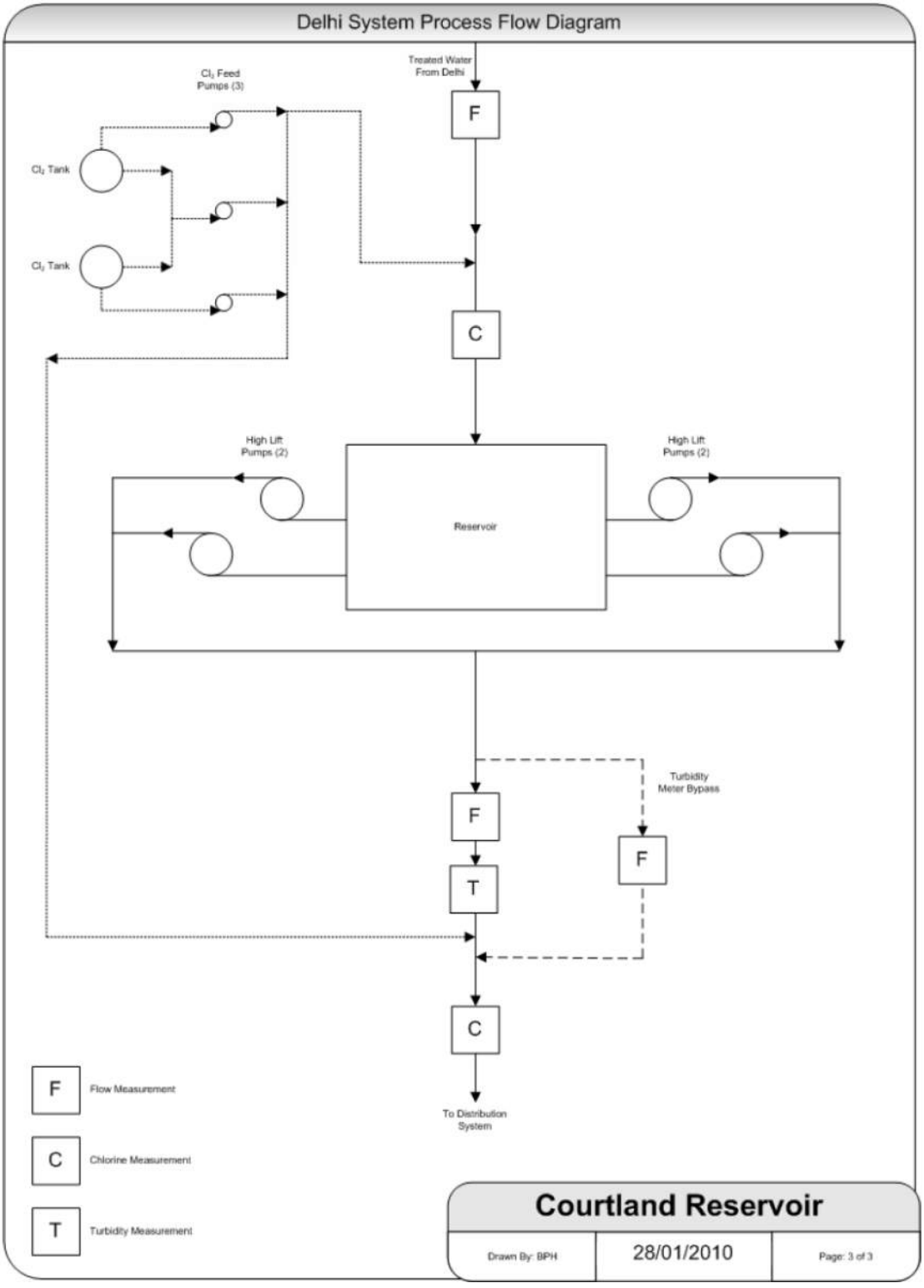


[Source: Operational Plan 2019.pdf, August 2019]

Delhi Wells 3A and 3B



Courtland Reservoir



Ministry of Environment and Energy

Ministère de l'Environnement et de l'Énergie

Ontario

ENVIRONMENTAL SERVICES
JUL 19 1994
FILE:

JUL 18 1994

SEWAGE
NUMBER 3-0815-94-006

C.A.O.		M.I.S.	
R. CHAIRMAN		E. & D.	
H. CLERK		PUB. SVC.	
COUNCIL		ROADS	
S. DEV.	✓	P. SVC.	
ENV. SVC.		SOC. SVC.	
HEALTH		CONSERV.	

The Regional Municipality
of Haldimand-Norfolk
70 Town Centre Drive
Townsend, Ontario
N0A 1S0

You have applied in accordance with Section 53 of the Ontario Water Resources Act for approval of:

a sanitary sewage pumping station to be constructed in the Township of Delhi, on Main Street, consisting of a 5 metres by 5 metres by 8 metres deep concrete chamber together with two (2) submersible raw sewage pumps each rated at 45 litres per second at a T.D.H. of 24.4 metres, one of the pumps to be provided with a mixing valve assembly, provision for a third pump, including piping, electrical, mechanical works, 24 hour attended alarm system, 1 access cover, one (1) vent pipe, ladder, a portable trailer mounted generator, and a 200mm diameter sanitary sewer forcemain, all in accordance to the plans and specifications prepared by Associated Engineering (Ont.) Ltd., Consulting Engineers.

The above noted sewage works are approved under Section 53 of the Ontario Water Resources Act.

DATED AT TORONTO this 13th *day of* July 1994

W. Ng, P. Eng.
Director
Section 53
Ontario Water Resources Act

RP/nr

Attn: -Mr. G. van der Wolf, Clerk, R.M. of Haldimand-Norfolk
cc: -Ms. B.M. Cadman, Clerk, Twp. of Delhi
-District Manager, MOEE Hamilton District Office
-Mr. R. Willcocks, P. Eng., Associated Engineering (Ont.) Ltd.

0979 (06/93)

CONTENT COPY OF ORIGINAL

Ontario

Ministry of the Environment, Conservation and Parks
Ministère de l'Environnement, de la Protection de la nature et des Parcs

PERMIT TO TAKE WATER
Surface Water

NUMBER 3645-BUTNBB

Reference Number 2166-BTPJMW

Pursuant to Section 34.1 of the Ontario Water Resources Act, R.S.O. 1990 this Permit To Take Water is hereby issued to:

The Corporation of Norfolk County
183 Main St Delhi
Norfolk, Ontario, N4B 2M3
Canada

For the water taking from: Lehman Reservoir

Located at: Lot 186, Concession South Side of Talbot Road East, Geographic Township of Middleton
Norfolk

For the purposes of this Permit, and the terms and conditions specified below, the following definitions apply:

DEFINITIONS

(a) "Director" means any person appointed in writing as a Director pursuant to section 5 of the OWRA for the purposes of section 34.1, OWRA.

(b) "Provincial Officer" means any person designated in writing by the Minister as a Provincial Officer pursuant to section 5 of the OWRA.

(c) "Ministry" means Ontario Ministry of the Environment, Conservation and Parks.

(d) "District Office" means the Hamilton District Office.

(e) "Permit" means this Permit to Take Water No. 3645-BUTNBB including its Schedules, if any, issued in accordance with Section 34.1 of the OWRA.

(f) "Permit Holder" means The Corporation of Norfolk County.

CONTENT COPY OF ORIGINAL

(g) "OWRA " means the *Ontario Water Resources Act,* R.S.O. 1990, c. O. 40, as amended.

You are hereby notified that this Permit is issued subject to the terms and conditions outlined below:

TERMS AND CONDITIONS

1. Compliance with Permit

1.1 Except where modified by this Permit, the water taking shall be in accordance with the application for this Permit To Take Water, dated September 4, 2020 and signed by Shaun Earls, and all Schedules included in this Permit.

1.2 The Permit Holder shall ensure that any person authorized by the Permit Holder to take water under this Permit is provided with a copy of this Permit and shall take all reasonable measures to ensure that any such person complies with the conditions of this Permit.

1.3 Any person authorized by the Permit Holder to take water under this Permit shall comply with the conditions of this Permit.

1.4 This Permit is not transferable to another person.

1.5 This Permit provides the Permit Holder with permission to take water in accordance with the conditions of this Permit, up to the date of the expiry of this Permit. This Permit does not constitute a legal right, vested or otherwise, to a water allocation, and the issuance of this Permit does not guarantee that, upon its expiry, it will be renewed.

1.6 The Permit Holder shall keep this Permit available at all times at or near the site of the taking, and shall produce this Permit immediately for inspection by a Provincial Officer upon his or her request.

1.7 The Permit Holder shall report any changes of address to the Director within thirty days of any such change. The Permit Holder shall report any change of ownership of the property for which this Permit is issued within thirty days of any such change. A change in ownership in the property shall cause this Permit to be cancelled.

2. General Conditions and Interpretation

2.1 Inspections
The Permit Holder must forthwith, upon presentation of credentials, permit a Provincial Officer to carry out any and all inspections authorized by the OWRA, the *Environmental Protection Act*, R.S.O. 1990, the *Pesticides Act*, R.S.O. 1990, or the *Safe Drinking Water Act,* S. O. 2002.

2.2 Other Approvals
The issuance of, and compliance with this Permit, does not:

(a) relieve the Permit Holder or any other person from any obligation to comply with any other applicable legal requirements, including the provisions of the *Ontario Water Resources Act*, and the *Environmental Protection Act*, and any regulations made thereunder; or

(b) limit in any way any authority of the Ministry, a Director, or a Provincial Officer, including the authority to require certain steps be taken or to require the Permit Holder to furnish any further information related to this Permit.

2.3 Information
The receipt of any information by the Ministry, the failure of the Ministry to take any action or require any person to take any action in relation to the information, or the failure of a Provincial Officer to prosecute any person in relation to the information, shall not be construed as:

(a) an approval, waiver or justification by the Ministry of any act or omission of any person that contravenes this Permit or other legal requirement; or

(b) acceptance by the Ministry of the information's completeness or accuracy.

2.4 Rights of Action
The issuance of, and compliance with this Permit shall not be construed as precluding or limiting any legal claims or rights of action that any person, including the Crown in right of Ontario or any agency thereof, has or may have against the Permit Holder, its officers, employees, agents, and contractors.

2.5 Severability
The requirements of this Permit are severable. If any requirements of this Permit, or the application of any requirements of this Permit to any circumstance, is held invalid or unenforceable, the application of such requirements to other circumstances and the remainder of this Permit shall not be affected thereby.

2.6 Conflicts
Where there is a conflict between a provision of any submitted document referred to in this Permit, including its Schedules, and the conditions of this Permit, the conditions in this Permit shall take precedence.

3. Water Takings Authorized by This Permit

3.1 **Expiry**
This Permit expires on **October 30, 2030**. No water shall be taken under authority of this Permit after the expiry date.

3.2 Amounts of Taking Permitted
The Permit Holder shall only take water from the source, during the periods and at the rates and amounts of taking specified in Table A. Water takings are authorized only for the purposes specified in Table A.

CONTENT COPY OF ORIGINAL

Table A

	Source Name / Description:	Source: Type:	Taking Specific Purpose:	Taking Major Category:	Max. Taken per Minute (litres):	Max. Num. of Hrs Taken per Day:	Max. Taken per Day (litres):	Max. Num. of Days Taken per Year:	Zone/ Easting/ Northing:
1	Lehman Reservoir	Pond Online	Municipal	Water Supply	4,732	24	6,815,000	365	17 539851 4744598
						Total Taking:	6,815,000		

4. Monitoring

4.1 Under section 9 of O. Reg. 387/04, and as authorized by subsection 34(6) of the *Ontario Water Resources Act*, the Permit Holder shall, on each day water is taken under the authorization of this Permit, record the date, the volume of water taken on that date and the rate at which it was taken. The daily volume of water taken shall be measured by a flow meter or calculated in accordance with the method described in the application for this Permit, or as otherwise accepted by the Director. The Permit Holder shall keep all records required by this condition current and available at or near the site of the taking and shall produce the records immediately for inspection by a Provincial Officer upon his or her request. The Permit Holder, unless otherwise required by the Director, shall submit, on or before March 31st in every year, the records required by this condition to the ministry's Water Taking Reporting System.

4.2 Where the Director, Public Works and Environmental Services Department of The Corporation of Norfolk County and the Director, Section 34, Ontario Water Resources Act, R.S.O. 1990, agree in writing on a plan for the monitoring of the environmental effects of some or all of the County's water takings, including the water taking authorized under this permit, the requirements of 4.1 will be superseded and the County shall implement the monitoring program, with reporting provisions, as detailed in that agreement.

5. Impacts of the Water Taking

5.1 Notification
The Permit Holder shall immediately notify the local District Office of any complaint arising from the taking of water authorized under this Permit and shall report any action which has been taken or is proposed with regard to such complaint. The Permit Holder shall immediately notify the local District Office if the taking of water is observed to have any significant impact on the surrounding waters. After hours, calls shall be directed to the Ministry's Spills Action Centre at 1-800-268-6060.

5.2 For Surface-Water Takings
The taking of water (including the taking of water into storage and the subsequent or simultaneous withdrawal from storage) shall be carried out in such a manner that streamflow is not stopped and is not reduced to a rate that will cause interference with downstream uses of water or with the natural functions of the stream.

CONTENT COPY OF ORIGINAL

6. Director May Amend Permit
The Director may amend this Permit by letter requiring the Permit Holder to suspend or reduce the taking to an amount or threshold specified by the Director in the letter. The suspension or reduction in taking shall be effective immediately and may be revoked at any time upon notification by the Director. This condition does not affect your right to appeal the suspension or reduction in taking to the Environmental Review Tribunal under the *Ontario Water Resources Act*, Section 100 (4).

The reasons for the imposition of these terms and conditions are as follows:

1. Condition 1 is included to ensure that the conditions in this Permit are complied with and can be enforced.

2. Condition 2 is included to clarify the legal interpretation of aspects of this Permit.

3. Conditions 3 through 6 are included to protect the quality of the natural environment so as to safeguard the ecosystem and human health and foster efficient use and conservation of waters. These conditions allow for the beneficial use of waters while ensuring the fair sharing, conservation and sustainable use of the waters of Ontario. The conditions also specify the water takings that are authorized by this Permit and the scope of this Permit.

In accordance with Section 100 of the Ontario Water Resources Act, R.S.O. 1990, you may by written Notice served upon me and the Environmental Review Tribunal within 15 days after receipt of this Notice, require a hearing by the Tribunal. Section 101 of the Ontario Water Resources Act, R.S.O. 1990, as amended, provides that the Notice requiring the hearing shall state:

1. The portions of the Permit or each term or condition in the Permit in respect of which the hearing is required, and;
2. The grounds on which you intend to rely at the hearing in relation to each portion appealed.

In addition to these legal requirements, the Notice should also include:

a. The name of the appellant;
b. The address of the appellant;
c. The Permit to Take Water number;
d. The date of the Permit to Take Water;
e. The name of the Director;
f. The municipality within which the works are located;

This notice must be served upon:

CONTENT COPY OF ORIGINAL

The Secretary
Environmental Review Tribunal
655 Bay Street, 15th Floor
Toronto ON
M5G 1E5
Fax: (416) 326-5370
ERTTribunalsecretary@ontario.ca

AND

The Director, Section 34.1,
Ministry of the Environment, Conservation and Parks
Floor 1, 135 St Clair Ave W
Toronto, ON
M4V 1P5

Further information on the Environmental Review Tribunal's requirements for an appeal can be obtained directly from the Tribunal:

by Telephone at	by Fax at	by e-mail at
(416) 212-6349	(416) 326-5370	www.ert.gov.on.ca
Toll Free 1(866) 448-2248	Toll Free 1(844) 213-3474	

This Permit cancels and replaces Permit Number 6423-89RPHE, issued on 2010/10/27.

Dated at Toronto this 30th day of October, 2020.

Gregory Meek
Director, Section 34.1
Ontario Water Resources Act, R.S.O. 1990

Schedule A

This Schedule "A" forms part of Permit To Take Water 3645-BUTNBB, dated October 30, 2020.

CONTENT COPY OF ORIGINAL

Ontario

Ministry of the Environment and Climate Change
Ministère de l'Environnement et de l'Action en matière de changement climatique

AMENDED PERMIT TO TAKE WATER
Ground Water

NUMBER 8103-AJ8LMA

Reference Number 0021-AH3L6A

Pursuant to Section 34.1 of the Ontario Water Resources Act, R.S.O. 1990 this Permit To Take Water is hereby issued to:

The Corporation of Norfolk County
183 Main St.
Norfolk, Ontario
N4B 2M3

For the water taking from: Delhi Municipal Well Field (Well 1, Well 2, Well 3a and Well 3b)

Located at: Lot 19, Concession 14, Geographic Township of Windham
Norfolk

For the purposes of this Permit, and the terms and conditions specified below, the following defi apply:

DEFINITIONS

(a) "Director" means any person appointed in writing as a Director pursuant to section 5 of the OWRA for the purposes of section 34.1, OWRA.

(b) "Provincial Officer" means any person designated in writing by the Minister as a Provincial Officer pursuant to section 5 of the OWRA.

(c) "Ministry" means Ontario Ministry of the Environment and Climate Change.

(d) "District Office" means the Hamilton District Office.

(e) "Permit" means this Permit to Take Water No. 8103-AJ8LMA including its Schedules, if any, issued in accordance with Section 34.1 of the OWRA.

(f) "Permit Holder" means The Corporation of Norfolk County.

(g) "OWRA " means the Ontario Water Resources Act, R.S.O. 1990, c. O. 40, as amended.

CONTENT COPY OF ORIGINAL

You are hereby notified that this Permit is issued subject to the terms and conditions outlined be

TERMS AND CONDITIONS

1. Compliance with Permit

1.1 Except where modified by this Permit, the water taking shall be in accordance with the application for this Permit To Take Water, dated December 16, 2016 and signed by Gary Houghton, and all Schedules included in this Permit.

1.2 The Permit Holder shall ensure that any person authorized by the Permit Holder to take water under this Permit is provided with a copy of this Permit and shall take all reasonable measures to ensure that any such person complies with the conditions of this Permit.

1.3 Any person authorized by the Permit Holder to take water under this Permit shall comply with the conditions of this Permit.

1.4 This Permit is not transferable to another person.

1.5 This Permit provides the Permit Holder with permission to take water in accordance with the conditions of this Permit, up to the date of the expiry of this Permit. This Permit does not constitute a legal right, vested or otherwise, to a water allocation, and the issuance of this Permit does not guarantee that, upon its expiry, it will be renewed.

1.6 The Permit Holder shall keep this Permit available at all times at or near the site of the taking, and shall produce this Permit immediately for inspection by a Provincial Officer upon his or her request.

1.7 The Permit Holder shall report any changes of address to the Director within thirty days of any such change. The Permit Holder shall report any change of ownership of the property for which this Permit is issued within thirty days of any such change. A change in ownership in the property shall cause this Permit to be cancelled.

2. General Conditions and Interpretation

2.1 Inspections
The Permit Holder must forthwith, upon presentation of credentials, permit a Provincial Officer to carry out any and all inspections authorized by the OWRA, the Environmental Protection Act, R.S.O. 1990, the Pesticides Act, R.S.O. 1990, or the Safe Drinking Water Act, S. O. 2002.

2.2 Other Approvals
The issuance of, and compliance with this Permit, does not:

(a) relieve the Permit Holder or any other person from any obligation to comply with any other applicable legal requirements, including the provisions of the Ontario Water Resources Act, and the Environmental Protection Act, and any regulations made thereunder; or

(b) limit in any way any authority of the Ministry, a Director, or a Provincial Officer, including the authority to require certain steps be taken or to require the Permit Holder to furnish any further information related to this Permit.

2.3 Information
The receipt of any information by the Ministry, the failure of the Ministry to take any action or require any person to take any action in relation to the information, or the failure of a Provincial Officer to prosecute any person in relation to the information, shall not be construed as:

(a) an approval, waiver or justification by the Ministry of any act or omission of any person that contravenes this Permit or other legal requirement; or

(b) acceptance by the Ministry of the information's completeness or accuracy.

2.4 Rights of Action
The issuance of, and compliance with this Permit shall not be construed as precluding or limiting any legal claims or rights of action that any person, including the Crown in right of Ontario or any agency thereof, has or may have against the Permit Holder, its officers, employees, agents, and contractors.

2.5 Severability
The requirements of this Permit are severable. If any requirements of this Permit, or the application of any requirements of this Permit to any circumstance, is held invalid or unenforceable, the application of such requirements to other circumstances and the remainder of this Permit shall not be affected thereby.

2.6 Conflicts
Where there is a conflict between a provision of any submitted document referred to in this Permit, including its Schedules, and the conditions of this Permit, the conditions in this Permit shall take precedence.

3. Water Takings Authorized by This Permit

3.1 **Expiry**
This Permit expires on **May 31, 2023**. No water shall be taken under authority of this Permit after the expiry date.

3.2 Amounts of Taking Permitted
The Permit Holder shall only take water from the source, during the periods and at the rates and amounts of taking specified in Table A. Water takings are authorized only for the purposes specified in Table A.

CONTENT COPY OF ORIGINAL

Table A

	Source Name / Description:	Source: Type:	Taking Specific Purpose:	Taking Major Category:	Max. Taken per Minute (litres):	Max. Num. of Hrs Taken per Day:	Max. Taken per Day (litres):	Max. Num. of Days Taken per Year:	Zone/ Easting/ Northing:
1	Well 1	Well Drilled	Other - Water Supply	Water Supply	1,600	24	2,300,000	365	17 545671 4742768
2	Well 2	Well Drilled	Other - Water Supply	Water Supply	1,600	24	2,300,000	365	17 545730 4742552
3	Well 3a	Well Drilled	Other - Water Supply	Water Supply	654	24	941,760	365	17 545829 4742265
4	Well 3b	Well Drilled	Other - Water Supply	Water Supply	1,572	24	2,263,680	365	17 545803 4742286
						Total Taking:	7,805,440		

3.3 Notwithstanding the individual rates and amounts listed in Table A in Condition 3.2, the maximum combined rate and amount of taking from all four wells shall not exceed 79.8 litres per second (4,788 litres per minute) and 6,894,720 litres per day, respectively.

4. Monitoring

4.1 Under section 9 of O. Reg.387/04, and as authorized by subsection 34(6) of the Ontario Water Resources Act, the Permit Holder shall, on each day water is taken under the authorization of this Permit, record the date, the volume of water taken on that date and the rate at which it was taken. The daily volume of water taken shall be measured by a flow meter or calculated in accordance with the method described in the application for this Permit, or as otherwise accepted by the Director. A separate record shall be maintained for each source. The Permit Holder shall keep all records required by this condition current and available at or near the site of the taking and shall produce the records immediately for inspection by a Provincial Officer upon his or her request. The Permit Holder, unless otherwise required by the Director, shall submit, on or before March 31st in every year, the records required by this condition to the ministry’s Water Taking Reporting System.

4.2 The Permit holder shall measure and record water levels in the following monitoring wells using automatic level loggers set at hourly frequency or less:

a) Deeper Overburden: TW1/08, TW1/09, TW2/09, TW7/91, TW9/91, TW12/91 and TW13/91

b) Shallow Overburden: MW5, MW6, MW7, MW8, MW10, OW1S, OW2S/D, and OW3S.

4.3 At the time of renewal or amendment to the Permit, the Permit Holder shall submit to the Director, a monitoring report which presents and interprets the water quantity data to be collected under Condition 4.2 in order to determine the spatial and temporal water level variation trend across the municipal well field. This report shall be prepared, signed and stamped by a licensed Professional Geoscientist or a licensed Professional Engineer specializing in hydrogeology who shall take responsibility for its accuracy.

5. Impacts of the Water Taking

5.1 Notification
The Permit Holder shall immediately notify the local District Office of any complaint arising from the taking of water authorized under this Permit and shall report any action which has been taken or is proposed with regard to such complaint. The Permit Holder shall immediately notify the local District Office if the taking of water is observed to have any significant impact on the surrounding waters. After hours, calls shall be directed to the Ministry's Spills Action Centre at 1-800-268-6060.

5.2 For Groundwater Takings
If the taking of water is observed to cause any negative impact to other water supplies obtained from any adequate sources that were in use prior to initial issuance of a Permit for this water taking, the Permit Holder shall take such action necessary to make available to those affected, a supply of water equivalent in quantity and quality to their normal takings, or shall compensate such persons for their reasonable costs of so doing, or shall reduce the rate and amount of taking to prevent or alleviate the observed negative impact. Pending permanent restoration of the affected supplies, the Permit Holder shall provide, to those affected, temporary water supplies adequate to meet their normal requirements, or shall compensate such persons for their reasonable costs of doing so.

If permanent interference is caused by the water taking, the Permit Holder shall restore the water supplies of those permanently affected.

6. Director May Amend Permit
The Director may amend this Permit by letter requiring the Permit Holder to suspend or reduce the taking to an amount or threshold specified by the Director in the letter. The suspension or reduction in taking shall be effective immediately and may be revoked at any time upon notification by the Director. This condition does not affect your right to appeal the suspension or reduction in taking to the Environmental Review Tribunal under the Ontario Water Resources Act, Section 100 (4).

The reasons for the imposition of these terms and conditions are as follows:

1. Condition 1 is included to ensure that the conditions in this Permit are complied with and can be enforced.

2. Condition 2 is included to clarify the legal interpretation of aspects of this Permit.

3. Conditions 3 through 6 are included to protect the quality of the natural environment so as to safeguard the ecosystem and human health and foster efficient use and conservation of waters. These conditions allow for the beneficial use of waters while ensuring the fair sharing, conservation and sustainable use of the waters of Ontario. The conditions also specify the water takings that are authorized by this Permit and the scope of this Permit.

In accordance with Section 100 of the *Ontario Water Resources Act*, R.S.O. 1990, you may by written Notice served upon me and the Environmental Review Tribunal within 15 days after receipt of th Notice, require a hearing by the Tribunal. Section 101 of the *Ontario Water Resources Act*, R.S.O. 1990 as amended, provides that the Notice requiring the hearing shall state:

1. The portions of the Permit or each term or condition in the Permit in respect of which the hearing is required, and;
2. The grounds on which you intend to rely at the hearing in relation to each portion appealed.

In addition to these legal requirements, the Notice should also include:

a. The name of the appellant;
b. The address of the appellant;
c. The Permit to Take Water number;
d. The date of the Permit to Take Water;
e. The name of the Director;
f. The municipality within which the works are located;

This notice must be served upon:

The Secretary
Environmental Review Tribunal
655 Bay Street, 15th Floor
Toronto ON
M5G 1E5
Fax: (416) 326-5370
ERTTribunalsecretary@ontario.ca

AND

The Director, Section 34.1, Ministry of the Environment and Climate Change
12th Floor
119 King St W
Hamilton ON L8P 4Y7
Fax: (905) 521-7820

Further information on the Environmental Review Tribunal's requirements for an appeal can be obtained directly from the Tribunal:

by Telephone at
(416) 212-6349
Toll Free 1(866) 448-2248

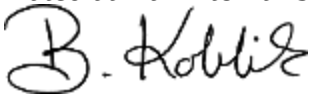
by Fax at
(416) 326-5370
Toll Free 1(844) 213-3474

by e-mail at
www.ert.gov.on.ca

CONTENT COPY OF ORIGINAL

This Permit cancels and replaces Permit Number 6318-99VQTA, issued on 2013/07/23.

Dated at Hamilton this 7th day of February, 2017.



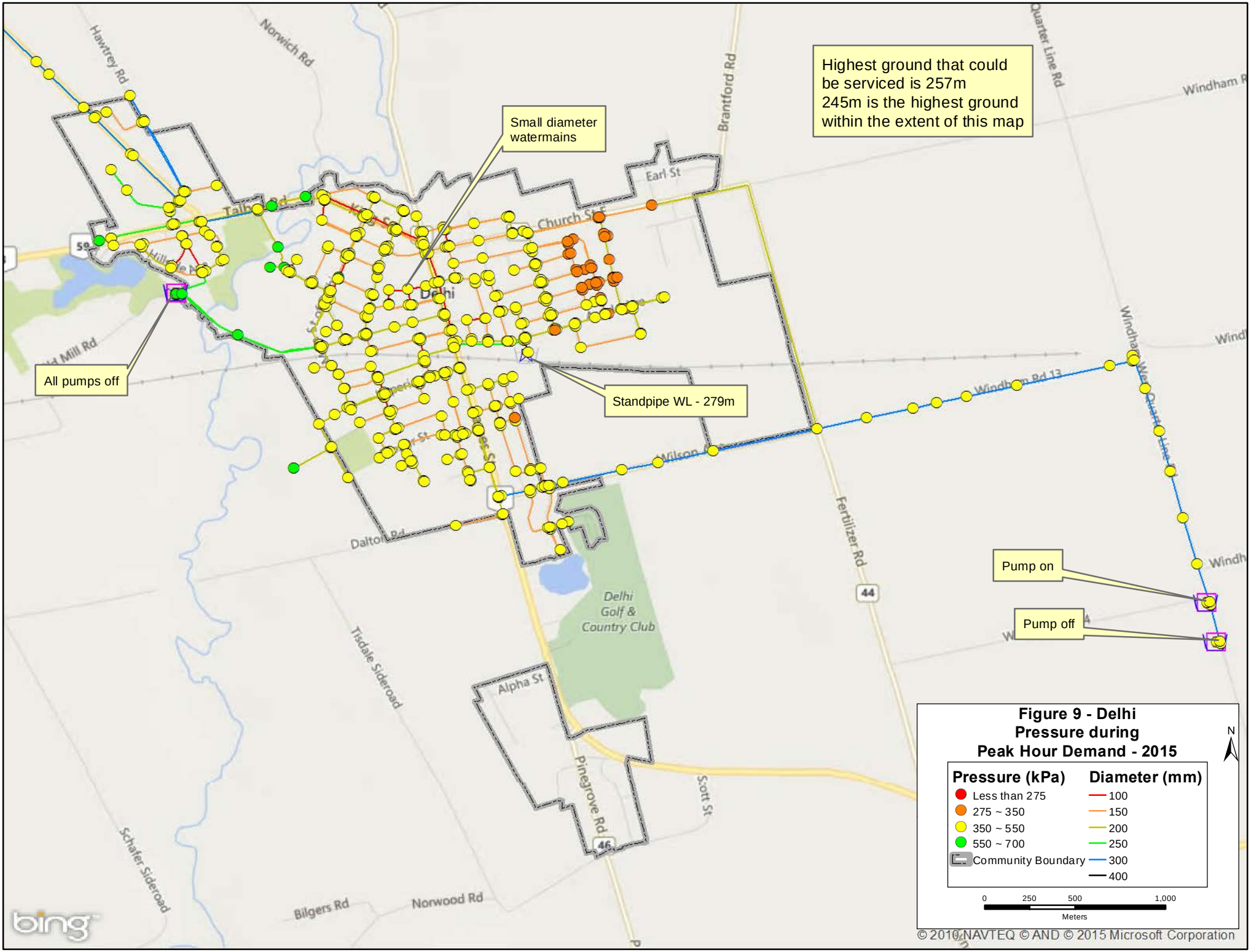
Belinda Koblik
Director, Section 34.1
Ontario Water Resources Act, R.S.O. 1990

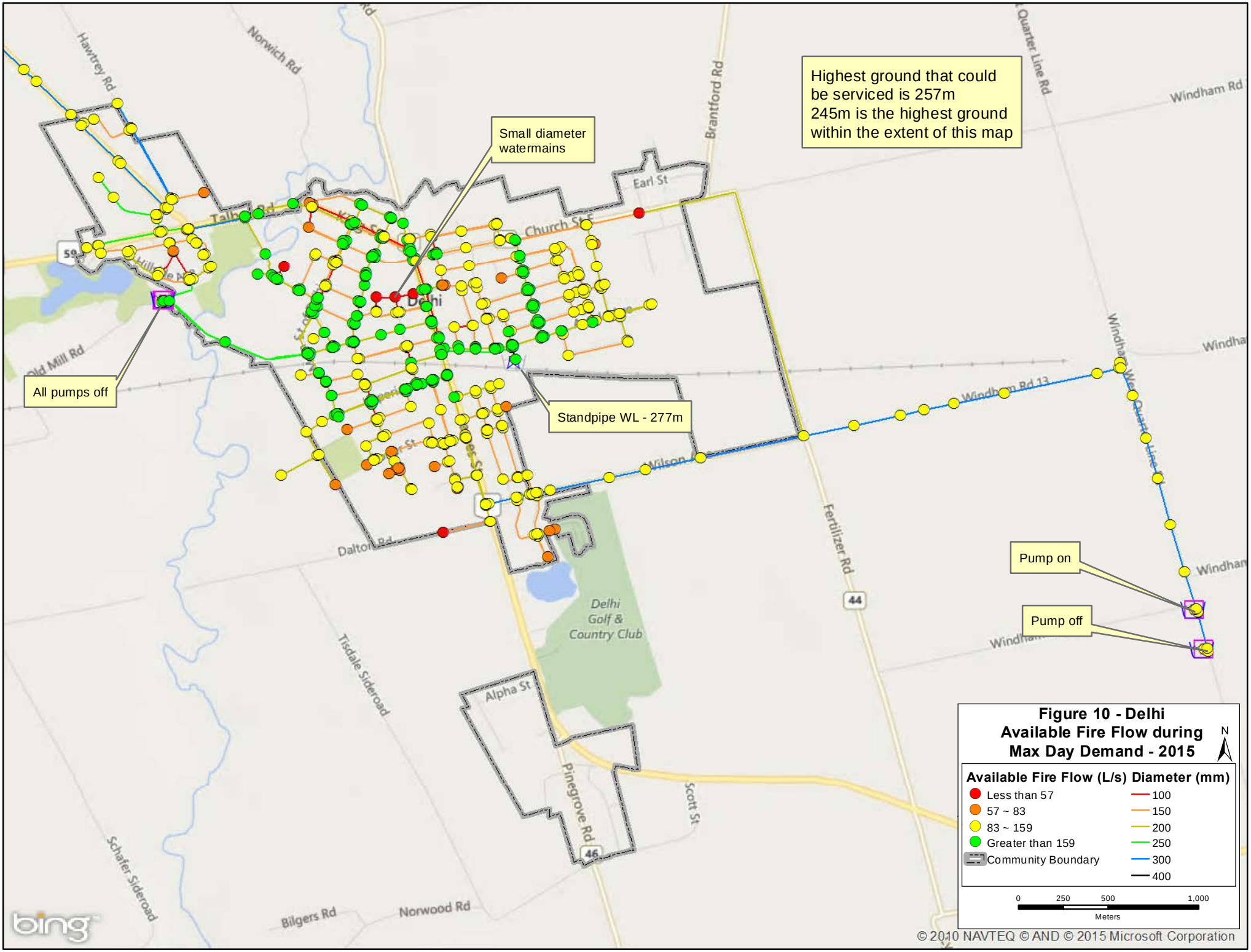
Schedule A

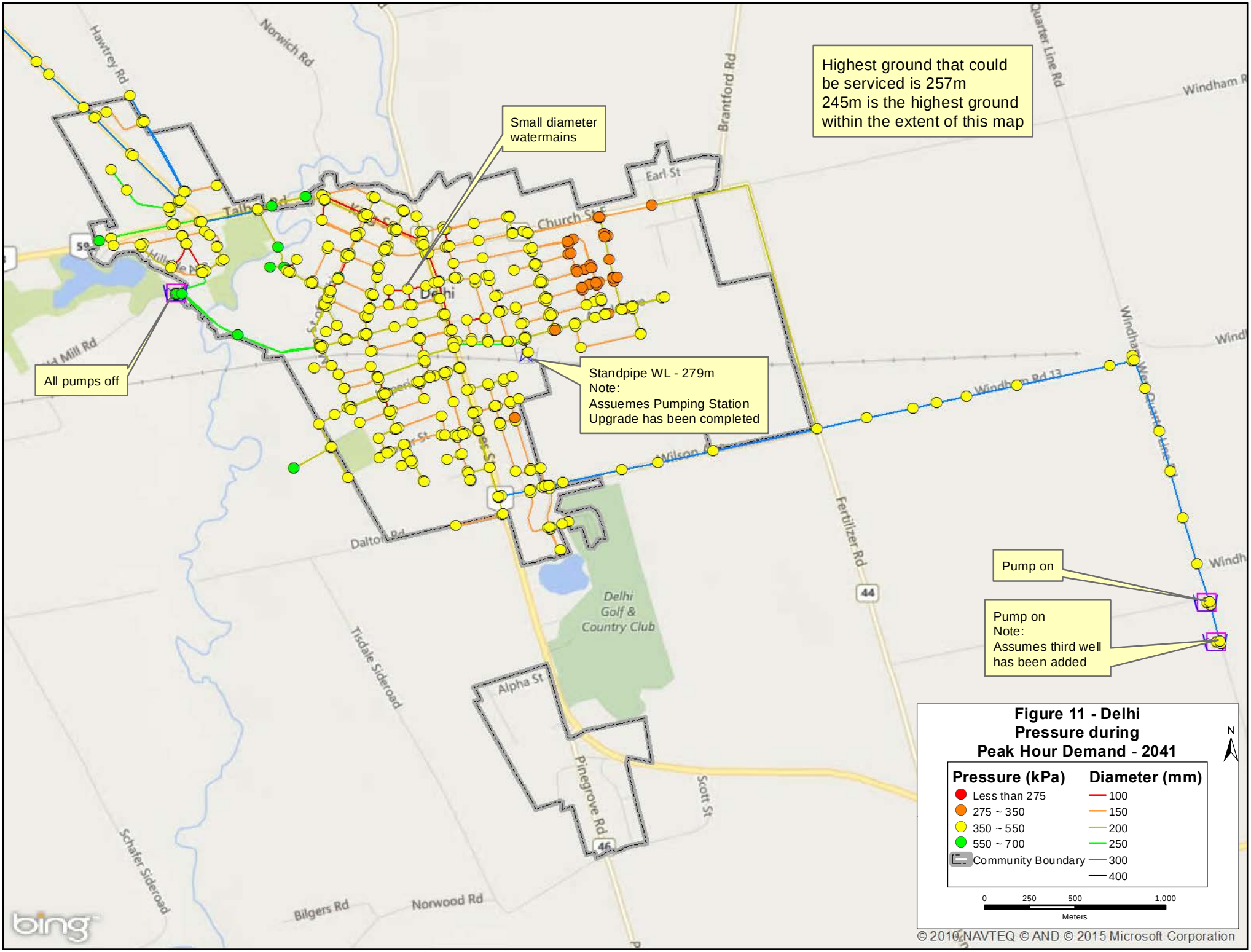
This Schedule “A” forms part of Permit To Take Water 8103-AJ8LMA, dated February 7, 2017.

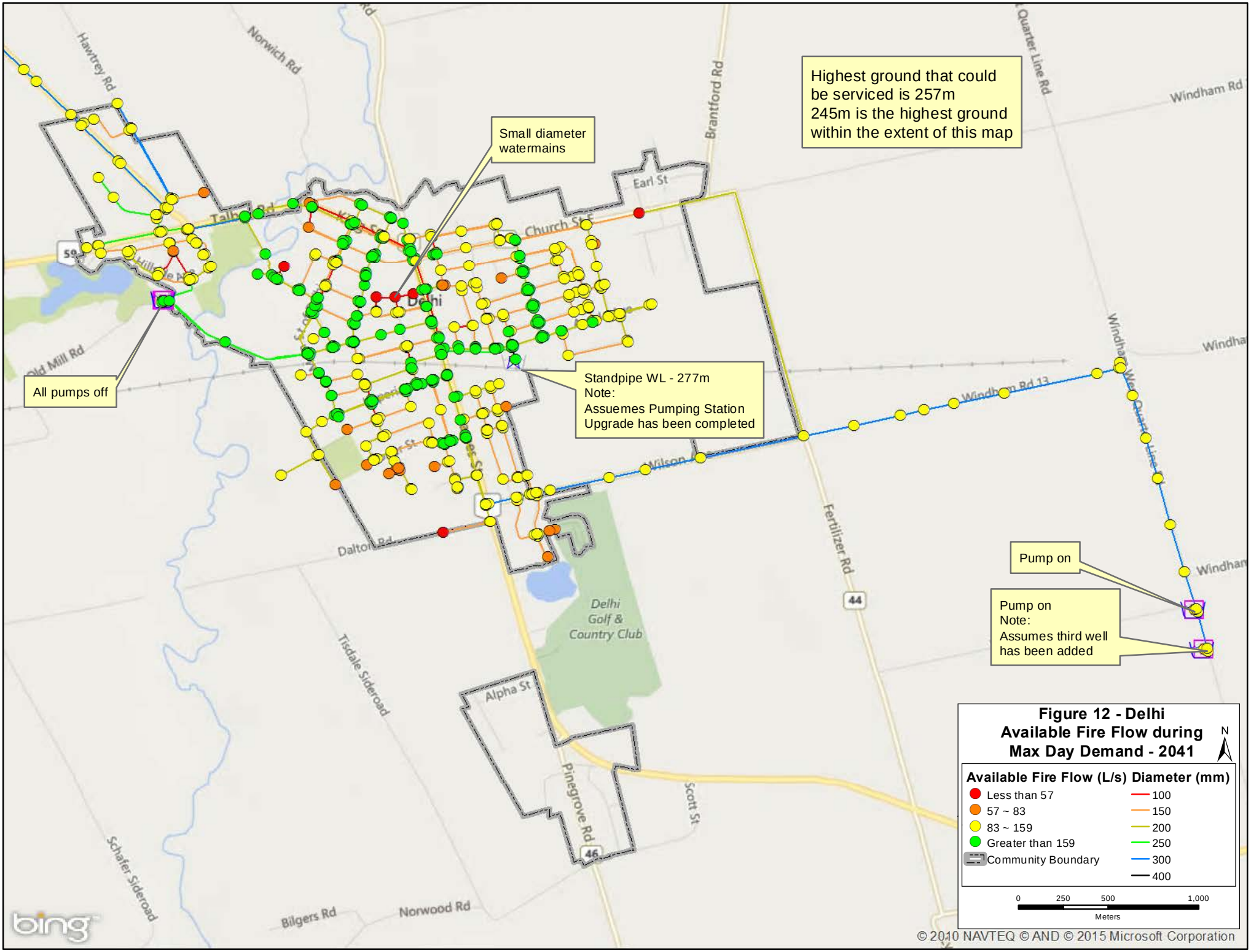
APPENDIX D

Modelling Scenarios (ISMP)


Highest ground that could be serviced is 257m
245m is the highest ground within the extent of this map
Small diameter watermains
All pumps off
Standpipe WL - 279m
Pump on
Pump off
Delhi
Delhi Golf & Country Club
Hawtrey Rd
Norwich Rd
Brantford Rd
Quarter Line Rd
Windham R
Earl St
Talbot Rd
Church St E
Hillside Dr
Mill Rd
Windham Rd 13
Wilson
Fertilizer Rd
Dalton Rd
Tisdale Sideroad
Alpha St
Pinegrove Rd
Scott St
Schafer Sideroad
Bilgers Rd
Norwood Rd
59
44
46
Figure 9 - Delhi
Pressure during
Peak Hour Demand - 2015
Pressure (kPa)
Less than 275
275 ~ 350
350 ~ 550
550 ~ 700
Community Boundary
Diameter (mm)
100
150
200
250
300
400
0 250 500 1,000
Meters
N
bing
© 2010 NAVTEQ © AND © 2015 Microsoft Corporation


Highest ground that could be serviced is 257m
245m is the highest ground within the extent of this map
Small diameter watermains
All pumps off
Standpipe WL - 277m
Pump on
Pump off
Figure 10 - Delhi
Available Fire Flow during
Max Day Demand - 2015
N
Available Fire Flow (L/s)
Less than 57
57 ~ 83
83 ~ 159
Greater than 159
Community Boundary
Diameter (mm)
100
150
200
250
300
400
0 250 500 1,000
Meters
Delhi
Delhi Golf & Country Club
Hawtrey Rd
Norwich Rd
Brantford Rd
Windham Rd
Earl St
Church St
Talbot Rd
Old Mill Rd
Wilson
Fertilizer Rd
Dalton Rd
Tisdale Sideroad
Alpha St
Pinegrove Rd
Scott St
Schafer Sideroad
Bilgers Rd
Norwood Rd
59
44
46
bing
© 2010 NAVTEQ © AND © 2015 Microsoft Corporation


Highest ground that could be serviced is 257m
245m is the highest ground within the extent of this map
Small diameter watermains
All pumps off
Standpipe WL - 279m
Note:
Assuemes Pumping Station Upgrade has been completed
Pump on
Pump on
Note:
Assumes third well has been added
Figure 11 - Delhi
Pressure during
Peak Hour Demand - 2041
Pressure (kPa)
Less than 275
275 ~ 350
350 ~ 550
550 ~ 700
Community Boundary
Diameter (mm)
100
150
200
250
300
400
0 250 500 1,000
Meters
N
Delhi
Delhi Golf & Country Club
Norwich Rd
Brantford Rd
Earl St
Church St
Talbot Rd
Hawtrey Rd
Mill Rd
Wilson
Fertilizer Rd
Windham Rd 13
Quarter Line Rd
Windham Centre Quarter Line
Dalton Rd
Tisdale Sideroad
Alpha St
Pinegrove Rd
Scott St
Schafer Sideroad
Bilgers Rd
Norwood Rd
bing
© 2010 NAVTEQ © AND © 2015 Microsoft Corporation


Highest ground that could be serviced is 257m
245m is the highest ground within the extent of this map
Small diameter watermains
All pumps off
Standpipe WL - 277m
Note:
Assuemes Pumping Station Upgrade has been completed
Pump on
Pump on
Note:
Assumes third well has been added
Figure 12 - Delhi
Available Fire Flow during Max Day Demand - 2041
Available Fire Flow (L/s)
Less than 57
57 ~ 83
83 ~ 159
Greater than 159
Community Boundary
Diameter (mm)
100
150
200
250
300
400
0 250 500 1,000
Meters
N
Delhi
Delhi Golf & Country Club
Hawtrey Rd
Norwich Rd
Brantford Rd
Windham Rd
Earl St
Church St
Talbot Rd
Old Mill Rd
Wilson
Fertilizer Rd
Dalton Rd
Tisdale Sideroad
Alpha St
Pinegrove Rd
Scott St
Schafer Sideroad
Bilgers Rd
Norwood Rd
59
44
46
bing
© 2010 NAVTEQ © AND © 2015 Microsoft Corporation

Planning Justification Report

Delhi Golf and Country Club Redevelopment

Delhi Development Inc.

Norfolk County

Official Plan Amendment
Zoning By-law Amendment
Draft Plan of Subdivision
Draft Plan of Condominium

January 2023

Revised March 2023

GSP group

Planning Justification Report

Delhi Golf and Country Club Redevelopment

Official Plan Amendment
Zoning By-law Amendment
Draft Plan of Subdivision
Draft Plan of Condominium

Norfolk County

January 2023
Revised: March 2023

Prepared for:

Delhi Development Inc.
c/o Geranium
#300 3190 Steeles Avenue East
Markham, Ontario
L3R 1G9

Prepared by:
GSP Group Inc.
72 Victoria Street South, Suite 201
Kitchener, Ontario
N2G 4Y9

Contents

1. Introduction....1
   - 1.1 Background and Context....1
   - 1.2 Purpose and Scope....2
   - 1.3 First Nations Consultation....2

2. Site Location and Context....3
   - 2.1 Subject Site....3
   - 2.2 Surrounding Context....3

3. Proposed Redevelopment....6

4. Settlement Area Boundary Expansion....9
   - 4.1 Provincial Policy Statement 2020....9
   - 4.2 Norfolk County Official Plan....14

5. Planning Policy Review....19
   - 5.1 Provincial Policy Statement 2020....19
   - 5.2 More Homes, More Choice: Ontario's Housing Supply Action Plan....22
   - 5.3 Bill 23: More Homes Built Faster Act, 2022....23
   - 5.4 Norfolk County Official Plan....24
   - 5.5 Haldimand Norfolk Housing and Homelessness Plan....31
   - 5.6 Zoning By-law 1-Z-2014....31
   - 5.7 Draft Plan of Subdivision....34

6. Technical Report Summaries....37
   - 6.1 Functional Servicing Report (FSR) and Stormwater Management Report....37
   - 6.2 Traffic Impact Study....38
   - 6.3 Phase I Environmental Site Assessment....38

6.4 Environmental Noise Report....38
6.5 Hydrogeological Assessment....39
6.6 Preliminary Geotechnical Investigation Report....39
6.7 Servicing Study Technical Memorandum....39
6.8 Economic Benefits Report....39
6.9 Environmental Impact Assessment (EIS)....40
6.10 Archaeological Assessment....40

7. Subject Applications and Planning Opinion....42
7.1 Subject Official Plan Amendment....42
7.2 Subject Zoning By-law Amendment....42
7.3 Draft Plan of Condominium....43
7.4 Draft Plan of Subdivision....44
7.5 Planning Opinion....44

8.0 Public Consultation Plan....48

9.0 Conclusion....49

1. Introduction

1.1 Background and Context

GSP Group is the planning consultant to Delhi Development Inc. and its development manager, Geranium, (collectively, the "Owners"), who are proposing to redevelop the Delhi Golf and Country Club lands (the "Subject Site") located at 905 James Street and 76 Wilson Avenue in Delhi area of Norfolk County. A Planning Justification Report was filed as part of the February 2, 2023, Official Plan Amendment, Zoning By-law Amendment, Draft Plan of Subdivision, and Draft Plan of Condominium submission in relation to the proposed redevelopment of the Subject Site. Since this submission, revisions have been made to the development proposal, and as such this revised Planning Justification Report has been prepared to analyze, discuss, and provide a planning opinion on the revised applications. The Subject Site immediately abuts the southern boundary of the Delhi Urban Area, with the Gilbertville Settlement Area adjacent to the south. For the purposes of this report, Urban Area and Settlement Area will be used interchangeably and shall refer to the *Settlement Areas* as defined by the Provincial Policy Statement.

The golf course as well as surrounding housing and other existing commercial uses on the east side of James Street abut the existing Delhi Urban Area boundary. The Owners are requesting an expansion of the Delhi Urban Area to include the Subject Site and facilitate the development of a residential subdivision, as proposed in this Official Plan Amendment. In addition to implementing the settlement area boundary expansion, the proposal contemplates the redesignation of the lands, a Zoning By-law Amendment, a Draft Plan of Subdivision, and a Draft Plan of Condominium to facilitate the development of 724 residential lots and a block for seniors housing apartments on the Subject Site on full municipal services while protecting natural heritage features and open spaces (the "Proposed Redevelopment"). On February 2, 2023, this application was submitted. Since this time, the proposal has been revised to the now proposed 724 residential lots, up from the previous 492. Rationale for this revision is provided under Section 7.5 of this Report.

The Subject Site is currently designated as Open Space, Agricultural, Hazard Lands, and Provincially Significant Wetlands in Schedule B-17 of the County of Norfolk Official Plan ("OP"). The Subject Site is zoned Open Space, Hazard Lands, and Provincially Significant Wetlands in County of Norfolk Zoning By-law 1-Z-2014. As such, both Official Plan Amendment (the "Subject OPA") and Zoning By-law Amendment (the "Subject ZBA") applications are required to facilitate the Proposed Redevelopment. Draft Plan of Subdivision and Condominium applications are also being submitted to organize the Proposed Redevelopment (the "Subject Applications"). These implementing instruments have been revised accordingly based on the revisions to the Proposed Development.

In order to facilitate the redevelopment of the Subject Site on full municipal services, an Urban Settlement Area boundary expansion is required. In addition to the Official Plan Amendment for a settlement area boundary expansion as part of this submission package, a letter prepared by GSP Group was provided to the County on December 17th, 2021, requesting that the County consider including the Subject Site into Delhi Urban Area through the ongoing Comprehensive Review of the OP. A formal pre-consultation meeting for the Proposed Redevelopment was held with the County on October 12th, 2022.

1.2 Purpose and Scope

This Report has been prepared to provide a planning opinion for the Proposed Redevelopment of the Subject Site and Subject Applications. The objectives of this Report are as follows:

- To provide an overview of the Subject Site, including site description and surrounding uses;
- To provide an overview of the Proposed Redevelopment;
- To provide a summary and assessment of the policies regarding the expansion of urban settlement areas;
- To provide an analysis of how the Proposed Redevelopment aligns with the policy direction for lands within an urban settlement area; and,
- To provide an opinion on the planning merits of the Proposed Redevelopment.

1.3 First Nations Consultation

Delhi Development Inc. began engagement with the First Nations Communities within the Delhi area on October 30, 2022. This included sending an introductory email with the conceptual development plan as well as the draft Stage 1 Archaeological Assessment to the Mississaugas of the Credit First Nations (MCFN), Six Nations of the Grand River (Eco-Centre) and Haudenosaunee Confederacy Chiefs Council (Haudenosaunee Development Institute [HDI]) for review and comment. The engagement also included phone conversations with each of the First Nation representatives and the Proponents Indigenous Consultant. The First Nations were invited to participate during the Stage 2 Archaeological Fieldwork, which began December 5, 2022, and concluded for the 2022 season on December 22, 2022. MCFN, Six Nations and HDI all participated in the field work and provided 1 field liaison to attend each of the scheduled days on site. The fieldwork will resume in the Spring of 2023 and the First Nations will be invited to join again at that time.

2. Site Location and Context

2.1 Subject Site

The Subject Site is known municipally as 905 James Street and 76 Wilson Avenue and abuts the Delhi Urban Area and in close proximity to the Gilbertville Settlement Area in Norfolk County. The Subject Site is approximately 55.32 hectares in area, with frontages along James Street, Wilson Avenue, Tisdale Drive, and St. Michael's Street.

The Subject Site is currently occupied by the Delhi Golf and Country Club, which provides 18 golf holes, a driving range, and restaurant/clubhouse/event space. Several wetland areas are located on the property, and are noted as being Provincially Significant, resulting in the developable area of the Subject Site being approximately 30 hectares. The Subject Site also includes 76 Wilson Avenue, which is a property containing a single detached dwelling abutting the northern area of the golf course (see **Figure 1**).

2.2 Surrounding Context

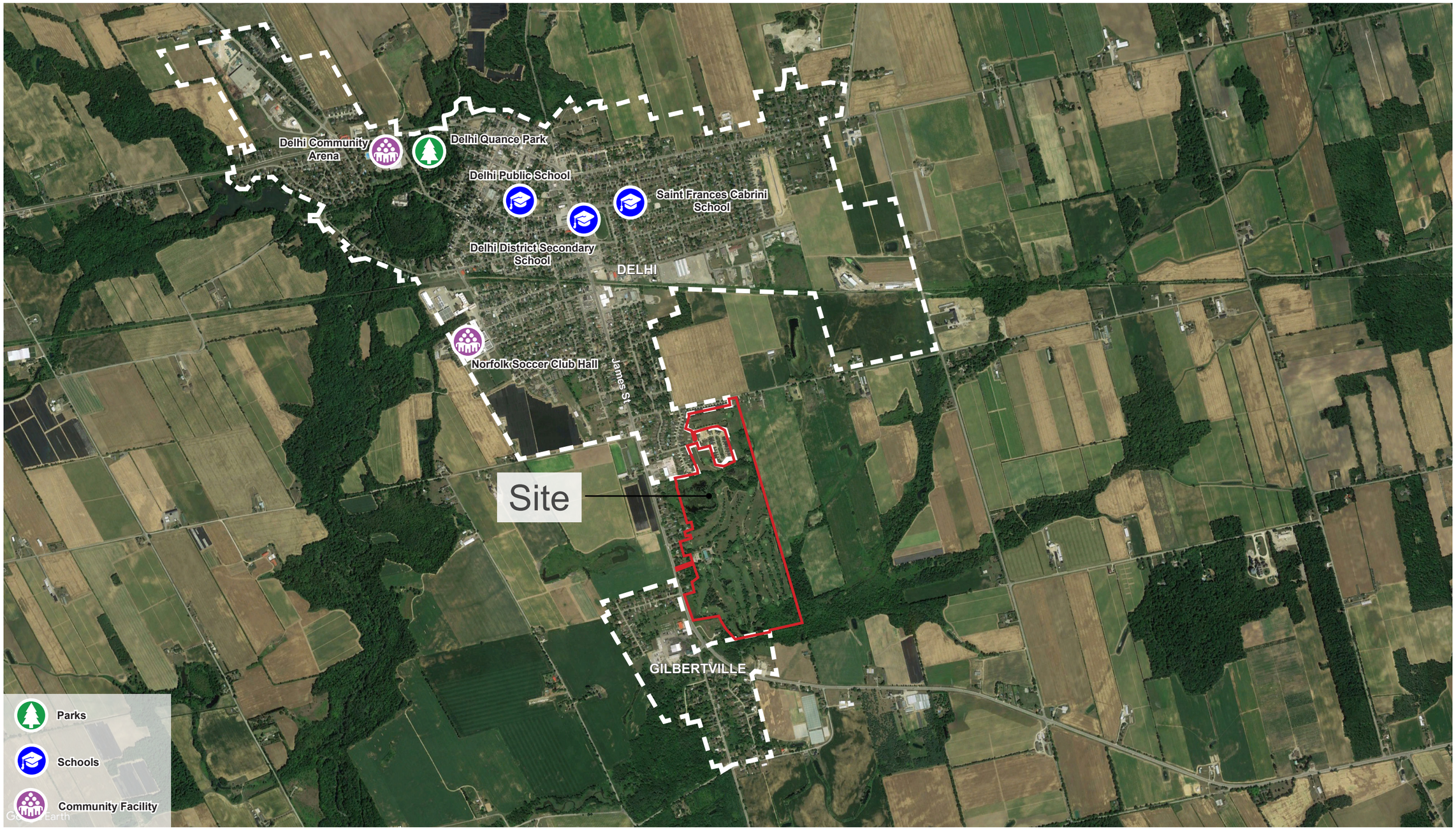
As noted above, the Subject Site abuts the Delhi Urban Area. The Urban Area boundary is shared with the property line in the northern area of the Subject Site. This section of the boundary is irregularly shaped, resulting in the Subject Site surrounding portions of the Urban Area; specifically, Wilson Ave and St. Michael's Street. St. Michael's Street features the recently constructed Norfolk Fairway Estates, a collection of 37 single detached dwellings within lot sizes generally being 13 metres (roughly 42-44 feet) in width. Beyond these residential uses is the Urban Area of the Delhi community, which provides several commercial and community amenities (see **Figure 2**).

The Delhi Golf and Country Club is accessed from James Street/Highway 3, a provincial highway. James Street currently features rural residential housing which abuts the Subject Site. Further along James Street to the south is the Hamlet of Gilbertville. This area is generally characterized by two clusters of residential uses, with non-residential uses located along James Street. Agricultural lands are generally located to both the east and west of the Subject Site. The northern boundary of the Gilbertville Settlement Area (identified within Norfolk to be a Hamlet Area) abuts the most southerly boundary of the Subject Site.

Site Location

Source: Google Earth (2021)

Figure 1



GSP group

Surrounding Context
Source: Google Earth (2021)

Figure 2

3. Proposed Redevelopment

The concept plan for the Subject Site consists of a mix of density and housing types, a central community commons and a block for retirement home use, while maintaining the environmental areas on the property (see **Figure 3**). A total of 874 residential dwellings are proposed, in a mix of single detached, street townhouse and group townhouse, and retirement home units.

A variety of housing types are proposed to provide a range of affordability options.

Housing Type	Unit Count (Original Proposal)	Unit Count (Current Proposal)
5.5 metre (18 ft) Group Townhouse	0	129
5.5 metre (18 ft) Street Townhouse	0	313
6 metre (20 ft) Street Townhouse	0	130
6.7 metre (22 ft) Street Townhouse	0	32
6 metre (20 ft) Group Townhouse	108	0
7.6 metre (25 ft) Semi-detached lot	166	0
9.1 metre (30 ft) Single detached lot	0	57
11 metre (36 ft) Single detached lot	131	50
13.5 metre (44 ft) Single detached lot	106	10
18 metre (60 ft) Single detached lot	3	3
Retirement Home	Approximately 150	Approximately 150
Total	**664**	**874**

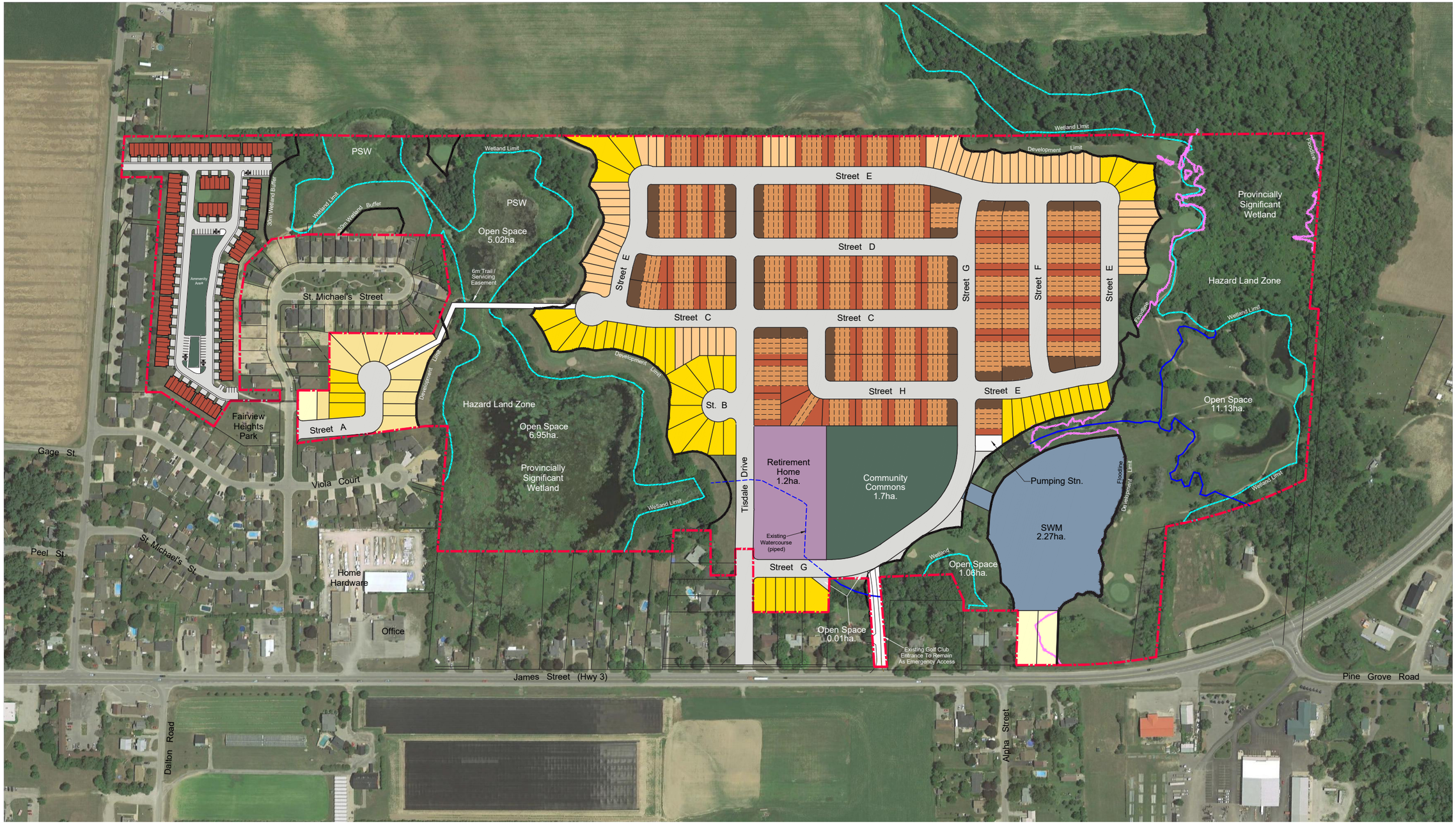
The group townhouse units are located in the northern area of the Subject Site, with access provided from Wilson Avenue. This area of the Subject Site surrounds the existing Urban Area of Delhi, which currently features townhouse dwellings. The proposed townhouse units, organized into 19 freehold condominium blocks, ranging from 4 to 8 units per block, provide a consistent built-form transition from the existing uses to the development proposed on the balance of the Subject Site. This northern part of the Subject Site will be subject to a Draft Plan of Condominium which also provides an outdoor amenity area as detailed in Section 7.3 of this Report.

The mix of street townhouse and single detached lots are proposed to provide a variety of built-forms. 15 single detached lots are provided on Street A, accessed by St. Michael's Street. 10 of these lots are 13.5 metres and one 18 metre to provide a consistent lot pattern with the existing lots on St. Michael's Street.

Two 18 metre wide single detached lots are proposed along James Street, consistent with the existing single detached homes along this street. The remaining lots are provided centrally in the Subject Site.

The retirement home is located at the corner of Tisdale Drive as it enters the proposed Subdivision and proposed Street G, and is adjacent to the proposed community commons (a public park). The existing access to the Delhi Golf Course is to remain but be repurposed solely as an emergency access point.

A substantial community commons space of approximately 1.7 hectares is provided along proposed Street G, adjacent to the retirement home. All Provincially Significant Wetlands (PSWs) are maintained with development set back at least 30 metres. The community commons and PSW areas contribute significant natural spaces for both recreational and passive enjoyment, as well as maintaining the existing ecological function of these features. The proposed servicing easement/trail will utilize the existing cart path, and minimal alternations are proposed in this area to ensure that the appropriate infrastructure can be installed. This easement/trail will continue to provide a pedestrian connection to the houses proposed on Street A. Additionally, a 2.27 hectare stormwater management pond is proposed, accessible from Street G.



GSP group

Figure 3

Concept Plan

Source: GSP Group (2023)

4. Settlement Area Boundary Expansion

A letter prepared by GSP Group was provided to the County of Norfolk on December 17, 2021, requesting that a settlement area boundary expansion for the Subject Site be contemplated through Norfolk County's Comprehensive Review process. The letter provided an overview and analysis of the applicable planning policies that support an expansion of the Delhi Urban Area to include the Subject Site. The following policy analysis is consistent with the review in the provided letter to the County, supplemented to reflect the additional technical work undertaken by the consulting team that accompany the planning applications. The Subject OPA proposes an expansion to the Settlement Area boundary, which is guided by the following policies.

4.1 Provincial Policy Statement 2020

The Provincial Policy Statement 2020 (PPS) sets the policy framework for land use planning in Ontario, covering policies about managing growth, using and managing natural resources, protecting the environment, and public health and safety.

An Official Plan Amendment to implement an Urban Area boundary expansion as well as redesignation of the Subject Site is required to facilitate the Proposed Redevelopment. PPS policy 1.1.3.8 provides direction for settlement area expansions:

A planning authority may identify a settlement area or allow the expansion of a settlement area boundary only at the time of a Comprehensive Review and only where it has been demonstrated that:

a) sufficient opportunities to accommodate growth and to satisfy market demand are not available through intensification, redevelopment and designated growth areas to accommodate the projected needs over the identified planning horizon;

b) the infrastructure and public service facilities which are planned or available are suitable for the development over the long term, are financially viable over their life cycle and protect public health and safety and the natural environment;

c) in prime agricultural areas:

1. *The lands do not comprise specialty crop areas;*
2. *alternative locations have been evaluated, and*
    - *i. there are no reasonable alternatives which avoid prime agricultural areas; and*
    - *ii. There is no reasonable alternatives on lower priority agricultural lands in prime agricultural areas;*

d) *The new or expanding settlement areas is in compliance with the minimum distance separation formulae and*

e) *Impacts from new or expanding settlement areas on agricultural operations which are adjacent or close to the settlement area are mitigated to the extent feasible.*

The Proposed Redevelopment is consistent with and meets the criteria of PPS policy 1.1.3.8 as further described in this section.

Comprehensive Review Process

Under the definitions provided by the PPS, a Comprehensive Review: *Means a) for the purposes of policies 1.1.3.8, 1.1.3.9 and 1.3.2.4, an official plan review which is initiated by a planning authority, or an official plan amendment which is initiated or adopted by a planning authority, which:*

1. *is based on a review of population and employment projections and which reflect projections and allocations by upper-tier municipalities and provincial plans, where applicable; considers alternative directions for growth or development; and determines how best to accommodate the development while protecting provincial interests;*
2. *utilizes opportunities to accommodate projected growth or development through intensification and redevelopment; and considers physical constraints to accommodating the proposed development within existing settlement area boundaries;*
3. *is integrated with planning for infrastructure and public service facilities, and considers financial viability over the life cycle of these assets, which may be demonstrated through asset management planning;*
4. *confirms sufficient water quality, quantity and assimilative capacity of receiving water are available to accommodate the proposed development;*
5. *confirms that sewage and water services can be provided in accordance with policy 1.6.6; and*
6. *considers cross-jurisdictional issues.*

Norfolk County is currently undertaking a Comprehensive Review of its Official Plan including a "Growth Management Study" to establish long-term growth management principles and identify options to accommodate growth to 2051. The County's Growth Management webpage that states, *"the study is considered a Comprehensive Review that will be utilized during the next five-year Official Plan review process or development of a new Official Plan."* Based on the above definition, this study is considered a *Comprehensive Review*, and policies 1.1.3.8, 1.1.3.9 and 1.3.2.4 of the PPS are applicable.

PPS policy 1.1.3.8 a) sufficient opportunities to accommodate growth through intensification and redevelopment.

The County's Growth Management Study is being completed in 4 Phases. The County released the Watson & Associates ("Watson") Long-Term Growth Analysis, dated December 7th, 2021, as part of Phase 2B of the Norfolk County Comprehensive Review. Based on Watson's preliminary analysis of long-term growth, it is anticipated that expansions of existing settlement areas will be required to meet the current and future needs of Norfolk County. It is understood that considerations for settlement area expansions will be provided as Watson & Associates continue into the next phases of work for the Comprehensive Review.

Based on the preliminary identified need for expansion, the Subject Site is an ideal candidate for several reasons, including but not limited to the existence of prime agricultural lands around the County's settlement areas and servicing constraints in the County's urban areas other than Delhi, as described below. Further to the Watson growth projections, and as identified in the Economic Benefits Report prepared by Altus Group, the Census data for 2021 was released subsequent to the December 7th report, demonstrating that Norfolk County is growing significantly faster than the 2021 forecast.

PPS policy 1.1.3.8 b) available infrastructure and public service facilities over the long term.

Based on the projections prepared by Watson, it appears that the County will have difficulty accommodating its short-term growth demand within the existing settlement areas, as it relates to utilizing existing infrastructure.

However, the existing servicing infrastructure in Delhi has capacity to accommodate the Proposed Redevelopment for residential uses on full municipal services, as concluded by R.J. Burnside and T.Y Lin. Further, the Proposed Redevelopment utilizes existing accesses to the Subject Site without the need for additional accesses off existing roads. These access points include access to James Street via an extension of Tisdale Drive, as well as direct access to Wilson Avenue and St. Michael's Street. The existing road infrastructure is sufficient to service the Proposed Redevelopment with minor improvements only recommended for the Tisdale Drive access off James Street, as summarized in the Transportation Impact Study prepared by BA Group. This existing capacity in Delhi contrasts to the lack of capacity/servicing infrastructure in the County's other settlement areas.

Existing public services including, public service facilities, elementary and secondary schools, a community arena, and library are all amenities located in Delhi that will service the Proposed Redevelopment. Furthermore, additional park space through the community

commons in the Proposed Redevelopment will serve as a public park for the new residents within the Proposed Redevelopment.

PPS policy 1.1.3.8 c) expansion into prime agricultural areas does not compromise specialty crops and there are no other alternatives.

The Proposed Redevelopment and request for an Urban Area boundary expansion does not compromise Prime Agricultural Areas as the Subject Site does not contemplate removal of prime agricultural land. The existing use of the lands is a golf course and would not compromise specialty crop areas. This further confirms that the Proposed Redevelopment is an ideal candidate to be included into the Delhi Urban Area through the expansion of the Urban Area boundary.

It is understood that Norfolk County has a large supply of Agricultural designated land, which is considered prime agricultural areas. Although a small area of the Subject Site is designated in Schedule B-17 of the Norfolk County Official Plan, it is reasonable to expect that an Urban Area boundary expansion to include the Subject Site meets the above-noted PPS policy. Given that the Subject Site is currently operating as a golf course, together with the presence of adjacent residential uses, it is clear that no lands are being removed from active agricultural use; as such, this application is not requesting an Urban Area boundary expansion into prime agricultural land. An examination of the lands surrounding each of the settlement areas in the County illustrates that the Subject Site is the only parcel adjacent to a settlement area that is not wholly designated as Agricultural in the Official Plan.

As part of Phase 3 of the County's Comprehensive Review process, the County is undertaking a Land Evaluation and Area Review (LEAR) study. The purpose of this study is to delineate prime agricultural areas in the County. However, based on our review of surrounding agricultural operations, the Subject Site is not near livestock operations and as such, the expansion of the Delhi Urban Area boundary to include the Subject Site would satisfy the Province's Minimum Distance Separation Formulae.

PPS policy 1.4.1 b) is also applicable as it states that planning authorities shall:

"maintain at all times where new development is to occur, land with servicing capacity sufficient to provide at least a three-year supply of residential units available through lands suitably zoned to facilitate residential intensification and redevelopment, and land in draft approved and registered plans".

The Economic Benefits Report prepared by Altus Group, dated March 2023, and submitted as part of this application, reports that the three-year supply for Norfolk County is roughly

1,400 dwelling units. The introduction of 874 residential dwellings in a location immediately adjacent to an existing Urban Area Boundary is estimated to cover more than half of this three-year supply.

Most of Norfolk's Urban Settlement areas do not have water supply capacity available to accommodate significant growth. Implementation of the Inter-Urban Water Supply (IUWS) Strategy, which is intended to address these deficiencies, is expected to take many years, at significant expense to the County.

Although Delhi is the only Urban Area in Norfolk County with sufficient water supply and wastewater treatment capacity available to accommodate significant growth, less than 20 gross hectares of vacant developable land remains in the settlement area. An Urban Area boundary expansion to include the Subject Site would make efficient use of existing capacity in the water supply and wastewater treatment plants in Delhi.

Optimizing the use of existing infrastructure in Delhi through the Proposed Redevelopment will help Norfolk County achieve and maintain land with servicing capacity sufficient to comply with PPS policy 1.4.1 b) and provide a minimum three-year supply of residential units over the next decade.

The Proposed Redevelopment will be serviced by full municipal services and will generate significant Development Charge revenue and require very limited new infrastructure. Development of the Subject Site will generate revenues for the County utilizing existing servicing infrastructure. This could help the County pay for the Inter-Urban Water Supply Strategy and other planned capital works. Given the unit count of the Proposed Redevelopment, it is estimated that development charges to be collected by the County would amount to approximately $13.9 million, based on the Development Charges effective for 2023.

Policy 1.6.6.1 of the PPS states:

"Planning for sewage and water services shall: a) accommodate forecasted growth in a manner that promotes the efficient use and optimization of existing: 1. municipal sewage services and municipal water services …"

An Urban Area boundary expansion to include the Subject Site to facilitate the Proposed Redevelopment is consistent with PPS policy for Settlement Area boundary expansions. It will also help fulfill housing demand to meet the required three-year supply and Norfolk's forecasted growth in a manner that will optimize and efficiently use existing municipal wastewater and water supply services.

4.2 Norfolk County Official Plan

In addition to the criteria provided by the PPS, Section 6.4 of the Norfolk County Official Plan (the "OP") outlines further considerations for expanding settlement areas within the County. The Norfolk County OP is the principal land use planning tool used to manage growth and development within the County to the year 2036. The County, as outlined previously in this report, is currently undertaking a Comprehensive Review of the OP to bring it into conformity with the direction of the PPS and a planning horizon of 2051. This review is ongoing, and the current OP remains in force and effect until the Comprehensive Review is complete and adopted by Council.

Specifically, Policy 6.4.i) states... *the amount of land included within the expansion area is justified based upon the amount and nature of land available for development within the County as a whole and the Urban Areas on an individual basis, the population and household projections for the County, and the intended role of the Urban Area.*

The response to this policy is contained under PPS policy 1.1.3.8.a) found on page 10 of this Report.

Additionally, the OP states that the County will support and promote the continued development of Delhi as the third largest urban area in the County. As noted in the Watson long-term growth forecast, settlement area expansions will be required to accommodate the projected growth. As determined by Altus in their Economic Benefits Report, the projected growth within the Watson report has already been exceeded based on Census data released after the publication of the Watson report. If the County is growing at rate that is faster than set out in the assumptions used in the Watson report, then it is reasonable to conclude that the need for additional housing and land to accommodate it is also greater than noted in the Watson report.

The Proposed Redevelopment is the ideal candidate to be included within the Delhi Urban Area boundary as it is the only parcel in the County situated adjacent to an existing Urban Area boundary that is not agricultural land and there is sufficient servicing capacity available. The Proposed Redevelopment can provide housing in the short-term, which would assist the County in meeting their three-year supply requirements and generate municipal revenue to fund capital expenditures for other settlement areas.

i) the proposed expansion is a logical extension of the Urban Area and will be serviced by full municipal sewer and water services;

The Subject Site abuts the existing Delhi Urban Area boundary and is a logical extension of the Urban Area. In addition, the Subject Site abuts existing development serviced by full municipal sewer and waster services. It is reasonable, efficient and good planning to utilize this existing infrastructure to service to the Proposed Redevelopment. The analysis conducted by RJ Burnside and Associates and T.Y. Lin concludes that Delhi has sufficient capacity within the existing wastewater treatment system to support redevelopment of the Subject Site. Further to this, Delhi is the only urban area within Norfolk County that currently has excess capacity in the water system to support additional demand. Unlike the other five (5) Urban Areas in Norfolk County, Delhi is not constrained from a servicing capacity perspective.

ii) *the land is physically suitable for development, considering any constraints, such as Hazards Lands, or Natural Resource Areas;*

The Subject Site is physically suitable for development as it has previously been developed and is currently used as a golf course. There are portions of the Subject Site that contain Provincially Significant Wetlands (PSWs); however, they are proposed to be protected. The Proposed Redevelopment and resulting site alteration will avoid the PSWs and maintain appropriate buffers as outlined in the Environmental Impact Study (EIS) prepared by Beacon Environmental dated March 2023. The EIS provides further details on the retention of these areas and mitigation measures for maintaining/enhancing ecological function to the existing natural heritage features.

iii) *the proposed expansion will have a compact form, an appropriate mix of land uses, where practical, and densities that efficiently use land, infrastructure, and public facilities, while providing for adequate parks and open space;*

The Proposed Redevelopment of the Subject Site for residential uses will provide a logical extension of existing uses surrounding the golf course and efficiently use land abutting the Delhi Urban Area. The Proposed Redevelopment contemplates a mix of housing that is in keeping with the character of the existing community and offers appropriate transition from the existing uses to the proposed, as well as parkland, open space and natural heritage areas.

iv) *the transportation network can reasonably accommodate the additional volume of traffic and demand for services;*

The existing transportation network and existing accesses to the Subject Site can reasonably accommodate the additional volume of traffic and demand from the Proposed

Redevelopment. James Street, via an extension of the existing Tisdale Drive, would provide a main access to the redevelopment of the Subject Site, with secondary accesses provided along Wilson Avenue and St. Michael's Street. As outlined in the Transportation Impact Study (TIS) prepared by BA Group, dated March 2023, all existing accesses can reasonably accommodate the projected traffic volumes from Proposed Redevelopment, with turn lanes and signalization at James Street at Tisdale Drive.

v) *suitable community and public facilities are available, or can be provided to accommodate the expansion area;*

Delhi is the third largest Urban Area within Norfolk County and contains a range of public and community facilities including elementary and secondary schools, a library, and community arena. These services are available to the future residents of the Proposed Development. These services would be further supported through potential user revenues. Further, the Proposed Redevelopment contemplates a significant portion of the lands (24.21 ha) will be retained as open space/natural heritage area, which would provide passive recreation to existing and future residents. The Proposed Redevelopment also contemplates a community commons, which is proposed to be approximately 1.71 ha and be developed for a community use/public park.

vi) *a suitable plan for phasing, financing and construction of the infrastructure for the expansion area is developed;*

Given that the Subject Site abuts the existing Delhi Urban Area, extending municipal services to the Proposed Redevelopment is not an onerous undertaking. The Functional Servicing Report (FSR) prepared by R.J. Burnside as well as the Servicing Memo prepared by T.Y. Lin reports on the servicing strategies for external and internal servicing requirements to accommodate the Proposed Redevelopment.

vii) *prime agricultural areas are only included within the expansion area if there are no reasonable alternative areas with lower priority agricultural land;*

The existing use of the Subject Site is a golf course. The lands were previously developed and are not used for agricultural purposes. The Subject Site is designated Parks and Open Space, Provincially Significant Wetland, Hazard Land, and a small area (approximately 11%) in the northernmost portion of the Subject Site (areas fronting St. Michael's Street and Wilson Avenue) is designated Agricultural. The lands designated as Agricultural are also being used as a golf course and existing residential homes, which are not traditional agricultural uses. Although the County staff considers most of the agricultural areas in the

County outside of identified settlement areas to be prime agricultural areas, the redevelopment of the Subject Site, including the area designated as Agricultural would not constitute the removal prime agricultural land, based on the existing land use. No adverse impacts are anticipated on existing agricultural operations from redevelopment of the Subject Site for residential uses.

viii) *opportunities for intensification, infill and redevelopment have been explored, and accounted for in evaluating alternatives to an Urban Area expansion;*

Norfolk County has expressed the various servicing constraints that have precluded development within some of the existing Urban Areas. This mainly relates to water capacity, which is significantly limited in most settlement areas in Norfolk County, with the exception of the Delhi community. There is a significant time and cost to introduce the necessary infrastructure to allow for redevelopment and intensification in the other existing settlement areas in the County, outside of Delhi. The Delhi community is not subject to the servicing constraints that are affecting other Urban Areas in Norfolk County. As such, it is anticipated that with the expansion of the Urban Area boundary to include the Subject Site, the site could be redeveloped without delay, as there are no servicing constraints. This would generate a timely stream of development charge revenues and user charges which could be used to help fund the costly new infrastructure required for development in other parts of the County. The Proposed Redevelopment would provide housing supply to meet the County's three-year supply needs, which would help fund the new infrastructure facilitating intensification, infill, and redevelopment in the other settlement areas where there is a moratorium on development until servicing is in place.

ix) *the proposed expansion will not impact cultural heritage resources;*

The County's Heritage and Cultural Mapping indicates that the proposed Urban Area boundary expansion would not impact any cultural heritage resources. Further to this, archaeology works carried out by qualified archaeologist in consultation with the First Nations are underway and will ensure that the proposed expansion will not impact cultural heritage resources.

x) *the proposed expansion will not impact any Significant Natural Heritage Features as identified on Schedule "C" and/or Tables 1 or 2 of Section 3.5 (Natural Heritage Systems); and;*

Natural heritage features on the site have been surveyed through field investigations by Beacon Environmental in consultation with the Long Point Region Conservation Authority.

The Proposed Redevelopment protects and preserves the existing Natural Heritage Features on-site and as such, the proposed Urban Area boundary expansion will not impact these features. The existing PSWs located on the Subject Site are proposed to be retained to preserve the existing ecological function of these features. Further details on the mitigation and protections measures of these Natural Heritage Features are outlined in the EIS prepared by Beacon Environmental.

xi) *the proposed expansion satisfies the Province's Minimum Distance Separation Formulae.*

As noted in the PPS section, the proposed Urban Area boundary expansion to include the Subject Site satisfies the Province's Minimum Distance Separation Formulae as there are no livestock operations within close proximity to the Subject Site. Given the existing land use context of the Subject Site and the surrounding land uses, expansion or intensification of nearby agricultural operations would already be limited even without the Proposed Redevelopment.

Settlement Area Expansion Conclusion

Based on the above analysis of Provincial and County policies for boundary expansions, it is clear that the Subject Site is the ideal candidate for the proposed expansion of the Delhi Urban Area boundary. The expansion proposed in the Subject OPA satisfies the criteria in the PPS and OP as it is the only non-agricultural parcel immediately abutting an existing Urban Area that can be serviced by existing municipal water and wastewater. The revenues generated from the Proposed Redevelopment have potential to offset the financial burden associated with funding new infrastructure to service development within the other five (5) existing Urban Settlement Areas. Further, the timing of the Proposed Redevelopment satisfies the growing need to supply new housing in the County of Norfolk and it meets the Provincial mandate to generate more housing, more quickly as called for in *Bill 23, More Homes Built Faster Act, 2022*.

5. Planning Policy Review

In the context of the Urban Area boundary expanded to include the Subject Site, the Proposed Redevelopment must align with the policy direction for lands within settlement areas. This section provides an analysis of the applicable planning policies.

5.1 Provincial Policy Statement 2020

The overriding vision of the PPS states that *"the long-term prosperity and social well-being of Ontario depends upon planning for strong, sustainable and resilient communities for people of all ages, a clean and healthy environment, and a strong and competitive economy."* The following is a summary of existing PPS policies relevant to the Proposed Redevelopment.

Managing and Directing Land Use

Policy 1.1.1 states, in part, *"Healthy, liveable and safe communities are sustained by:*

a) promoting efficient development and land use patterns which sustain the financial well-being of the Province and municipalities over the long term;

b) accommodating an appropriate affordable and market-based range and mix of residential types (including single-detached, additional residential units, multi-unit housing, affordable housing, and housing for older persons), employment (including industrial and commercial), institutional (including places of worship, cemeteries and long-term care homes), recreation, park and open space, and other uses to meet long-term needs;

c) avoiding development and land use patterns which may cause environmental or public health and safety concerns;

e) promoting the integration of land use planning, growth management, transit-supportive development, intensification and infrastructure planning to achieve cost-effective development patterns, optimization of transit investments, and standards to minimize land consumption and servicing costs;

g) ensuring that necessary infrastructure and public service facilities are or will be available to meet current and projected needs;

h) promoting development and land use patterns that conserve biodiversity."

Response: The Proposed Redevelopment efficiently develops the Subject Site, providing 874 dwellings, the development and construction of which will contribute to the financial, economic and social well-being of the municipality over the long term. The Proposed Redevelopment contemplates a mix of dwelling types, including single detached and

townhouse forms, as well as a proposed retirement home contributing to the variety of housing options available in Delhi and the County.

In addition to housing, the Proposed Redevelopment also contemplates a substantial community commons area (1.71 ha) ensuring appropriate outdoor areas to meet the long term needs of the growing community. The PSWs located on the Subject Site will be protected with appropriate buffers, which will help conserve biodiversity and provide natural area for public benefit and enjoyment. The proposed roads will be built to a municipal standard to ensure safe movement throughout the neighbourhood.

As noted, RJ Burnside and Associates prepared an FSR, which concluded that the Delhi community has sufficient capacity within the existing wastewater treatment system to support the Proposed Redevelopment. In addition, Delhi is the only Urban Area within Norfolk County that currently has excess capacity in the water system, which would be able to support additional demand. Unlike Delhi, until significant servicing capacity limitations are addressed, further development in the other Urban Areas in Norfolk County will be constrained and essentially unable to offer cost effective development opportunities to meet forecasted growth in the short term.

Settlement Areas

Section 1.1.3 establishes the policies regarding the development of settlement areas, stating that *"the vitality and regeneration of settlement areas is critical to the long-term economic prosperity of our communities".*

Policy 1.1.3.1 directs that settlement areas are to be the focus of growth and development. This is furthered by policy 1.1.3.2, which states: *"Land use patterns within settlement areas shall be based on densities and a mix of land uses which:*

a) efficiently use land and resources;

b) are appropriate for, and efficiently use, the infrastructure and public service facilities which are planned or available, and avoid the need for their unjustified and/or uneconomical expansion;

c) minimize negative impacts to air quality and climate change, and promote energy efficiency;

d) prepare for the impacts of a changing climate;

e) support active transportation;

f) are transit-supportive, where transit is planned, exists or may be developed

Land use patterns within settlement areas shall also be based on a range of uses and opportunities for intensification and redevelopment in accordance with the criteria in policy 1.1.3.3, where this can be accommodated.

Policy 1.1.3.3 furthers that Planning authorities are to *"identify appropriate locations and promote opportunities for transit-supportive development, accommodating a significant supply and range of housing options through intensification and redevelopment where this can be accommodated taking into account existing building stock or areas, including brownfield sites, and the availability of suitable existing or planned infrastructure and public service facilities required to accommodate projected needs."*

Response: The mix of urban residential uses on the Subject Site efficiently uses land and resources in an established community area. Servicing infrastructure is available in this location which avoids the need for costly infrastructure expansion in other areas of the County, especially in the short term. The proposed street and group townhouse units as well as the retirement home contribute to the mix of housing available in Delhi, an important aspect of transit supportive development and intensification given Delhi's current predominantly single detached built form.

Housing

Policy 1.4.3 directs planning authorities to *"provide for an appropriate range and mix of housing options and densities to meet projected market-based and affordable housing needs of current and future residents of the regional market area by:*

- *b. permitting and facilitating*
  - *i. all housing options required to meet the social, health, economic and well-being requirements of current and future residents, including special needs requirements and needs arising from demographic changes and employment opportunities; and*
  - *ii. all types of residential intensification, including additional residential units, and redevelopment in accordance with policy 1.1.3.3*
- *c. directing the development of new housing towards locations where appropriate levels of infrastructure and public service facilities are or will be available to support current and projected needs;*

Response: As noted, the Proposed Redevelopment provides a range of single detached and townhouse units, as well as retirement home apartment units. This variety provides an appropriate range and mix of options and densities to meet the needs of the County's existing and future residents. Appropriate levels of infrastructure are available and several public service facilities are located within Delhi and the County.

5.2 More Homes, More Choice: Ontario's Housing Supply Action Plan

In May 2019, the Province of Ontario released the Housing Supply Action Plan. This Plan documented the severity of the housing shortage across the Province and the related housing affordability challenges. The Plan states:

> *"Every town, city and community in Ontario is unique. But no matter where you go, one thing is the same – people are looking for housing that meets their needs and their budget."*
>
> *"Ontario needs more housing, and we need it now."*
>
> *"Government cannot address the housing crisis on its own. We can make it easier for municipalities, non-profits and private firms to build housing. We can help to boost supply and give people more choice."*
>
> *"More homes, more choice outlines our government's plan to tackle Ontario's housing crisis and encourages our partners to do their part by starting now, to build more housing that meets the needs of people in every part of Ontario."*

In December 2021, the Province established a Housing Affordability Task Force to consult with municipalities, the public and industry on additional means by which to increase market housing supply.

On February 8, 2022 the Ministry of Municipal Affairs and Housing published the Report of the Ontario Housing Affordability Task Force, which highlights expert recommendations for additional measures to increase the supply of market housing to address the housing crisis. In the letter of transmittal to the Minister, the Chair of the Task Force states *"The way housing is approved and built was designed for a different era when the province was less constrained by space and had fewer people. But it no longer meets the needs of Ontarians. The balance has swung too far in favour of lengthy consultations, bureaucratic red tape, and costly appeals. It is too easy to oppose new housing and too costly to build. We are in a housing crisis and that demands immediate and sweeping reforms."*

Among its 15 recommendations, the Task Force urges the Province to *"set a bold goal of adding 1.5 million homes over the next 10 years and updating planning guidance to make this a priority."* The effect of this would be to effectively double the amount of new housing that is delivered on an annual basis over recent levels for the next decade.

The Proposed Redevelopment aligns with the mission of the Housing Supply Action Plan and the Task Force's recommendations, by contributing to the supply of new market

housing. Additionally, the Housing Supply Action Plan brought changes to the Provincial Policy Statement (now in the 2020 PPS) to:

- encourage the development of more and different types of housing;
- reduce barriers and costs for developers and provide greater predictability;
- update planning and development policies to reflect Ontario's changing needs; and,
- recognize local decision-making in support of new housing and economic development.

5.3 Bill 23: More Homes Built Faster Act, 2022

On November 28, 2022, the More Homes Built Faster Act, 2022 ("Bill 23") received royal assent. This Bill was introduced, and the Act enacted, to support Ontario's Housing Supply Action Plan and is part of a long-term strategy to help build more homes and make life more affordable for Ontario families.

Bill 23 makes a number of legislative changes, with the intent of increasing the supply of housing and speed in which housing can be constructed in Ontario. Initiatives of the plan includes, and is not limited to:

- Addressing the missing middle
- Building more homes near transit
- Supporting the Growth and Standardization of Affordable and Rental Housing
- Freezing, Reducing and Exempting fees for Building Attainable, Affordable and Non-Profit Housing
- Streamlining Bureaucratic Processes to Get More Homes Built Faster
- Improving the Ontario Land Tribunal to Support Building More Homes Faster
- Creating a New Attainable Housing Program
- Protecting Ontario Homebuyers from Unethical Developers
- Taking Action to Crack Down on Land Speculation
- Improving Ontario's Heritage and Growth Planning

The proposed expansion of the Delhi Urban Area to facilitate the Proposed Redevelopment aligns with the Province's mandate and specifically the policies outlined in Bill 23. Not only will the Proposed Redevelopment make a significant contribution to the supply of housing supply, but the technical work has been completed to make the project shovel ready in 2023 as soon as the necessary approvals are in place. The Proposed Redevelopment is aligned with the spirit and intent of the significant initiatives presented by the Province and will contribute to much needed housing supply in the short term.

5.4 Norfolk County Official Plan

The Norfolk County OP is the principal land use planning tool used to manage growth and development within the County to the year 2036. The County, as outlined previously in this report, is currently undertaking a Comprehensive Review of the OP to bring it into conformity with the direction of the PPS and a planning horizon of 2051. This review is ongoing, and the current OP remains in force and effect until the Comprehensive Review is complete and adopted by Council.

Sustainable Natural Heritage

Section 3.0 of the OP, Sustainable Natural Heritage, provides policy direction on protecting, enhancing, and restoring significant natural features and functions, as well as reducing the risk to public safety and property from natural hazards, such as flooding and unstable slopes.

Section 3.5 provides the three categories for environmental considerations:

a) *Provincially Significant Features, as described in Section 3.5.1 (Provincially Significant Features), and Section 7.4 (Provincially Significant Wetlands Designation);*
b) *Natural Heritage Features, as described in Section 3.5.2 (Natural Heritage Features), and identified on Schedule "C" to this Plan; and*
c) *Hazard Lands, as designated and described in Section 7.3 (Hazard Lands Designation) and designated on Schedule "B" to this Plan.*

Further, Section 3.5.1 provides the following regarding Provincially Significant Features:

a) *Development and site alteration shall not be permitted in a Provincially Significant Feature unless in accordance with provincial and federal requirements.*
b) *Development and site alteration shall not be permitted on lands adjacent to the natural heritage features and areas, unless the ecological function of the adjacent land has been evaluated and it has been demonstrated that there will be no negative impacts on the natural features or on their ecological functions that cannot be adequately mitigated. The extent of adjacent land shall be defined as indicated in Table 1. An Environmental Impact Study (EIS) in accordance with Section 9.7.1 (Environmental Impact Study) of this Plan shall be required for all development proposals adjacent to or abutting areas identified as Provincially Significant Features.*

Response: The Subject Site contains a provincially significant wetland and hazard lands. These areas are not proposed to be developed, will be maintained, and protected with a 30-metre buffer from development. An EIS was prepared providing an analysis of these areas, concluding that the Proposed Redevelopment will not negatively impact these areas. Further, policy 7.4.2.c) establishes that "*New utilities or facilities such as roads, sewer or water lines shall be located outside of a Provincially Significant Wetland (PSW). Where such utilities or facilities must be located within a PSW, alternative methods and measures to minimize impacts on the wetlands shall be considered."* The existing cart path connecting to the portion of the Subject Site adjacent St. Michael's Street will be maintained, and serve as additional function as a servicing easement. It is not anticipated that this will require an amendment to the County OP based on above policy 7.4.2.c) and technical work completed for the Subject Applications.

Maintaining Healthy Communities

Section 5.0 of the OP, Maintaining Healthy Communities, identifies several factors that contribute to the health of communities and a maintained high quality of life. This includes the inter-relationship of the protection of natural heritage, adequacy of infrastructure, land use, growth management, and housing. Section 5.3 provides the policies regarding housing:

a) *At all times, the County shall maintain the ability to accommodate residential growth for a minimum of 10 years through land which is designated and available for residential development. Additionally, the County shall ensure that where new development is to occur, land with servicing capacity sufficient to provide at least a 3-year supply of residential units in draft approved and registered plans, or in cases of residential intensification and redevelopment, land appropriately zoned in the Zoning By-law and available for development or redevelopment.*

b) *The County shall ensure that a full range of housing types and densities are provided to meet the anticipated demand and demographic change. All forms of housing required to meet the social, health and well-being of current and future residents, including those with special needs shall be encouraged. The County shall target that 15 percent of all new housing built in Norfolk County be multi-residential dwellings and 15 percent be semi-detached and townhouse dwellings.*

f) *The County shall consider applications for infill development, intensification and redevelopment of sites and buildings through intensification based on the following criteria:*

   i. *the development proposal is within an Urban Area, and is appropriately located in the context of the residential intensification study;*

   ii. *the existing water and sanitary sewer services can accommodate the additional development;*

   iii. *the road network can accommodate the traffic generated;*

iv. *the proposed development is compatible with the existing development and physical character of the adjacent properties and surrounding neighbourhood; and*

v. *the proposed development is consistent with the policies of the appropriate Land Use Designation associated with the land.*

Response: Altus Group has determined Norfolk County may have less than the minimum three-year housing supply. Their analysis determines that the 874 proposed units of the Proposed Redevelopment would make a significant contribution to the short-term housing supply, providing more than half of the approximately 1,400 required supply in a location that has servicing capacity.

The Proposed Redevelopment will provide a variety of housing types, expanding the variety of housing options and densities available. The proposed housing will contribute to the 15% goal set out in the OP for townhouse dwellings, as well as retirement home units, all of which helps to respond to the anticipated needs of changing demographics. The Proposed Redevelopment meets the criteria set out in policy 5.3.1.f) above, as indicated through the submitted technical reports and is consistent in character and compatibility with the surrounding residential uses.

Section 5.4, Community Design, establishes the policies regarding how the County shall seek to maintain and improve the physical design characteristics of the Urban Areas in the context of new and existing development and stress a generally high quality of settlement design. Policy b) states, in part:

"Through the review of development applications, the County:

- *shall ensure that new development is designed in keeping with the traditional character of the Urban Areas, in a manner that both preserves the traditional image of the Urban Areas and enhances the sense of place within the County while maintaining the community image of existing settlement areas;*
- *shall promote efficient and cost-effective development design patterns that minimize land consumption;*
- *shall promote the improvement of the physical character, appearance and safety of streetscapes, civic spaces, and parks*
- *shall strongly encourage design that considers and, wherever possible, continues existing and traditional street patterns and neighbourhood structure."*

Further to the list of criteria provided in policy b) above, policies c) and h) provide further direction regarding the Proposed Redevelopment:

- *Adequate measures shall be taken to ensure that the permitted uses have no adverse effects on adjacent land uses.*
- *A high quality of park and open space design is strongly encouraged. The land for parkland dedication shall be carefully selected to facilitate their use as a central focal point for new or existing neighbourhoods.*

Response: The Proposed Redevelopment takes its cues from the existing character of the Delhi community, with a portion of housing proposed as single detached dwellings. However, in keeping with provincial and county policy, the proposal also transitions to a denser built form through townhouses and a mid-rise retirement home building containing apartments.

The roads proposed in the Draft Plan of Subdivision will be built to a municipal standard and designed appropriately to ensure safe and welcoming streetscapes. The development of the Subject Site represents the cost-effective use of existing infrastructure, a fundamental planning principle. This is in comparison to the County-wide context where significant servicing constraints currently exist and the need for costly infrastructure expansions limit the ability to accommodate growth, especially in the short term.

Regarding policies c) and h), it is not anticipated that there will be negative impacts on the adjacent land uses. The Subject Site is largely surrounded by natural areas and residential uses, which will not be impacted. To the east are agricultural cropping uses, which are not livestock operations, and it is not anticipated they will be impacted by the development of residential uses on the Subject Site. Further, in addition to the community commons, which is the proposed parkland area, large open space areas will be maintained, aligning with the policy direction.

Managing Growth

Section 6.0 of the OP, Managing Growth, outlines the growth and development policies and urban structures for the six Urban Areas, and ensures the long-term protection of the County's agricultural and rural resources and conservation of natural heritage.

The County is divided into two interrelated parts: settlement areas and the rural area. Settlement areas are comprised of two components: Urban Areas and Rural Settlement Areas. Section 6.4 provides the policies for the Urban Areas of the County. The preamble of this section establishes that the Urban Areas within the County have historically functioned as focal points of growth and development activity, and this role will continue. Policy a) directs that each Urban Area is unique and will accommodate a varied range of growth and development. Policy b) provides further direction, stating:

"It is the policy of this Plan that the Urban Areas will incorporate the following:

i. *a full range of housing types, including affordable and special needs housing;*
ii. *business opportunities at appropriate locations to provide a wide range of employment and services to residents, businesses and visitors;*
iii. *full municipal services, as feasible and appropriate, and an appropriate level of transportation infrastructure;*
iv. *a concentration of community services for the County, including social, cultural, entertainment, health, educational and other supporting facilities; and*
v. *an open space, natural heritage and recreational network that is integrated with open spaces throughout the County, and provides appropriate passive, natural and active areas."*

Section 6.5 provides the policies for each Urban Area, with the section specific to Delhi being Section 6.5.3. It is stated that the County *"will support and promote the continued development of Delhi as the third largest Urban Area in the County. The Delhi Urban Area is recognized as an important urban community, employment, cultural and agricultural support centre in the County."* Policy a) further supports the development of the Delhi Urban Area, stating:

a) *The County shall support the development of a full range of housing types in the Delhi Urban Area, including affordable and special needs housing.*

Response: Regarding the policies directing the function of Urban Areas, the Proposed Redevelopment provides a full range of housing options, including specialty housing. Additionally, the increase in residents to the area will contribute to the economic vitality of Delhi and the other urban areas of the County. As indicated in the FSR, there is sufficient municipal servicing capacity available to service the Proposed Redevelopment. Natural heritage areas are maintained and protected by appropriate buffers on the Subject Site, and a significant open space area is provided, delivering both passive and active recreational areas.

The Proposed Redevelopment would seamlessly integrate into the existing Urban Area as it provides a range of housing types and is readily serviceable by existing municipal water and wastewater infrastructure.

Managing Land Use

Lastly, Section 7.0 of the OP, Managing Land Use, contains the land use designations of the County (see **Figure 4**). Through the proposed expansion of the Delhi Urban Area, the developable areas of the Subject Site would be redesignated to the Urban Residential

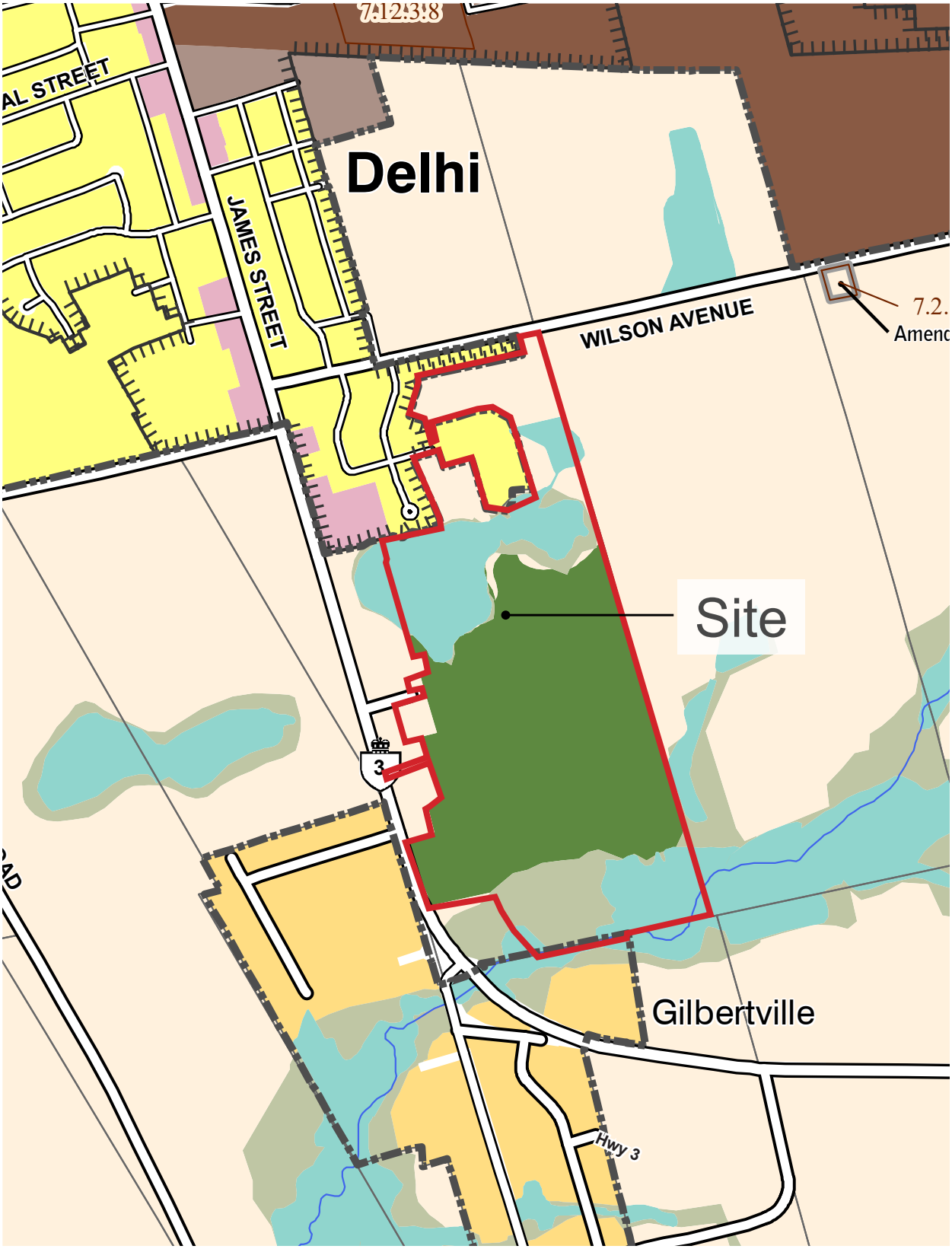
Designation (the PSW and Hazard lands will remain under their current designations). The Urban Residential Designation, as contained in Section 7.7 of the OP, applies to the Urban Areas of the County. Single detached, semi-detached, and townhouse dwellings together with housing for seniors are permitted under this land use designation, as are neighbourhood parks and parkettes.

This section generally directs that single and semi-detached housing forms should have an average net density of 15 units per hectare. The density increases to be generally 15 to 30 units per hectare for medium density uses. Further, medium density uses are to meet the following criteria:

i. *the density, height and character of the development shall have regard to adjacent uses;*
ii. *the height and massing of the buildings at the edge of the medium density residential development shall have regard to the height and massing of the buildings in any adjacent low density residential area and may be subject to additional setbacks, or landscaping to provide an appropriate buffer;*
iii. *the development will be encouraged to have direct access to an arterial or collector road, where possible and appropriate;*

Response: As noted, each of the proposed housing types is permitted under the Urban Residential designation. Regarding density, the northernmost Group Townhouses (Block 202 on the Draft Plan of Subdivision) provides 129 units on 3.67 hectares of land, resulting in a density of approximately 35 units per hectare. While this does slightly exceed the 15 to 30 unit per hectare density range, it should be noted that according to policy this is a "general" guideline and the intent of the density range is maintained.

The remaining developable portion of the Subject Site is 27.44 hectares, proposing 745 residential units, resulting in a density of 27.15 units per hectare, in keeping with Official Plan policy. The townhouse units proposed off Wilson Avenue are located adjacent to existing townhouse buildings, providing a complimentary built form and scale to ensure compatibility.



Land Use Plan

Source: Norfolk County Official Plan Schedule "B-17" (2020)

Figure 4

5.5 Haldimand Norfolk Housing and Homelessness Plan

In addition to the policies in Norfolk County's Official Plan, the Proposed Redevelopment satisfies a variety of housing needs across Norfolk and Haldimand Counties as articulated in the Haldimand Norfolk Housing and Homelessness Plan ("the Plan"), which sets out a ten-year direction to provide Haldimand and Norfolk, along with its housing partners access to safe, appropriate housing options in the community. The Plan was undertaken in 2019 and published in 2020 for the ten-year horizon of 2020-2030. The Plan concluded with key findings from the work undertaken to determine the nature of the housing demand in Haldimand and Norfolk Counties.

- *The population of Haldimand and Norfolk is increasing and projected to continue to increase but at a slower rate compared to Ontario, suggesting the need for dwellings will continue to grow*
- *Older adults and seniors make up a large proportion of the population in Haldimand and Norfolk and the share of seniors is expected to continue to increase in the next five to ten years, indicating a need for dwellings that allow seniors to age in place*
- *Household sizes in Haldimand and Norfolk are shrinking and the majority of households are made up of couples without children and persons living alone. This suggests a need for smaller dwelling sizes*

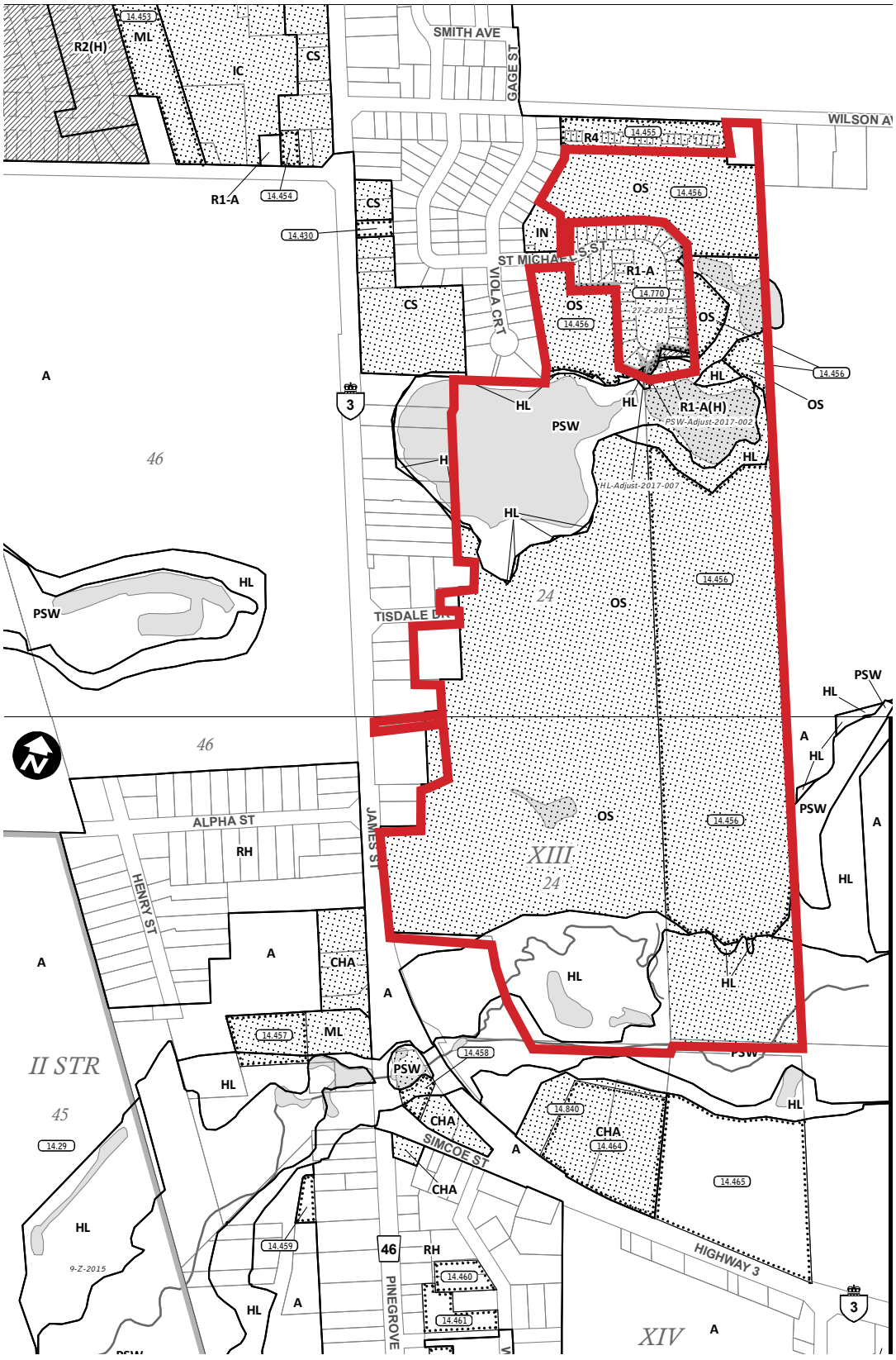
There is demand for more housing in Haldimand and Norfolk Counties. The Proposed Redevelopment can provide 874 dwelling units in a variety of housing forms to meet the needs of the growing population in Norfolk County, specifically Delhi. The Proposed Redevelopment can be developed in a timely manner and as such will not only address the demand of the growing population but significantly contribute to the County's three-year housing supply needs. The Proposed Redevelopment contemplates a variety of housing forms including single-detached, street and group townhouses, and a retirement home with approximately 150 units. The proposal is an all-encompassing community with a range of dwelling sizes, allowing residents to move between housing types, or downsize and move into a retirement home unit, serving the needs of many types of residents and promoting aging in place.

5.6 Zoning By-law 1-Z-2014

Under the County of Norfolk's Zoning By-law 1-Z-2014, the Subject Site is currently zoned Open Space (OS 14.456), Hazard Lands (HL), and Provincially Significant Wetland (PSW) (see **Figure 5**). A Zoning By-law Amendment is required to facilitate the Proposed Redevelopment.

The Subject ZBA proposes to change the zoning of the Subject Site to the R2, R4, R5, and Open Space with site-specific provisions, coinciding with the lotting plan and proposed uses of the concept plan.

The ZBA does not propose to alter the zone boundaries of the HL or PSW zones. Based on “uses permitted in all zones” in the Zoning By-law, the proposed servicing plan can be accommodated and services can utilize the existing cart-path area that goes through the PSW zone. To ensure this is the case, the pump station and stormwater management pond are included in the proposed site-specific zoning.



GSP group

Figure 5

Zoning By-Law

Source: Norfolk County Zoning By-Law Schedule A22,Schedule A-40 (2021)

5.7 Draft Plan of Subdivision

Section 51 of the *Planning Act* sets out the requirements for the legal division of land and/or property, such as an application for Draft Plan of Subdivision. Specifically, Section 51(24) outlines the criteria which the approval authority "shall have regard to" when making decisions on the legal division of land and/or property. Recognizing that the Draft Plan of Subdivision creates the lot fabric for the Subject Site, the applicable criteria and responses explaining how each criterion has been satisfied are outlined in the table below.

Criteria for the Evaluation of a Draft Plan of Subdivision		
Section	**Criteria**	**Response**
51(24)	In considering a draft plan of subdivision, regard shall be had, among other matters, to the health, safety, convenience, accessibility for persons with disabilities and welfare of the present and future inhabitants of the municipality	• The health and safety of future inhabitants will be ensured through high quality design and building design that is AODA compliant. Both public and private roads will be designed to meet municipal and required standards and ensure access for maintenance and emergency vehicles.
(a)	The effect of development of the proposed subdivision on matters of provincial interest as referred to in Section 2	• The PSWs and related buffers on the Subject Site will be maintained through the Proposed Redevelopment. • A Stage 1 Archaeological Assessment was completed and submitted to the Ministry. A Stage 2 Archaeological Assessment will be completed. • The Proposed Redevelopment assists with the provision of a full range of housing in Delhi and Norfolk County.
(b)	Whether the proposed subdivision is premature or in the public interest	• As indicated in Section 4 of this Report, the County is currently undertaking a Comprehensive Review of the OP, which is the appropriate time to request and secure an adjustment to an Urban Area boundary. • Assuming the Urban Area boundary expansion, the subdivision is a natural extension of the existing developed areas of Delhi. • The Proposed Redevelopment assists with the provision of a full range of

		housing in Delhi and the County and is in the public interest. • New development in this location serves the public interest by making wise use of both land resource and servicing infrastructure adjacent to an existing built-up area.
(c)	Whether the plan conforms to the Official Plan and adjacent plans of subdivision, if any	• In the context of an Urban Area boundary expansion to include the Subject Site, the re-designation of the lands to the Urban Residential designation is appropriate and in keeping with the Official Plan.
(d)	The suitability of the land for the purposes for which it is to be subdivided	• As noted above, the majority of the Subject Site is to be designated Urban Residential. • Technical studies have concluded that the land is suitable for the Proposed Redevelopment.
(e)	The number, width, location and proposed grades and elevations of highways, and the adequacy of them, and the highways linking the highways in the proposed subdivision with the established highway system in the vicinity and the adequacy of them	• The Subject Site has convenient access to and is located adjacent to James Street/Highway 3. As concluded in the TIS, the roads proposed in the subdivision and the surrounding road network are expected to operate within future capacity limits with the recommended signalization and turn lanes.
(f)	The dimensions and shapes of the proposed lots	• The proposed lots are of sufficient lot area with appropriate lot frontage. Refer to Section 3 of this Report for further details. • The proposed lots are generally rectangular in shape and sufficiently sized for residential use.
(g)	The restrictions or proposed restrictions, if any, on the land proposed to be subdivided or the buildings and structures proposed to be erected on it	• The PSW areas and related buffers are to be maintained through the Proposed Redevelopment.

	and the restrictions, if any, on adjoining land	
(h)	Conservation of natural resources and flood control	• Stormwater will be appropriately managed as detailed in the Stormwater Management Report. • The PSW areas on the Subject Site will be maintained with appropriate buffers to protect their function.
(i)	The adequacy of utilities and municipal services	• The Functional Servicing Report demonstrates that the Proposed Redevelopment can be adequately serviced with municipal water and wastewater infrastructure, without significant expansions to existing municipal systems.
(j)	The adequacy of school sites	• The Subject Site is located a short distance from several schools, including the Delhi Public School, St. Francis Cabrini School, and Delhi District Secondary School.
(k)	The area of land, if any, within the proposed subdivision that, exclusive of highways, is to be conveyed or dedicated for public purposes	• The community commons is proposed to be conveyed to the County for purposes of public parkland.
(l)	The extent to which the plan's design optimizes the available supply, means of supplying, efficient use and conservation of energy	• The proposed dwellings will be built in accordance with the Ontario Building Code. • The Proposed Redevelopment represents an efficient use of available land.
(m)	The interrelationship between the design of the proposed plan of subdivision and site plan control matters related to any development on the land, if the land is also located within a site plan control area designated under subsection 41(2) of this Act	• A future Site Plan Approval application will be made for the retirement home and Townhouse blocks, should it be required.

6. Technical Report Summaries

6.1 Functional Servicing Report (FSR) and Stormwater Management Report

Functional Servicing and Stormwater Management Reports (FSR) have been prepared by R.J. Burnside & Associates Limited (March 2023) to demonstrate that the Proposed Redevelopment can be developed on full municipal services as seen in the Conceptual Underground Servicing Plan drawing (CUSP).

The development limit was determined through floodplain modelling and discussions with the Long Point Region Conservation Authority (LPRCA) and includes a proposed modification to the floodplain in two areas to optimize the design and development limit of the Site. The adjustments to the floodplain were made possible by the widening and naturalization of the open ditch channel, the larger channel resulted in a volume of cut material that offset the fill volumes for the floodplain adjustments.

One stormwater management (SWM) pond is proposed, which is to be located along the southwestern border of the developable area to meet the SWM criteria with respect to quantity, quality, erosion control, water balance, and conveyance of storm drainage for the Site.

The proposed water supply for the proposed subdivision will be delivered by the existing municipal watermain that services the community of Delhi. The water supply requirement is estimated to be 596 m^3/day for the Average Day Flow and 1267 m^3/day for the Maximum Day Flow (MAF). The watermain will be looped through the Subject Site, connecting to the future James Street watermain and the existing watermain on Wilson Avenue. The supply source along Watson Avenue, James Street, and Dalton Road will provide the minimum required pressure of 275kPa (40psi) for fire flow.

With respect to wastewater, the North Site will connect and discharge into the existing 200mm sanitary sewer system within the St Michaels Street ROW. From there the sewer flows by gravity into the nearby pumping station where it is pumped to the Main Street pumping station and into the Delhi WWTP. A new sanitary pumping station and forcemain is proposed to service the South Site. A collection of 200mm to 250mm gravity sewers within the South Site will collect flows and direct them to the proposed pumping station and onto the forcemain. The forcemain will connect to Delhi's existing sanitary sewer network.

The grading for the Proposed Redevelopment will satisfy the County of Norfolk grading criteria and the stormwater management requirements for this redevelopment.

6.2 Traffic Impact Study

A Traffic Impact Study (TIS) has been prepared by BA Group (March 2023). The traffic demand analysis determined that the site is expected to generate in the order of 405 and 490 two-way vehicle trips during the AM and PM peak hours respectively. The traffic analysis indicated that the transportation network can accommodate the travel demands of the Subject Site with a signalization upgrade and turn lanes to the James Street (Highway 3) / Tisdale Drive intersection which include a southbound left turn lane and a northbound right turn lane on James Street (Highway 3).

A Transportation Demand Management (TDM) Plan is also provided, aiming to encourage the use of alternate travel modes (transit, cycling, walking), increase vehicle occupancy, shift travel to off-peak periods, and reduce vehicle kilometres travelled. Several potential TDM strategies such as promotion of the use of area transit services, proposed signed bicycle route, and the construction of sidewalks are incorporated into the design of the Proposed Redevelopment.

6.3 Phase I Environmental Site Assessment

A Phase 1 Environmental Site Assessment (Phase 1 ESA) was prepared by Golder Associates Ltd. to provide a preliminary qualitative assessment of the environmental condition of the Subject Site.

Based on the information obtained and reviewed as part of this Phase One ESA, five areas of potential environmental concern (“APEC”) were identified. Accordingly, a Phase Two ESA is required for the submission of a Record of Site Condition (“RSC”), if an RSC is required.

6.4 Environmental Noise Report

A preliminary Environmental Noise Report was prepared by Jade Acoustics Inc. (March 2023) to determine if mitigation measures are required to meet the environmental noise guidelines set by the County of Norfolk and Ministry of Environment, Conservation and Parks (MOECP). The Report finds that with appropriate mitigation measures, all lots and blocks in the development will meet the noise guidelines. Mitigation measures include central air conditioning, warning clauses where minor excesses are required, inspection of acoustical treatments and mechanical equipment. A detailed investigation of the existing paintball facility adjacent to the south property line of the subject site limits has been recommended as part of the detailed environmental noise report which will be completed as a condition of draft plan approval during the detailed design process.

6.5 Hydrogeological Assessment

A Hydrogeological Assessment has been conducted by WSP Golder (March 2023) to provide an understanding of soil and groundwater conditions in the pre-development condition in order to assess the impact to groundwater, surface water, and ecologically sensitive areas in the post-development condition.

The water balance has compared pre- and post-development recharge and has provided recommendations on potential Low Impact Development (LID) measures to increase post-development infiltration. The preliminary dewatering assessment provides an estimate of anticipated pumping rates for excavations in utility servicing, residential basements, and the stormwater management pond (SWMP) in order to identify the likely water handling permit required. The assessment has additionally provided an estimate of long-term water management conditions, including an estimate of foundation drain collector flow if required.

6.6 Preliminary Geotechnical Investigation Report

A preliminary Geotechnical Investigation was undertaken by WSP Golder (March 2023) to assess the subsurface conditions on site as well as any geotechnical engineering recommendations for the Proposed Redevelopment. Based on the results of this investigation, the subsurface soil conditions encountered at the site are considered to be suitable for the Proposed Redevelopment. Engineering recommendations regarding the geotechnical design aspects of the project including underground services, pavements and building foundations have been provided and will be reviewed when the design grades and utility invert levels have been finalized as part of the detailed design.

6.7 Servicing Study Technical Memorandum

A Servicing Study Technical Memorandum was prepared by T.Y. Lin International (March 2023) to determine the servicing requirements and to explore the servicing options for the Proposed Redevelopment. Based on the County of Norfolk's 2016 Integrated Sustainable Master Plan (ISMP), the existing servicing infrastructure in proximity to the site is sufficient in capacity to service the Proposed Redevelopment. Operational requirements and potential servicing connection upgrades will be investigated and confirmed during detailed design.

6.8 Economic Benefits Report

An Economic Benefit Report was prepared by Altus Group Economic Consulting (March 2023). It demonstrates that the Proposed Redevelopment is in line with the PPS and supports the long-term economic development in the County of Norfolk. Based on the findings in the report, the Proposed Redevelopment would accommodate growth in a manner that promotes efficient use of existing municipal water, wastewater and road infrastructure and existing community services in Delhi, which provides economic and

financial benefits as well as long-term economic prosperity for the municipality satisfying the requirements set out in the PPS.

6.9 Environmental Impact Assessment (EIS)

An Environmental Impact Assessment (EIS) was prepared by Beacon Environmental. A comprehensive, seasonal field program was developed to understand the site conditions, context and function with respect to natural heritage features.

Natural heritage features were identified through Beacon's field program and through consultation with other members of the consulting team and included a PSW, Stoney Creek, wooded areas, fish habitat and habitat for endangered or threatened species.

Subject to the implementation of the recommended mitigation measures, the Proposed Redevelopment of the Subject Site demonstrates compliance and conformity with the relevant policies of the Provincial Policy Statement, County OP, Endangered Species Act, and the regulations of the LPRCA.

6.10 Archaeological Assessment

A Stage 1 Archaeological Assessment was prepared by WSP Golder for the Subject Site. This Assessment has been submitted to the Ministry of Heritage, Sport, Tourism, and Culture Industries. Background research determined the Study Area has archaeological potential for both Indigenous and historical Euro-Canadian archaeological resources. Based on the criteria outlined above, the Study Area was determined to have archaeological potential for both pre-contact Indigenous and historical Euro-Canadian sites.

Delhi Development Inc. began engagement with the First Nations Communities within the Delhi area on October 30, 2022. This included sending an introductory email with the conceptual development plan as well as the draft Stage 1 Archaeological Assessment to the Mississaugas of the Credit First Nations (MCFN), Six Nations of the Grand River (Eco-Centre) and Haudenosaunee Confederacy Chiefs Council (Haudenosaunee Development Institute [HDI]) for review and comment. The engagement also included phone conversations with each of the First Nation representatives and the Proponents Indigenous Consultant. The First Nations were invited to participate during the Stage 2 Archaeological Fieldwork, which began December 5, 2022, and concluded for the 2022 season on December 22, 2022. MCFN, Six Nations and HDI all participated in the field work and provided 1 field liaison to attend each of the scheduled days on site. The fieldwork will resume in the Spring of 2023 and the First Nations will be invited to join at that time.

To confirm and document areas of archaeological potential within the Study Area a property inspection was completed. The inspection revealed that the majority of the Study Area was disturbed by the construction of the Delhi Golf and Country Club golf course, which includes constructed golf greens, tee-off areas, bunkers, fairways, and manufactured terrain flanking all fairways, greens, and bunkers. The inspection also identified several areas within the Study Area as potentially undisturbed. These included several small, wooded areas, portions of manicured lawn, an overgrown grassy area along the southwestern edge of the Study Area, and the manicured lawn of the residential property at 76 Wilson Avenue.

The current use of the Study Area as a golf course indicates the property has been subject to some level of subsurface disturbance, but it is not possible through visual assessment to determine to what extent the development of the golf course impacted subsurface cultural artifacts that may be present. Three recommendations are presented:

1. Portions of the Study Area that exhibit disturbed conditions, slope or poorly drained areas, as observed during the Stage 1 property inspection, are recommended to be exempt from further Assessment;
2. Prior to any impacts to the portions of the Study Area that exhibit relatively undisturbed conditions, it is recommended these areas be subject to Stage 2 Assessment by means of shovel test pit survey at 5 m intervals; and,
3. Prior to any impacts to the portions of the Study Area that were identified during the Stage 1 property inspection as likely disturbed due to the construction of the golf course, but the level of disturbance was not able to be visually confirmed, it is recommended these areas be subject to Stage 2 Assessment by means of shovel test pit survey at 10 m intervals to confirm the extent of ground disturbance.

7. Subject Applications and Planning Opinion

7.1 Subject Official Plan Amendment

The Subject OPA proposes to implement the expansion of the existing Delhi Urban Area boundary to include the Subject Site and change the land use designation of the Subject Site from the Open Space and Agricultural designations to Urban Residential. Based on the criteria of Section 5.6.1 of the OP, the proposed community commons is considered to be sized between a Neighbourhood Park and parkette, both of which are permitted in the Urban Residential designation. The Urban Residential designation will apply to the stormwater management pond, with a site-specific policy to permit the facility. Similarly, the site-specific policy includes permission for the pump station to facilitate the connection to the municipal servicing system. The Hazard Lands and Provincially Significant Wetlands will remain as they are currently observed.

A Draft OPA has been submitted as part of this application.

7.2 Subject Zoning By-law Amendment

The Subject ZBA will implement the Subject OPA. The Hazard Lands and Provincially Significant Wetlands will be protected, while the remaining lands zone will be rezoned to the R2, R4, and R5 zones. It is noted that although the OP designates a portion of the Subject Site as Agricultural, no agricultural zone is present on the Subject Site, but rather aligns with the use of the land as a golf course.

The Subject ZBA proposes to introduce the following:

- The land proposed to be occupied by the single detached lots will be rezoned to the R2 zone. The R2 zone will include a provision to permit the proposed pump station.
- The land proposed to be occupied by the group and street townhouse dwellings will be rezoned to the R4 zone, with site-specific provisions for each dwelling type.
- The retirement home will be rezoned to the R5 zone.
- The community commons and stormwater management pond will be rezoned OS.

The following site-specific amendments are being sought:

- R2:
    - For single detached lots:
    - Permit an interior lot frontage of 9 metres

    - Permit a corner lot frontage of 13 metres
    - Permit an interior lot area of 270 m^2
    - Permit a corner lot area of 400 m^2
    - Permit an exterior side yard of 4.5 metres
    - Permit an interior side yard of 1.5 metres
    - Permit a pump station.
- R4 for group townhouses:
    - Permit a lot frontage of 5.4 metres to each dwelling unit
    - Permit a rear yard setback of 7 metres to each dwelling unit
- R4 for street townhouses:
    - Permit an interior lot area of 160 m^2
    - Permit an exterior lot area of 300 m^2
    - Permit an exterior side yard of 4.5 metres
    - Permit an interior unit lot frontage of 5.4 metres
    - Permit an exterior unit lot frontage of 10.5 metres
    - Permit a rear yard setback of 7 metres
- R5:
    - Permit a 0 metre setback to piped municipal drains.
- OS:
    - Permit a stormwater management pond.
- Permit a sight triangles measured back from an intersection a total of 7 metres along the street lines.

A Draft ZBA has been submitted as part of this application.

7.3 Draft Plan of Condominium

A Draft Plan of Condominium application is being submitted to facilitate the ownership structure of the townhouse block at the north end of the Subject Site. The Draft Plan of Condominium will be a common elements condominium, with freehold townhouses and shared ownership of the roads and amenity areas. The townhouse lots will be created through the Part Lot Control Exemption process. The lots will be Parcels of Tied Land (POTL), with each lot tied to the Common Element Condominium, and each owner contributing towards the shared costs of maintaining the services for the common element via condominium fees.

This plan of condominium includes the following:

- Drive aisles will be built to the zoning by-law standard;
- 44 visitor parking spaces, including 8 barrier free spaces;
- A common outdoor amenity area.

7.4 Draft Plan of Subdivision

A Draft Plan of Subdivision application is being submitted to create the blocks for the Proposed Redevelopment. A total of 214 blocks are proposed, as well as seven roads (A through H). The block breakdown is as follows:

Blocks	Description	Area (ha)
1-120	Residential	5.45
121-201	Street Townhouses	9.34
202	Group Townhouses	3.67
203	Retirement Home	1.21
204	Community Commons	1.71
205-210	Open Space	24.21
211	Stormwater Management	2.27
212	Pumping Station	0.06
213	Emergency Access	0.15
214	Trail/Servicing Easement	0.14
	Roads	7.11
Total		**55.32**

Applications for release of part-lot control will be submitted for the street townhouse lots in the future.

7.5 Planning Opinion

The revised Proposed Redevelopment continues to be consistent with both PPS and OP direction regard the provision of a range of housing, with an increase in the number of attainable units. By developing a greater number of small dwellings, additional attainable houses will be provided.

The Proposed Redevelopment continues to be consistent with the PPS. The Proposed Redevelopment is consistent with Policy 1.1.1.a), which directs for the efficient use of land and municipal services to sustain the financial well-being of the Province and municipalities over the long term. PPS Policy 1.1.1.b) directs for the accommodation of an appropriate affordable and market-based range and mix of residential types (including single-detached, additional residential units, multi-unit housing, affordable housing, and housing for older persons), employment (including industrial and commercial), institutional (including places

of worship, cemeteries and long-term care homes), recreation, park and open space, and other uses to meet long-term needs. The Proposed Redevelopment is increasingly consistent with this policy, as a greater number of more affordable housing options are provided, and contribute to the range of housing options available in the County and Delhi.

The Proposed Redevelopment continues and improves consistency with the housing policies of the PPS. Policy 1.4.3 directs planning authorities to "provide for an appropriate range and mix of housing options and densities to meet projected market-based and affordable housing needs of current and future residents of the regional market area by:

b. permitting and facilitating

i. all housing options required to meet the social, health, economic and well-being requirements of current and future residents, including special needs requirements and needs arising from demographic changes and employment opportunities; and

ii. all types of residential intensification, including additional residential units, and redevelopment in accordance with policy 1.1.3.3

c. directing the development of new housing towards locations where appropriate levels of infrastructure and public service facilities are or will be available to support current and projected needs.

The increase in the number of townhouse dwellings proposed further contributes to the housing options of current and future residents, in a location with available servicing that can support projected needs.

The Proposed Redevelopment continues to conform to the OP. OP Policy 5.4 establishes the community design policies, which the Proposed Redevelopment continues to achieve. The new development is designed to be in keeping with the traditional character of Urban Areas, as the proposed lot pattern places single detached uses to the perimeter of the Subject Site to appropriately transition to the existing residential uses. The group townhouses remain at the northern end of the Subject Site to transition to the existing townhouse dwellings along Wilson Avenue. The Street Townhouses are located at the interior of the Subject Site, providing the efficient development patterns and attainable housing, allowing the Proposed Redevelopment to better algin with Provincial policy and mandates while integrating with the exiting character of the area. The Proposed Redevelopment is an efficient and cost-effective development design pattern that minimizes land consumption, better conforming to the OP.

In addition, the Proposed Redevelopment further aligns with Provincial mandate to provide further housing, as directed by the More Homes Built Faster Act (Bill 23). The additional housing units proposed further contributes to this mandate, and does so in a more attainable manner than previously proposed.

Over the 2021 to 2051 period, Norfolk County is expected to accommodate substantially more residential growth and market demand than had been planned for in the County's existing Official Plan. Furthermore, opportunities to accommodate growth in some of the County's Urban Areas is limited, especially in the short term, by servicing or physical constraints. As part of the Comprehensive Review of the OP currently underway, the County is assessing whether existing opportunities are sufficient to accommodate forecast growth and market demand and consider alternative directions for growth. In determining how best to accommodate development while protecting provincial interests and delivering on Provincial objectives for housing supply, the proposed Delhi Urban Area boundary expansion should be approved.

Delhi is the only settlement area in Norfolk County that has land abutting the settlement boundary, being the Subject Site, that is not Agricultural land. Accommodating growth in this location also protects agricultural land in other areas of the County in keeping with both the Province's and County's commitment to prime agricultural land. Delhi is also the only settlement area with sufficient water and accompanying wastewater treatment capacity available to accommodate significant growth, specifically in the short term. The proposed Delhi Urban Area boundary expansion optimizes existing infrastructure in Delhi which will help Norfolk County achieve and maintain sufficient land with servicing capacity to accommodate growth and market demand until the major infrastructure improvements required to address servicing constraints in other parts of the County are completed.

As the Proposed Redevelopment of the Subject Site will generate significant development charge revenue and require limited new infrastructure, it will help reduce the amount of financing the County will need to borrow to fund the long-planned Inter-Urban Water Supply Strategy and the planned capital expenditures needed to accommodate growth in other settlement areas.

Further, as indicated in the Economic Benefits Report, residential development, particularly affordable housing, helps to attract a young working-age population. A 2020 blog from the Centre for Urban Research and Land Development at Toronto Metropolitan University highlighted that a deterioration in housing affordability was driving population out of the Toronto CMA and into other parts of Ontario, Haldimand-Norfolk being a top destination for these flows. Population flows into the region were driven by those of the working aged population. Based on the activity rates noted in the 2018 Norfolk County Development Charges Background Study, the residential redevelopment proposed for the Subject Site could boost the labour pool in Norfolk County by 914 jobs.

Overall, the expansion of the Delhi Urban Area to include the Subject Site is consistent with the policies of the PPS, conforms with OP, including the urban residential policies, and is consistent with the provincial objectives set out in Bill 23 to deliver more housing more quickly, including attainable housing, and will facilitate the creation of jobs.

The Proposed Redevelopment is consistent with the PPS and conforms with OP policies. It expands the mix of residential options available in Delhi and the County while also providing specialty housing in the form of the retirement home. Together, the proposed housing options help provide attainable housing. A community commons is proposed to provide a significant public outdoor space and contribute to the vibrancy of the community. The residential uses proposed are consistent with the character of Delhi, transitioning appropriately with the existing residential built forms that border the Subject Site.

Regarding the proposed site-specific amendments presented in the Subject ZBA, these amendments are necessary to introduce the urban residential lots. The request site-specific amendments are reflective of the urban nature of the Proposed Redevelopment, and are consistent with the general provisions and zoning by-law requirements of municipalities with these urban built forms. Modern and compact built forms can be provided, and the amendments proposed to lot area and exterior side yard address specific lots where a deviation from the zoning by-law standard is required to efficiently use the Subject Site. The amendments to the group townhouse provisions are to provide clarity on the where the setbacks are to be measured within the block.

Site-specific zone provisions and OP policies are proposed to provide clear language to permit the stormwater management pond and pump station, which is also consistent with the approach of other stormwater management ponds in the County. Additionally, a site-specific zone provision is proposed to provide clear language that ensures the development is not restricted by piped municipal drains.

8. Public Consultation Strategy

As part of the application package, the *Planning Act* requires a Public Consultation Strategy to outline opportunities for members of the public to be involved in the processing of the Subject Applications. The Applicant is proposing to utilize the public process provided in the *Planning Act*.

In accordance with Sections 17(15), 17(17), 17(19), 17(21), 34(12), 34(13), 51(20) and 51(23) of the *Planning Act*, the County of Norfolk provides public notice of the applications in the prescribed manner and holds a Statutory Public Meeting as part of a regularly scheduled Council Meeting. Any individuals or property owners that request further notification regarding the applications would be formally notified by the Municipality as to the time and location when the County of Norfolk Council will be considering the applications. In addition, a public open house is being held by the Owner on March 27, 2023.

9. Conclusion

This Planning Justification Report accompanies the Official Plan Amendment to implement an Urban Area boundary expansion and redesignation of lands, Zoning By-law Amendment, and Draft Plan of Subdivision and Condominium applications for the Delhi Golf Course lands in Norfolk County. These applications are required to facilitate the development of the Subject Site, as presented through the revised Proposed Redevelopment.

The Proposed Redevelopment consists of a mix of single detached, townhouse, and retirement home dwellings. A total of 874 dwelling units are proposed, along with a large community commons space centrally located in the Proposed Redevelopment. The existing Provincially Significant Wetlands and Hazard Lands will be protected and buffered appropriately from development.

The Planning Opinion concludes that the Subject Applications for the Subject Site remain justified for the following reasons:

- They are consistent with the Provincial Policy Statement, 2020;
- They support the Province's direction to Build More Homes Faster, as called for by the recently approved Bill 23;
- They conform to the policies of the Norfolk County Official Plan;
- The Proposed Redevelopment will contribute to a greater mix of housing options, including specialty housing in the form of a retirement home, in Delhi and Norfolk County;
- Sufficient infrastructure and capacity are available to service the Proposed Redevelopment, where this is not the case in other settlement areas in the County.

It is therefore our opinion that the Subject Applications continue to be appropriate, represent good planning, and should be approved.

Prepared by:

Hugh Handy, MCIP, RPP
Vice President

Evan Wittmann, MCIP, RPP
Planner

DELHI DEVELOPMENT INC. C/O GERANIUM

HYDROGEOLOGIAL ASSESSMENT DELHI GOLF AND COUNTRY CLUB

MARCH 11, 2023

211-13079-00

HYDROGEOLOGICAL ASSESSMENT DELHI GOLF AND COUNTRY CLUB

DELHI, ONTARIO

DELHI DEVELOPMENT INC. C/O GERANIUM

OUR REF. NO. 211-13079-00
DATE: MARCH 2023

WSP
100 COMMERCE VALLEY DRIVE WEST
THORNHILL, ON, CANADA L3T 0A1

TEL.: +1 905 882-1100
FAX: +1 905 882-0055
WSP.COM

WSP Canada Inc.

March 11, 2023

Delhi Development Inc. c/o Geranium
3190 Steeles Avenue East, Suite 300
Markham, ON
L3R 1G9

Attention: Ms. Jennifer Ormiston, Project Manager, Land Development, Geranium

Dear Ms. Ormiston:

Subject: Hydrogeological Assessment – Delhi Golf and Country Club, Delhi, Ontario

WSP Golder (WSP) is pleased to present the results of a Hydrogeological Assessment carried out on proposed redevelopment of the Delhi Golf and Country Club, located at 905 James Street in the Community of Delhi, Ontario (the "Site"). WSP was retained by Delhi Development Inc. Care Of (c/o) Geranium (the "Client") to conduct a hydrogeological investigation to accompany an Official Plan Amendment (for boundary expansion and redesignation), a Zoning By-law Amendment and draft plan of subdivision and condominium applications ("development applications") for a proposed residential development at the Site. This report includes an investigation on soil and groundwater conditions, a water balance assessment to compare pre- and post-development infiltration and runoff, and a preliminary dewatering assessment to estimate flow rates for both short-term construction and long-term water management.

We trust this report meets your requirements. If you have any questions regarding this report, please contact the undersigned.

Yours Sincerely,

Leon Halwa, M.Sc., P.Geo
Hydrogeologist
Earth and Environment

Phyllis McCrindle, M.Sc., P.Geo.
Senior Hydrogeologist
Earth and Environment

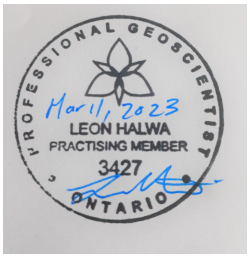
WSP ref.: 211-13079-00

100 Commerce Valley Drive West
Thornhill, ON, Canada L3T 0A1

Tel.: +1 905 882-1100
Fax: +1 905 882-0055
wsp.com

SIGNATURES

PREPARED BY

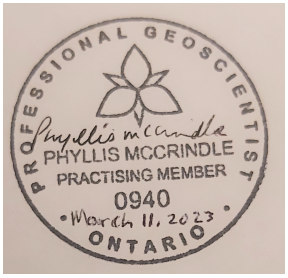


March 11, 2023

Leon Halwa, M.Sc., P. Geo
Hydrogeologist

Date

REVIEWED BY



March 11, 2023

Phyllis McCrindle, M.Sc., P.Geo.
Senior Hydrogeologist

Date

TABLE OF CONTENTS

1 INTRODUCTION 1
2 BACKGROUND 2
2.1 Site Description 2
2.2 Source Water Protection 2
2.3 Physiography, Topography and Drainage 7
2.4 Water Supply Wells 7
2.5 Regional Geology and Hydrostratigraphy 8
3 SITE CHARACTERIZATION (FIELD INVESTIGATION) 12
3.1 Work Program 12
3.2 Site Geology and Soil Conditions 13
3.2.1 Hydrualic Conductivity Testing 18
3.2.2 Grain Size Analysis 19
3.3 Groundwater Level Monitoring 21
4 WATER BALANCE 25
4.1 Water Balance Metholodology 25
4.2 Climate and Water Surplus 25
4.3 Inputs to the Water Balance 26
4.3.1 Pre-Development Conditions 27
4.3.2 Post-Development Conditions Without Mitigation Measures 30
4.3.3 Post-Development with Mitigation Measures 32
4.4 Water Balance Calculations 34
4.4.1 Pre-Development Conditions 34
4.4.2 Post-Development Conditions Without Mitigation 35
4.4.3 Post-Development Conditions with Mitigation 36
5 DEWATERING ASSESSMENT 38
5.1 Dewatering Potential 38
5.2 Dewatering Approach and assumptions 39
5.3 Dewatering Flow Rates 41
6 DISCUSSION AND RECOMMENDATIONS 46
7 STANDARD LIMITATIONS 48
8 REFERENCES 50

TABLES

TABLE 1: MECP WATER WELL RECORDS 8
TABLE 2: HYDRAULIC CONDUCTIVITY ESTIMATES FROM SINGLE WELL RESPONSE TESTING 18
TABLE 3: HYDRAULIC CONDUCTIVITY ESTIMATES BASED ON THE HAZEN APPROXIMATION 19
TABLE 4: SOIL CLASSIFICATION BASED ON GRAIN SIZE ANALYSIS 20
TABLE 5: SUMMARY OF GROUNDWATER MONITORING 21
TABLE 6: INFILTRATION FACTORS USED IN THE WATER BALANCE 27
TABLE 7: LAND-USE AREAS USED IN THE DEVELOPMENT 31
TABLE 8: WATER BALANCE SUMMARY RESULTS FOR THE ENTIRE SITE 34
TABLE 9: PRE AND POST DEVELOPMENT WATER BALANCE WITHOUT MITIGATION 35
TABLE 10: PRE AND POST DEVELOPMENT WATER BALANCE WITH MITIGATION 36
TABLE 11: SUMMARY OF ELEVATION RANGES AT THE SITE 38
TABLE 12: SUMMARY OF ESTIMATED DEWATERING RATES 43

FIGURES

FIGURE 1: SITE LOCATION 4
FIGURE 2: PROPOSED DEVELOPMENT PLAN 5
FIGURE 3: SOURCE WATER PROTECTION 6
FIGURE 4: MECP WATER WELL RECORDS 10
FIGURE 5: SURFICIAL GEOLOGY 11
FIGURE 6: BOREHOLE AND MONITORING WELL LOCATIONS 14
FIGURE 7: CROSS SECTION A-A' 15
FIGURE 8: CROSS SECTION B-B' 16
FIGURE 9: CROSS SECTION C-C' 17
FIGURE 10: INTERPRETED GROUNDWATER CONTOURS 24
FIGURE 11: PRE-DEVELOPMENT LAND USE 29
FIGURE 12: REPRESENTATIVE DEWATERING SECTIONS 42

APPENDICES

A BOREHOLE LOGS AND GRAIN SIZE CURVES

B MECP WATER WELL RECORDS

C HYDRAULIC CONDUCTIVITY ANALYSIS

D SOIL CLASSIFICATION AND HAZEN ANALYSIS

E WATER LEVEL MONITORING

F WATER BALANCE

G DEWATERING ASSESSMENT

1 INTRODUCTION

WSP Golder (WSP) was retained by Delhi Development Inc. c/o Geranium (the "Client") to conduct geotechnical, hydrogeological, and environmental investigations for a proposed redevelopment of the Delhi Golf and Country Club, located at 905 James Street in the Community of Delhi, Ontario (the "Site"). The results of the hydrogeological assessment have been prepared for the Site to accompany an official plan amendment (for a boundary expansion, and redesignation), zoning bylaw amendment and draft plan of subdivision and condominium applications ("development applications"). The Site location is shown in **Figure 1**.

The objective of the hydrogeological investigation is to provide an understanding of soil and groundwater conditions in the pre-development condition in order to assess the impact to groundwater, surface water, and ecologically sensitive areas in the post-development condition. The investigation has collected soil and groundwater data in order to characterize hydrogeological conditions at the site for use in both the water balance and dewatering assessments. A water balance has compared pre- and post-development recharge and has provided recommendations on potential Low Impact Development (LID) measures to increase post-development infiltration. The preliminary dewatering assessment provides an estimate of anticipated pumping rates for excavations in utility servicing, residential basements, and the stormwater management pond (SWMP) in order to identify the likely water handling permit required. The assessment has additionally provided an estimate of long-term water management conditions, including an estimate of foundation drain collector flow if required.

The interpretations and recommendations provided in this report pertain to the proposed redevelopment of the Delhi Golf and Country Club and is not applicable to other project sites. If the project is modified in concept, location, or elevation, the interpretations and recommendations in this report should be reviewed to ensure they remain valid.

2 BACKGROUND

2.1 SITE DESCRIPTION

The Site is approximately 55.32 hectares (ha) in area, occupied primarily by the Delhi Golf and Country Club. Approximately 59% (32.8 ha) of the Site is currently occupied by landscaped lawns, however areas of shrubs, woodland areas, and artificial water features exist within the golf course. There are approximately 10.7 ha of Provincially Significant Wetlands (PSWs) across the Site in two main areas. The first area is located at the southern end of the Site within the Stony Creek natural heritage area. Stony Creek flows from northeast to southwest along the southern end of the Site and is comprised of wooded wetlands along the tributary system. The second area of PSWs is in the west-central part of the Site east of James Street and south of St. Michaels Street (see **Figure 1**). These are identified as pocket wetlands connected via a tributary of Stony Creek, which bisects the Site along the northern end of the Site.

The Site resides south of the Urban Area of the former Township of Delhi in Norfolk County, along Highway 3. Agricultural lands border the Site to the east, while low-density single detached residential subdivisions border the Site along the west. A mix of agricultural lands, rural properties, and pockets of residential communities occupy area west of Highway 3.

The Site is proposed to be developed into a residential community with approximately 16.2 ha of residential homes, 8.1 ha of roads, sidewalks, and impervious recreational trails, 1.2 ha devoted to a retirement village, and 29.8 ha of area preserved as wetlands, open-spaced lawns, amenity areas, and natural areas[1] (see **Figure 2**). The existing golf course clubhouse and parking facilities are proposed for removal and replaced with a 1.7 ha area preserved as a community commons park setting. The redevelopment will be serviced with a 2.3 ha stormwater management pond (SWMP) and pumping station located in the southern end of the development (see **Figure 2**).

2.2 SOURCE WATER PROTECTION

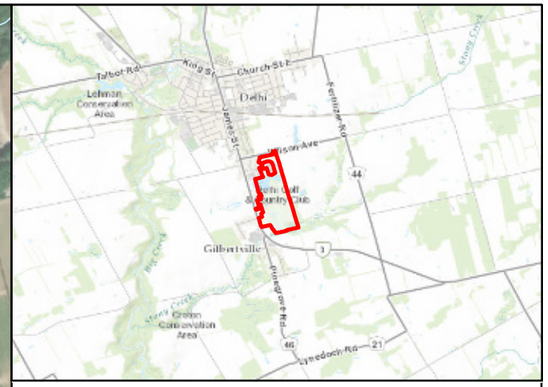
The Site resides within the Long Point Source Protection Area (Lake Erie Source Protection Region), with the entire Site mapped as a Highly Vulnerable Aquifer (HVA), based on the Ministry of the Environment, Conservation and Parks (MECP) Source Protection Information Atlas (see **Figure 3**). Areas identified as having HVA regulated areas typically have transmissive surficial conditions that may increase the risk of contamination to shallow aquifers. HVAs have been mapped through much of Norfolk County (and across all of the Site), likely due to the presence of shallow sand at the Site (see Sections 2.3 and 3.2). The Site is additionally designated as a Significant Groundwater Recharge Area (SGRA), which is designated in areas that are characterized by porous soils which allow accelerated infiltration into the aquifer. Although the Site is identified as being within an SGRA, the vulnerability and risk is classified as low (Vulnerability Score of 0). There are no designated Wellhead Protection Areas (WHPAs) at the Site, with the nearest WHPA approximately 2.5 km west of the Site (see **Figure 3**). WHPAs are areas on the land around a municipal water supply well with the size and lateral extend determined by how quickly water travels to the well, measured in years. The Clean Water Act (2006) requires a 100 m radius around the municipal supply well

[1] Based on the development designs provided by GSP dated February, 2023 (file cp21208zb).

(denoted as WHPA-A). WHPA-B, WBPA-C, and WHPA-D are areas denoted by a 2-year, 5-year, and 25-year time of travel respectively. The Delhi municipal supply wells (Wells 1 to 3) are located 3.4 km to the west of the Site, with the nearest WHPA-D at 2.5 km.

An assessment of source water protection areas across the Site have identified there would not be development restrictions or significant constraints as a result of source protection regulations. Areas of HVA and SGRAs contain a vulnerability score of 6 or less, which is determined by the MECP as not being significant. In accordance with the Long Point Source Protection Plan (2020), areas that are deemed to not have significant threats to drinking water do not have constraints to development.

Prepared By: Tanya.Peterson



LEGEND:

- SITE BOUNDARY
- 500 m STUDY AREA
- WATERCOURSE
- WATERBODIES
- PROVINCIALLY SIGNIFICANT WETLAND

TITLE:
SITE LOCATION MAP

PROJECT:
HYDROGEOLOGICAL INVESTIGATION
DELHI GOLF COURSE REDEVELOPMENT
DELHI, ONTARIO

CLIENT:
DELHI DEVELOPMENT INC. C/O GERANIUM

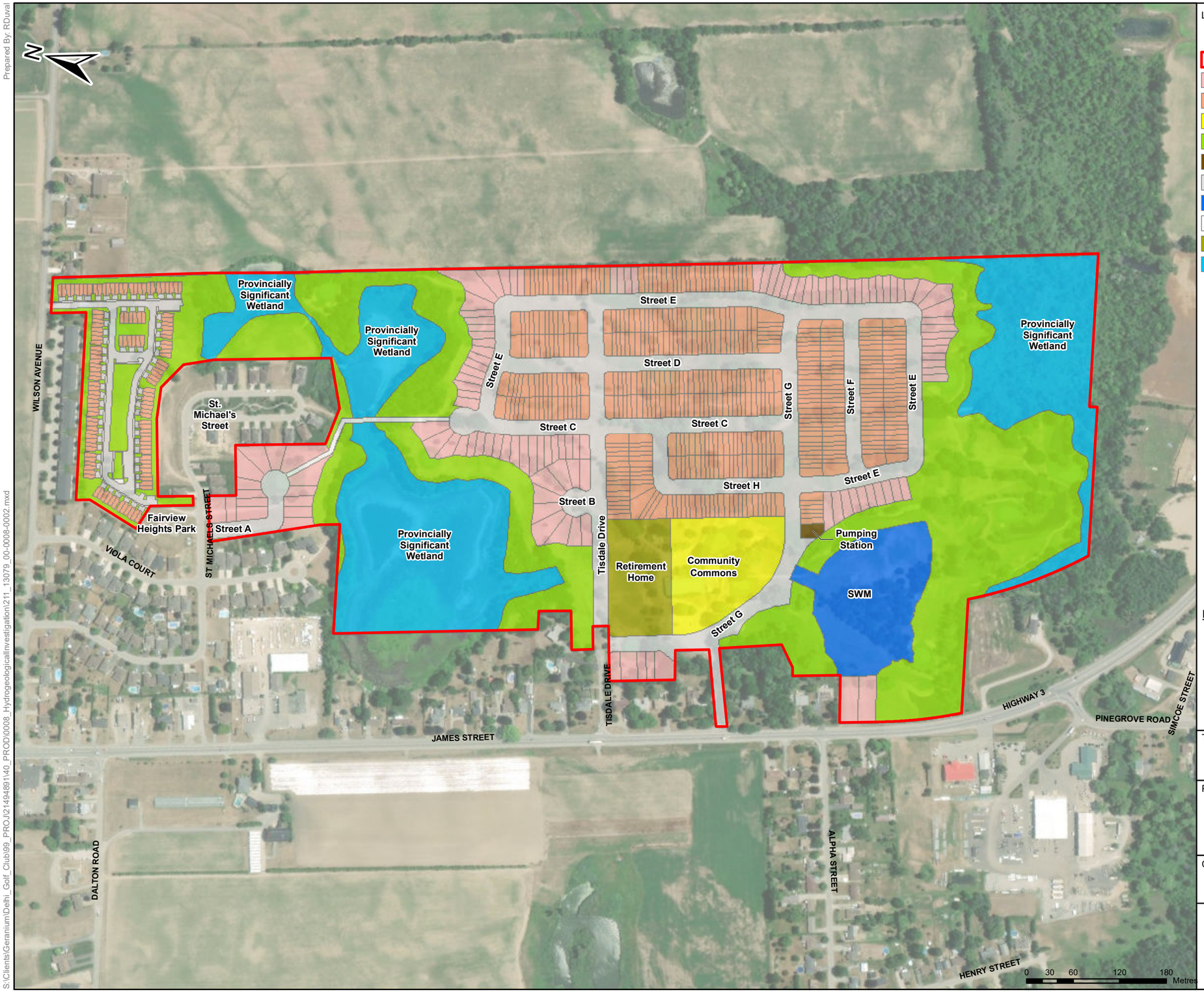
GOLDER

PROJECT NO.:	REVIEWED BY:
211-13079-00	LH
DATE: DECEMBER 2022	FIGURE: 1

C:\arProjects\211-13079-00\MXD\211-13079-00 Figure 1 Site Location.mxd

Prepared By: RDuval

S:\Clients\Geranium\Delhi_Golf_Club\99_PROJ\21494891\40_PROD\0008_Hydrogeological\Investigation\211_13079_00-0008-0002.mxd



LEGEND:

Label
SITE BOUNDARY
SINGLE DETACHED PROPERTY
TOWNHOUSE
COMMUNITY COMMONS
LAWN/OPEN SPACE
PUMPING STATION
ROAD
SWM
SIDEWALKS & TRAIL
RETIREMENT CENTRE
WETLAND

NOTES:

DEVELOPMENT DESIGNS ARE BASED ON CONCEPT PLANS PROVIDED BY THE GSP GROUP (PROJECT 21208) DATED FEBRUARY 23, 2023

TITLE:

POST DEVELOPMENT LANDUSE

PROJECT:

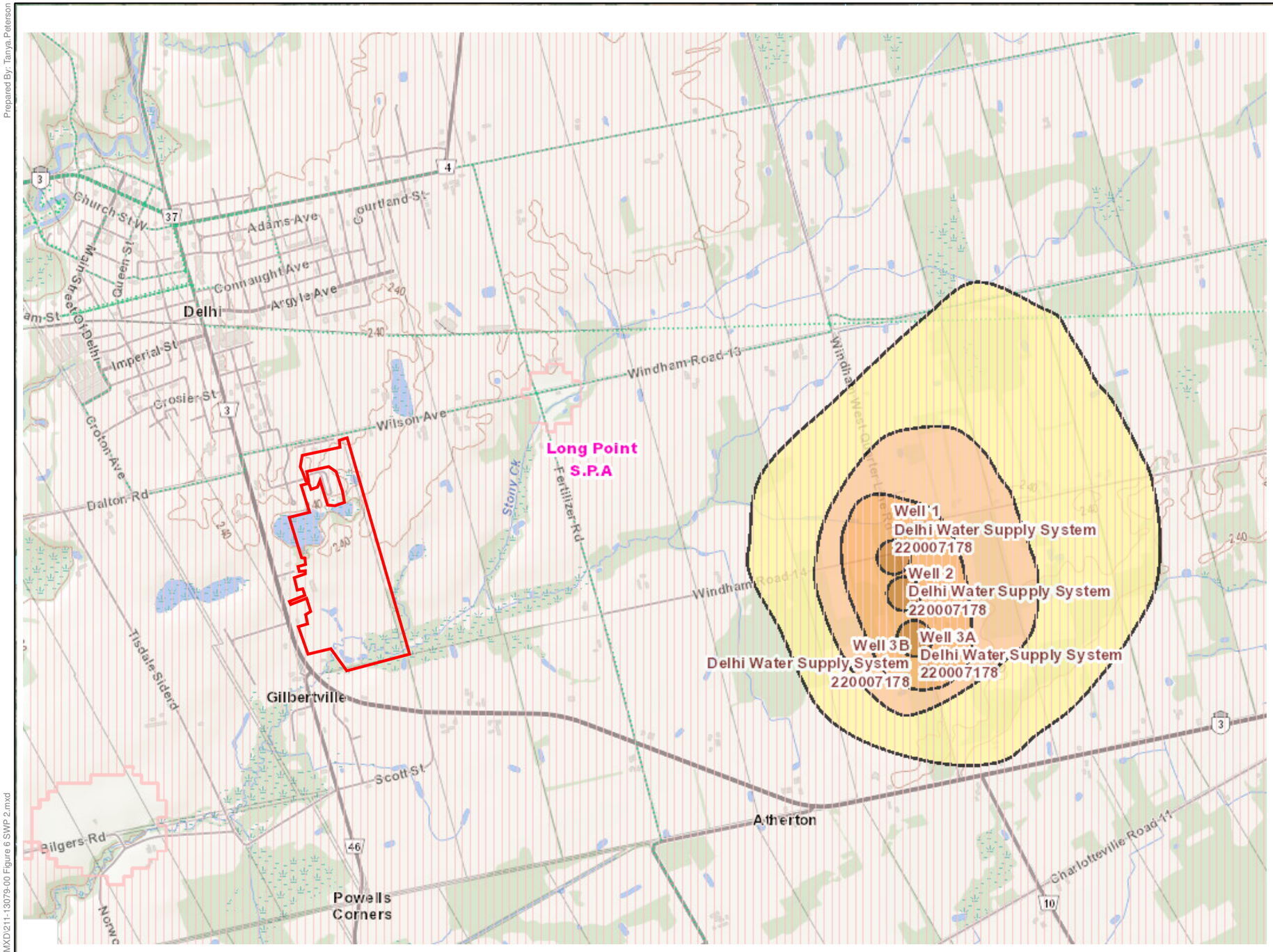
HYDROGEOLOGICAL INVESTIGATION
DELHI GOLF COURSE REDEVELOPMENT
DELHI, ONTARIO

CLIENT:

GOLFNORTH PROPERTIES INC. C/O GERANIUM

	PROJECT NO.:	REVIEWED BY:
wsp	211-13079-00	LH
	DATE: MARCH 2023	FIGURE: 8

Prepared By: Tanya.Peterson



LEGEND:

- SITE BOUNDARY
- S.P.A SOURCE PROTECTION AREA
- WATERCOURSE
- WATERBODIES
- WHPA A (VULNERABILITY SCORE 10)
- WHPA B (VULNERABILITY SCORE 8)
- WHPA C (VULNERABILITY SCORE 6)
- WHPA D (VULNERABILITY SCORE 4)
- HIGHLY VULNERABLE AQUIFER

Notes:

Source water protection regulated mapping is based on results from the MECP Source Protection Information Atlas

(https://www.lioapplications.lrc.gov.on.ca/SourceWaterProtection/index.html?viewer=SourceWaterProtection.SWPViewer&locale=en-CA)

Significant Groundwater Recharge Areas (SGRA) have not been shown on this figure as the entire area is identified as an SGRA with VS=0. This is described in Section 2.2 of the report

TITLE:
SOURCE WATER PROTECTION

PROJECT:
HYDROGEOLOGICAL INVESTIGATION
DELHI GOLF COURSE REDEVELOPMENT
DELHI, ONTARIO

CLIENT:
DELHI DEVELOPMENT INC. C/O GERANIUM

GOLDER

PROJECT NO.:	REVIEWED BY:
211-13079-00	LH
DATE: DECEMBER 2022	FIGURE: 3

D:\aProjects\211-13079-00\MXD\211-13079-00 Figure 6 SWP 2.mxd

2.3 PHYSIOGRAPHY, TOPOGRAPHY AND DRAINAGE

Available mapping from the Ontario Geological Survey (OGS Map 2715) indicate the Site resides within the Norfolk Sand Plains physiographic region as defined by Chatman and Putnam (1984). The Norfolk Sand Plains exist as a wedge-shaped deposit that extends across the western half of Norfolk County and was deposited as a delta from glacial lakes Whittlesey and Warren approximately 12,700 years before present. Chatman and Putnam (1984) described the deltaic sand as composed primarily of silt and fine-grained sand with thickness of up to 75 feet (23m). Thicker deposits of sand are documented towards the west, as the delta was deposited from west to east due to the westerly recession of glacial melt. Mapping by the OGS (Map 2715) identifies drumlinized till moraines at the north end of the Site, which is consistent with the description by Chatman and Putnam (1984) that describes several till moraines in the region covered by the sand plains. Borehole logging from the Site has confirmed the presence of silt and sands with thicknesses up to 7 m, with sandy silt to clayey silt till observed as interbeds in silt and sand layers. Further discussion of site geology is provided in Section 3.2.

The Site has gentle rolling topography with ground elevations that range between 238.8 masl at the north end of the Site to 227.5 masl at the south end of the Site based on a survey completed by RPE Surveying Limited on May 2, 2022, and topography provided by R.J. Burnside and Associates Limited (Burnside) that accompanied grading plans. The developable lands are relatively flat with an average slope of approximately 1.3%, while steeper sections are observed in natural areas adjacent to wetlands and in forested blocks at the south of the property. The overall average slope calculated across the full site in the pre-development condition has been estimated at 3.5%. Open-Source topographic mapping of Haldimand-Norfolk Region (elevationmap.net) confirms the Site gently slopes to the south towards the Stony Creek valley system.

The Site resides within the Big Creek Watershed, which is the largest watershed in the Long Point Conservation Area. Primary drainage of the watershed is Big Creek, which flows south through Delhi towards Lake Erie. The south end of the Site borders on Stony Creek, which flows from northeast to southwest, connecting to Big Creek approximately 2.7 km southwest of the Site. The areas of wetlands in the north-central part of the Site are situated along a tributary of Stony Creek that has its headwaters approximately 650 m northeast of the Site on the north side of Wilson Street, which flows through the golf course via a small drainage feature, connecting to Stony Creek at the south end of the Site. Stony Creek cuts into the sand plains with an elevation drop from about 227 masl at the south end of the Site to approximately 210 masl where it connects with Big Creek.

2.4 WATER SUPPLY WELLS

Water well records on file with the Ministry of the Environment, Conservation and Parks (MECP) for an area extending 500 m from the Site boundary were examined and plotted. **Figure 4** presents the distribution and function of water wells on record with the MECP within a 500 m radius of the Site. Copies of the Ministry's database printout are included in **Appendix A**.

A total of one hundred, twenty (120) water-well records were identified in the MECP database within 500 m of the Site and are summarized in Table 1 to compare well function with the type of well. The majority of the records exist along the western and northern side of the Site, corresponding to rural residences. A total of one hundred and ten (110) water supply wells were identified in the MECP well records drilled between 1953 and 2018. Records show that most of the water supply wells (107) identified in the records are shown as 6" diameter steel-cased drilled wells, while three (3) of these wells are identified as 30" diameter concrete- or galvanized-lined dug wells (installed between 1966 and 1976). The drilled water supply wells have been identified as domestic, commercial, or

agricultural water supply. Five (5) wells are identified as test wells drilled to depths ranging between 17 metres below ground surface (mbgs) and 32 mbgs. Two (2) records are shown as well-abandonments, while three (3) records show no information pertaining to well use and have been classified as unknown.

Table 1: MECP Water Well Records

WELL TYPE/FUNCTION	WATER SUPPLY	TEST WELLS	ABANDONED	UNKNOWN	TOTALS
Drilled Wells	107	5	1	0	**113**
Dug Wells	3	0	0	0	**3**
Unknown Well Type	0	0	1	3	**4**
Totals	**110**	**5**	**2**	**3**	**120**

Notes: The MECP water well record search was conducted on April 28, 2022.

Three (3) water well records indicate a termination depth into fractured limestone and shales, interpreted to be the bedrock at the site, with depths ranging between 47.7 mbgs and 67.0 mbgs. Soil stratigraphy described in the MECP records for these wells show primarily sandy soil with clay interbeds before terminating in fractured limestones. Six records are identified as flowing wells west of the Site along James Street associated with domestic water supply.

2.5 REGIONAL GEOLOGY AND HYDROSTRATIGRAPHY

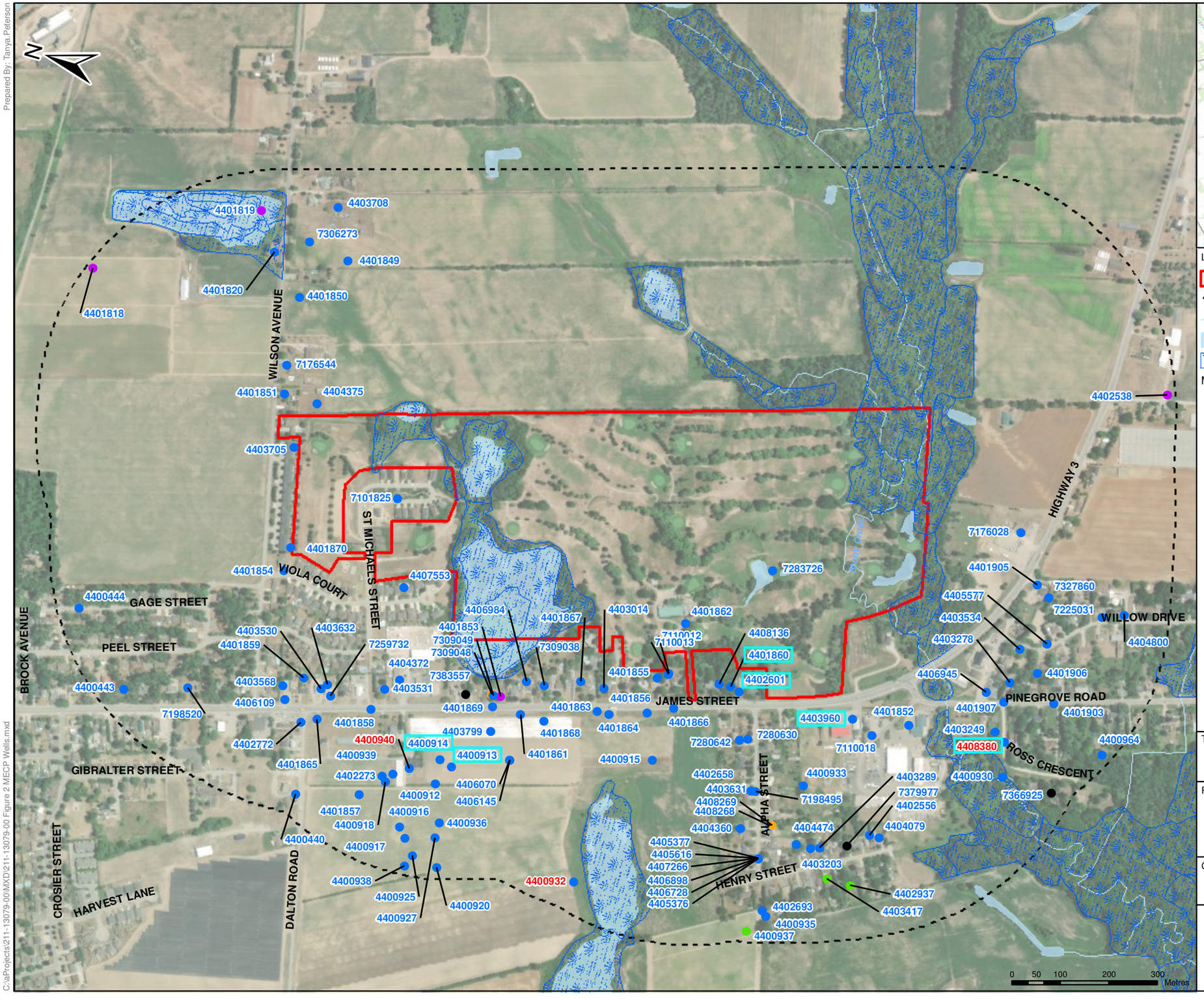
The surficial geology of the Site and surrounding area is presented in **Figure 5**[2]. Based on the Province of Ontario Ministry of Mines geological mapping online database, the area is predominantly underlain by glaciolacustrine deposits of silty sand, sand, with minor fine-grained soils. Modern alluvial deposits consisting of undifferentiated gravel, sand, silt, and clay are located within the Stoney Creek valley system. Borehole drilling at the Site is reasonably consistent with this interpretation with eight (8) of thirteen (13) boreholes drilled on-site (see Section 3.1) showing surficial soils composed of silty sand to sand. The Ontario Geological Survey (OGS Maps 2473 and 2715) as well as the Ontario Division of Mines (Map 2369) has mapped the Township of Delhi as being primarily underlain by shallow to mid-depth glaciolacustrine deposits composed of silt, silty sand and fine- to medium-grained sand, deposited during the Late Wisconsinan glacial period. Glaciolacustrine silt and sand layers mapped in the Township of Delhi and the vicinity of the Site (within the Norfolk Sand Plain physiographic region) were deposited during the Erie and Twocreekean Interstade periods in primarily shallow water (shoreline) depositional settings, with till moraines formed during the stadial periods (LESPR 2008). Sand layers mapped at the Site by the OGS have been interpreted primarily as Late Wisconsinan shoreline deposits controlled by glacial lakes Whittlesey and Warren, however some sands may have been slightly modified by wind (OGS 1978). As the sand were exposed during a decrease in lake levels, this allowed the wind to transport and be modified by wind. Wentworth till moraines (Paris and Galt Moraines) are mapped east of the Site, composed of clayey silt till to sandy silt till, which

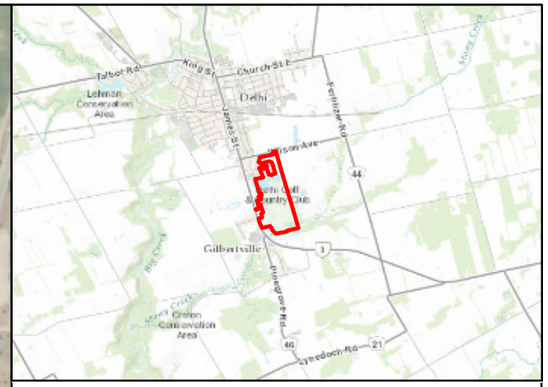
[2] Based on the Province of Ontario Ministry of Mines geological mapping database (2022) accessed at http://www.geologyontario.mndm.gov.on.ca/mines/data/google/mrd128/polygons/doc.kml

exist as interbeds within the sand deposits. OGS (1978) documents that the water level from glacial lake Whittlesey may have exceeded the moraine level, depositing shoreline sands that overlie the till deposits. This interpretation is consistent with observed stratigraphy at the Site during the borehole drilling program where sandy silt till to clayey silt till has been observed within silty sand deposits. Glaciolacustrine sand deposits in the Norfolk Sand Plain are documented as a significant overburden aquifer in the area of the Site, both above and beneath confining till layers. The deeper aquifer (underlying the till moraine) is considered a confined aquifer that pinches out to the east near the community of Simcoe, where the Haldimand Clay Plain becomes the dominant surficial feature (LESPR 2008). The surficial silty sand to sand aquifer in the area of the Site is considered an unconfined aquifer.

The glaciolacustrine deposits overlie Upper Silurian to Middle Devonian limestone bedrock deposited in the Michigan basin. The bedrock in the area of the Site (Dundee Formation) is described as grey to brown fossiliferous limestone that dips to the south and is characterized as fine-grained, cherty, and associated with Karst features (LESPR 2008). Three water well records identified in the MECP database were observed to encounter the limestone bedrock between 47.7 mbgs and 67.0 mbgs, located approximately 400 m west of the Site.

Prepared By: Tanya.Peterson





LEGEND:

- SITE BOUNDARY
- 500 m STUDY AREA
- WATERCOURSE
- WATERBODIES
- PROVINCIALLY SIGNIFICANT WETLAND

MECP WATER WELL LOCATION

- WATER SUPPLY (DRILLED WELL)
- WATER SUPPLY (DUG WELL)
- TEST WELL
- ABANDONED
- UNKNOWN

Notes:

Wells identified in RED are wells that have been advanced into the underlying limestone bedrock, confirmed to be between 47.7 and 67.0 mbgs.

Wells shown with a blue border are identified as flowing wells

TITLE:

MECP WATER WELL RECORDS

PROJECT:

HYDROGEOLOGICAL INVESTIGATION
DELHI GOLF COURSE REDEVELOPMENT
DELHI, ONTARIO

CLIENT:

DELHI DEVELOPMENT INC. C/O GERANIUM

WSP GOLDER	PROJECT NO.: 211-13079-00	REVIEWED BY: LH
	DATE: DECEMBER 2022	FIGURE: 4

C:\aProjects\211-13079-00\MXD\211-13079-00 Figure 2 MECP Wells.mxd

Prepared By: Tanya.Peterson

N

WILSON AVENUE

SCOTT STREET

HIGHWAY 3

Stony Creek

VIOLA COURT

ST MICHAELS STREET

GAGE STREET

PEEL STREET

BROCK AVENUE

SMITH AVENUE

JAMES STREET

TISDALE DRIVE

SIMCOE STREET

WILLOW DRIVE

PINEGROVE ROAD

ROSS CRESCENT

ALPHA STREET

HENRY STREET

GIBRALTER STREET

CROSIER STREET

HARVEST LANE

DALTON ROAD

0 50 100 200 300 Metres

LEGEND:

- SITE BOUNDARY
- 500 m STUDY AREA
- WATERCOURSE
- WATERBODIES
- STONE-POOR, CARBONATE-DERIVED SILTY TO SANDY TILL
- FINE-TEXTURED GLACIOLACUSTRINE DEPOSITS - MASSIVE-WELL LAMINATED
- COARSE-TEXTURED GLACIOLACUSTRINE DEPOSITS
- LITTORAL-FORESHORE DEPOSITS
- MODERN ALLUVIAL DEPOSITS

Note:
Surficial soil mapping is based on the Province of Ontario Ministry of Mines Geological Maps database (2022)

http://www.geologyontario.mndm.gov.on.ca/mines/data/google/mrd128/polygons/doc.kml

TITLE:
SURFICIAL GEOLOGY

PROJECT:
HYDROGEOLOGICAL INVESTIGATION
DELHI GOLF COURSE REDEVELOPMENT
DELHI, ONTARIO

CLIENT:
DELHI DEVELOPMENT INC. C/O GERANIUM

WSP GOLDER

PROJECT NO.:	REVIEWED BY:
211-13079-00	LH
DATE: DECEMBER 2022	FIGURE: 5

C:\aProjects\211-13079-00\MXD\211-13079-00 Figure 4 Surficial Geology.mxd

3 SITE CHARACTERIZATION (FIELD INVESTIGATION)

3.1 WORK PROGRAM

The hydrogeological program has been designed to assess groundwater and soil conditions at the Site in order to provide a detailed hydrogeological interpretation including a water balance to compare pre- and post-development water surplus, and a dewatering assessment to accompany the development applications. The hydrogeological assessment has included the following scope of work:

- A review of all available background materials pertinent to the site, including previous geotechnical, hydrogeological, and environmental reports, as well as published geological mapping and interactive mapping platforms provided by the MECP Source Protection Information Atlas (MECP 2020), and the MNRF natural heritage mapping platform to compile soil and groundwater data, used in the water balance and dewatering assessments;
- Field Investigations, including:
  - A borehole drilling program by Golder Associates was carried out between December 1 and December 15, 2021 that includes fourteen (14) boreholes drilled across the site with depths ranging between 6.2 mbgs and 9.8 mbgs (see **Figure 6**). Monitoring wells were installed in ten (10) of these wells to measure water levels and conduct hydraulic conductivity testing. One nested piezometer (BH21-11 A/B) was established on-site to characterize vertical hydraulic gradients for use in the pond liner design. During the borehole drilling program, fourteen (14) soil samples were collected for grain size distribution used in the water balance. Borehole logs are provided in **Appendix B**;
  - The installation of one mini-piezometer (MP) and surface water (SW) monitoring stations in each of the two main wetland areas on the Site (a total of 2 MP/SW stations) in order to characterize groundwater-surface water interactions;
  - Six single well response tests were carried out between December 21, 2021 and January 14, 2022 to provide an estimate of the hydraulic conductivity of representative soils at the Site to be used in dewatering assessment; and,
  - Static water levels from monitoring wells were measured by Golder Associates staff on five occasions between December 14, 2021 and October 7, 2022 to identify the water table elevation used in the dewatering assessment and to make recommendations on LIDs at the Site. Additionally, static water levels and staff gauge readings were measured on five occasions (concurrent with monitoring wells) from MP and SW stations to establish vertical hydraulic gradient information.
- It should be noted that water quality sampling was not carried out in the hydrogeological scope of work, however appropriate water quality samples for comparison against the Provincial Water Quality Objectives (PWQO) and relevant sewer-use bylaws will be conducted prior to obtaining water handling permits prior to construction;
- A monthly site-specific water balance was carried out for the site to assess the pre- and post-development infiltration and surface runoff at the site, and to identify water surplus deficits as a result of the redevelopment. The water balance was prepared using the methodology outlined in the MOE Stormwater Management and

Planning Manual (2003), and has investigated potential LIDs to maintain pre-development infiltration volumes; and,

- A preliminary dewatering assessment was conducted to estimate short-term construction pumping rates during excavations of residential basements, utility trenching, and at the SWMP. The dewatering assessment additionally has provided long-term water management flow rates that may be encountered at subdrainage systems at the SWMP as well as in perimeter drainage at residential units.

3.2 SITE GEOLOGY AND SOIL CONDITIONS

The on-site borehole drilling program by Golder Associates in December 2021 has identified topsoil at thirteen of the fourteen boreholes with a thickness ranging between 15 cm and 68 cm. Soil logs at one borehole (BH21-8) did not document topsoil, however organic rich sandy silt was logged from surface, consistent with topsoil descriptions of the other wells. In the remainder of the thirteen boreholes, topsoil was described as dark brown sandy silt to silty sand, with some occurrences of clayey silt towards the north of the Site. Organic content, pH, and soil nutrient analysis was not documented during this investigation, and materials identified as topsoil were classified based on visual and textural observations during borehole logging. The topsoil was underlain by glaciolacustrine sediments across the Site, which range in composition between clayey silt, silt, sandy silt, silty sand, sand, and seams of gravel. Silty sand and sand were observed as the dominant soil composition in all thirteen (13) boreholes with individual bed thicknesses that range between 0.38 m to 5.6 m. Eight (8) of the thirteen (13) boreholes showed silty sand or sand at surface (underlying the topsoil)[3], while eleven (11) of the thirteen (13) boreholes identified sand or silty sand underlying fine-grained soils (clayey silt, silt, or till), interpreted to be an aquitard. Only two boreholes (BH21-7 and BH21-9) do not show fine-grained materials overlaying the sand. Nine (9) wells show at least two discrete layers of silty sand or sand separated by fine-grained material, which ranged in thickness between 0.4 m and 2.3 m (average of 1.4 m)[4], demonstrating there is an upper and lower aquifer at the Site, separated by an intermittent aquitard (not observed in the central part of the Site).

One pair of nested monitoring wells is installed on the Site (BH21-11-S/D)[5], which has shown an upwards hydraulic gradient in all four monitoring events (see Section 3.3). Silty sand to sand layers that underly the confining layer range in thickness between 0.3 m to 5.1 m, however seven wells terminate in the silty sand to sand, therefore the true thickness of the lower aquifer cannot be ascertained.

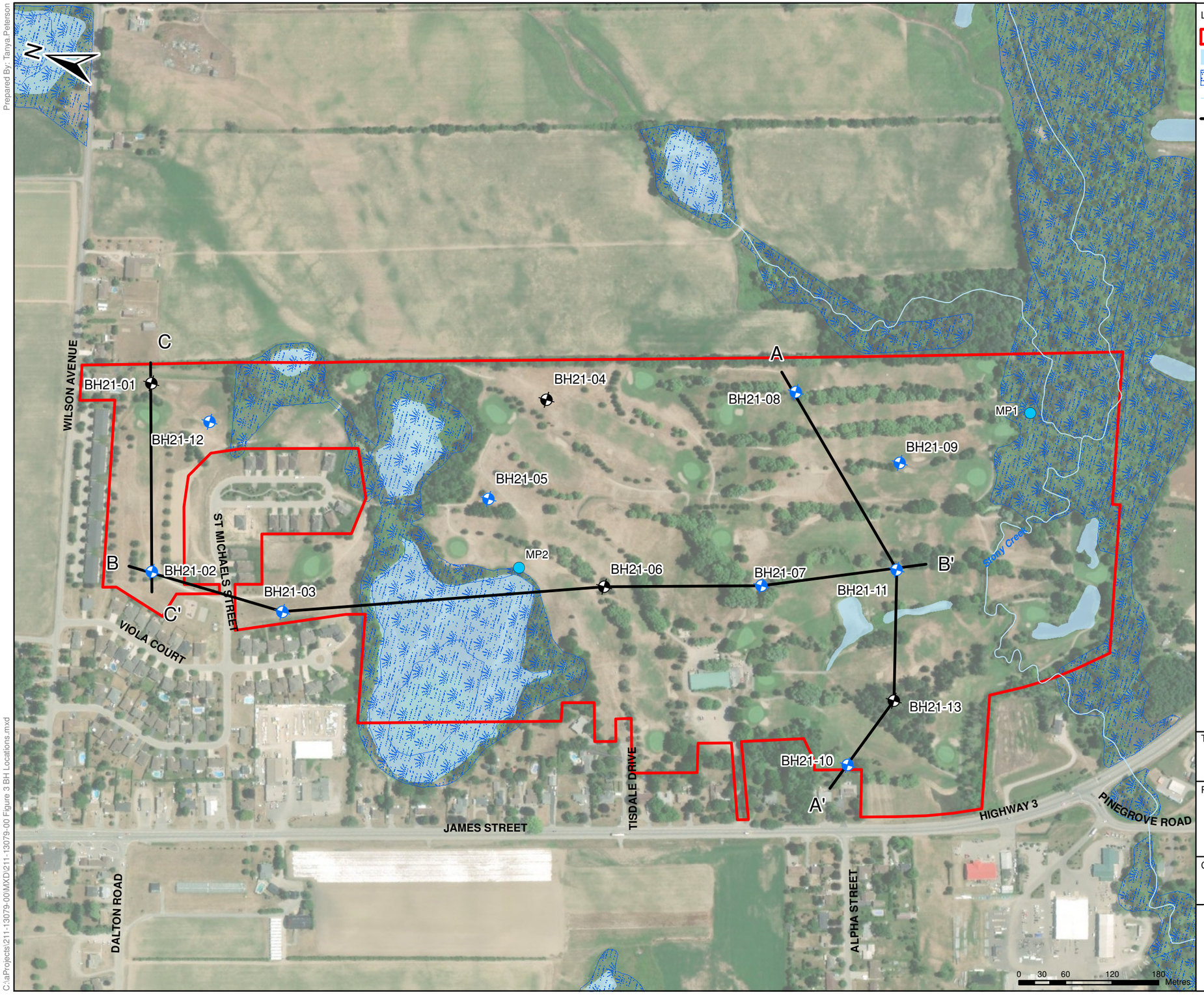
Figure 7 to Figure 9 presents three representative cross-sections through the Site which provides schematics of hydrostratigraphy, soil composition, and topographic profiles. These cross-sections demonstrate the interbedded nature of glaciolacustrine sediment, and the presence of an upper and lower aquifer system separated by a silty clay or silty clay till. Aquitard. At BH21-11, the deep piezometer extends to 9.8 mbgs, and shows a combined thickness of 4.2 m of sandy silt, silty sand, and sand that underlies the confining layer at this location, which is approximately 180 m east of the proposed location of the SWMP. Borehole 21-13 at the location of the proposed SWMP shows a 3.7 m thick layer of silty sand to sandy silt underlying a 2.3 m thick layer of clayey silt (see **Figure 7**).

[3] BH21-2, BH21-3, BH21-5, BH21-7, BH21-9, BH21-11, BH21-12, and BH21-13.

[4] Seven boreholes (BH21-1, BH21-2, BH21-3, BH21-6, BH21-10, BH21-12, and BH21-13) show only fine-grained materials including clayey silt, silt, silty sand till, sandy silt till, and clayey silt till as the interbedded material within the sand, whereas boreholes BH21-4 and BH21-11 have both sand and till as interbed materials.

[5] The deep and shallow monitoring wells have been labelled as BH21-11-A and BH21-11-B respectively on the borehole logs. The static monitoring well sheet in Appendix X has provided both A=deep and B=shallow for clarity.

Prepared By: Tanya.Peterson



LEGEND:

- SITE BOUNDARY
- WATERBODIES
- PROVINCIALLY SIGNIFICANT WETLAND
- WATERCOURSE
- CROSS SECTION
- BOREHOLE LOCATION
- MONITORING WELL
- MINI-PIEZOMETER STATION

TITLE:
BOREHOLE AND MONITORING WELL LOCATION PLAN

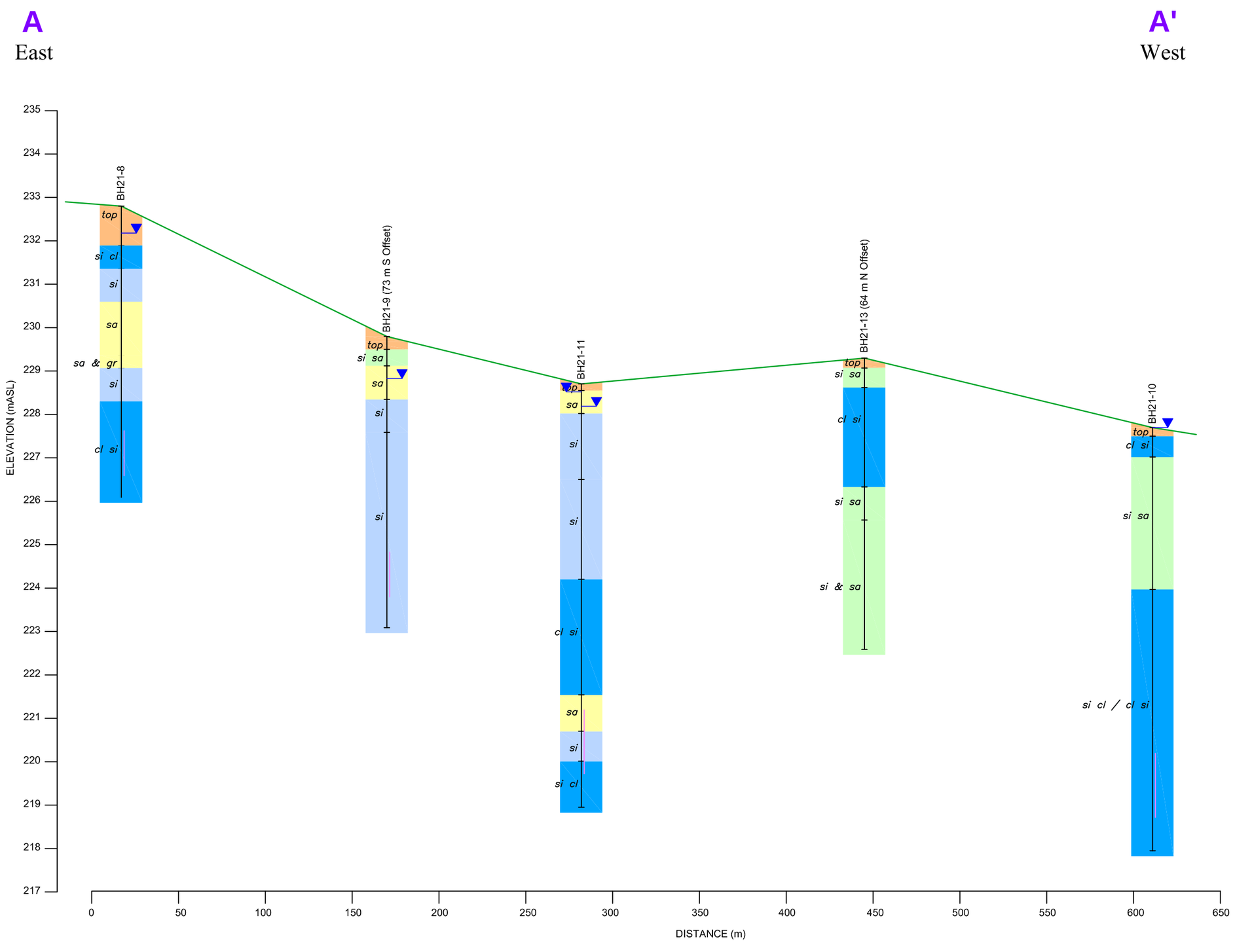
PROJECT:
HYDROGEOLOGICAL INVESTIGATION
DELHI GOLF COURSE REDEVELOPMENT
DELHI, ONTARIO

CLIENT:
DELHI DEVELOPMENT INC. C/O GERANIUM

GOLDER

PROJECT NO.:	REVIEWED BY:
211-13079-00	LH
DATE: December 2022	FIGURE: 6

C:\aProjects\211-13079-00\MXD\211-13079-00 Figure 3 BH Locations.mxd



LEGEND

BH21-1

WELL ID

GROUND SURFACE

WATER LEVEL / WELL SCREEN

CHANGE IN STRATIGRAPHY

END OF BORING (mBGL)

SOIL DESCRIPTION:

top - TOPSOIL
si - SILT
sa - SAND
cl - CLAY
gr - GRAVEL

- TOPSOIL
- SAND
- SILT
- SAND / SILT
- SAND / SILT TILL
- SILTY CLAY / CLAYEY SILT
- SILTY CLAY TILL

Note:
No vertical exaggeration has been applied to the cross sections, therefore topography is considered as apparent

NOTE:
THE ACTUAL SOIL STRATIFICATION HAS BEEN VERIFIED FROM DATA OBTAINED AT THE WELL LOCATIONS ONLY. THE INFERRED CONTACTS SHOWN ARE BASED ON GEOLOGICAL EVIDENCE AND THESE MAY VARY FROM THOSE SHOWN BETWEEN BORINGS. WELL DATA IS PROJECTED ONTO THE SECTION WHICH ALSO MAY CREATE SOME IRREGULARITIES IN CONTACT DEPTHS.

CROSS SECTION A-A'

HYDROGEOLOGICAL INVESTIGATION
DELHI GOLF COURSE REDEVELOPMENT
DELHI, ONTARIO

DATE: **DECEMBER 2022**

SCALES: AS SHOWN

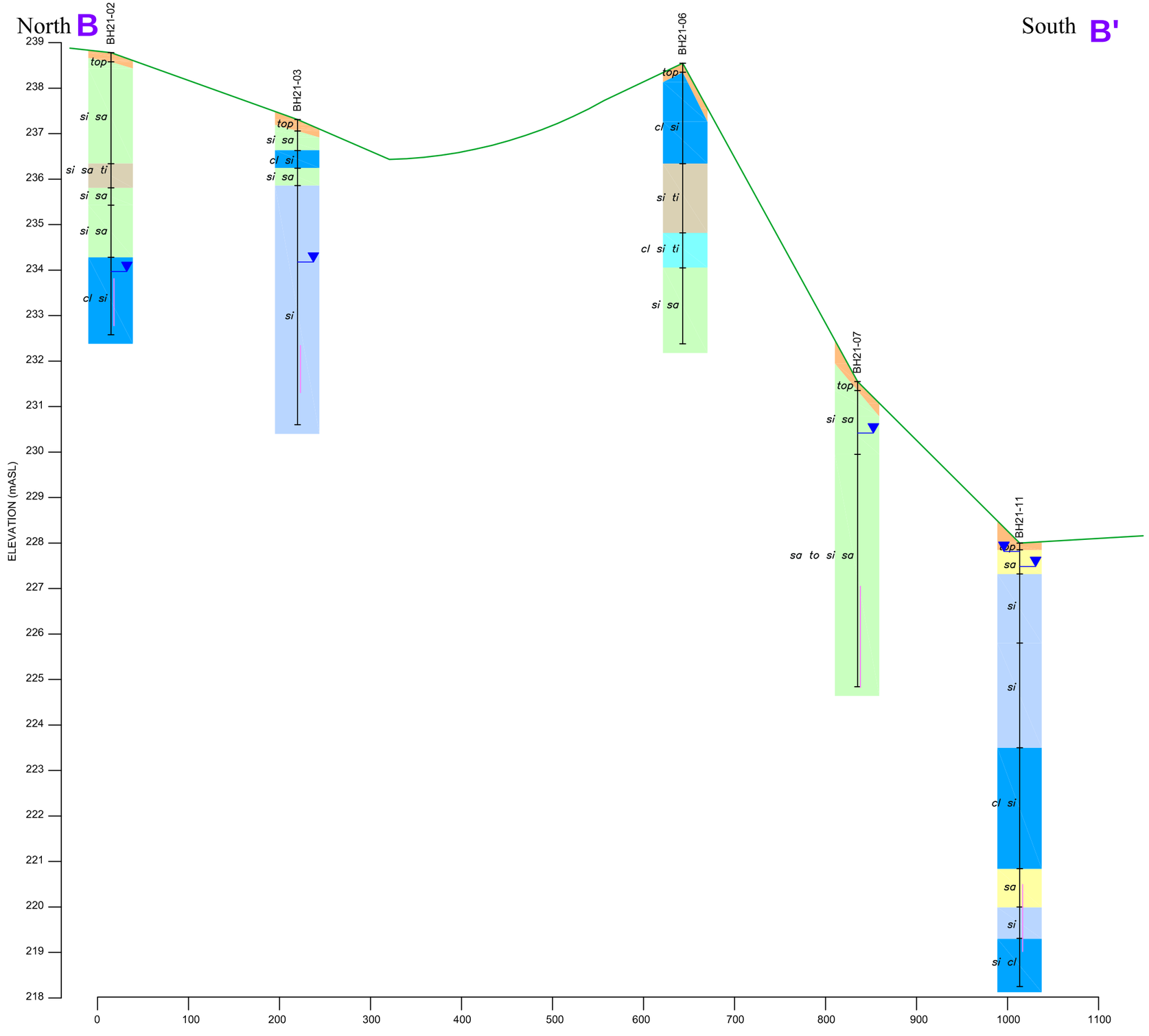
PROJECT: 211-13079-00

WSP GOLDER

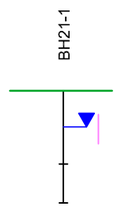
FIGURE
7

North **B**

South **B'**



LEGEND



WELL ID

GROUND SURFACE

WATER LEVEL / WELL SCREEN

CHANGE IN STRATIGRAPHY

END OF BORING (mBGL)

SOIL DESCRIPTION:

top - TOPSOIL
si - SILT
sa - SAND
cl - CLAY
gr - GRAVEL

Note:
No vertical exaggeration has been applied to the cross sections, therefore topography is considered as apparent

- TOPSOIL
- SAND
- SILT
- SAND / SILT
- SAND / SILT TILL
- SILTY CLAY / CLAYEY SILT
- SILTY CLAY TILL

NOTE:
THE ACTUAL SOIL STRATIFICATION HAS BEEN VERIFIED FROM DATA OBTAINED AT THE WELL LOCATIONS ONLY. THE INFERRED CONTACTS SHOWN ARE BASED ON GEOLOGICAL EVIDENCE AND THESE MAY VARY FROM THOSE SHOWN BETWEEN BORINGS. WELL DATA IS PROJECTED ONTO THE SECTION WHICH ALSO MAY CREATE SOME IRREGULARITIES IN CONTACT DEPTHS.

CROSS SECTION B-B'

HYDROGEOLOGICAL INVESTIGATION
DELHI GOLF COURSE REDEVELOPMENT
DELHI, ONTARIO

DATE: **DECEMBER 2022**

SCALES: AS SHOWN

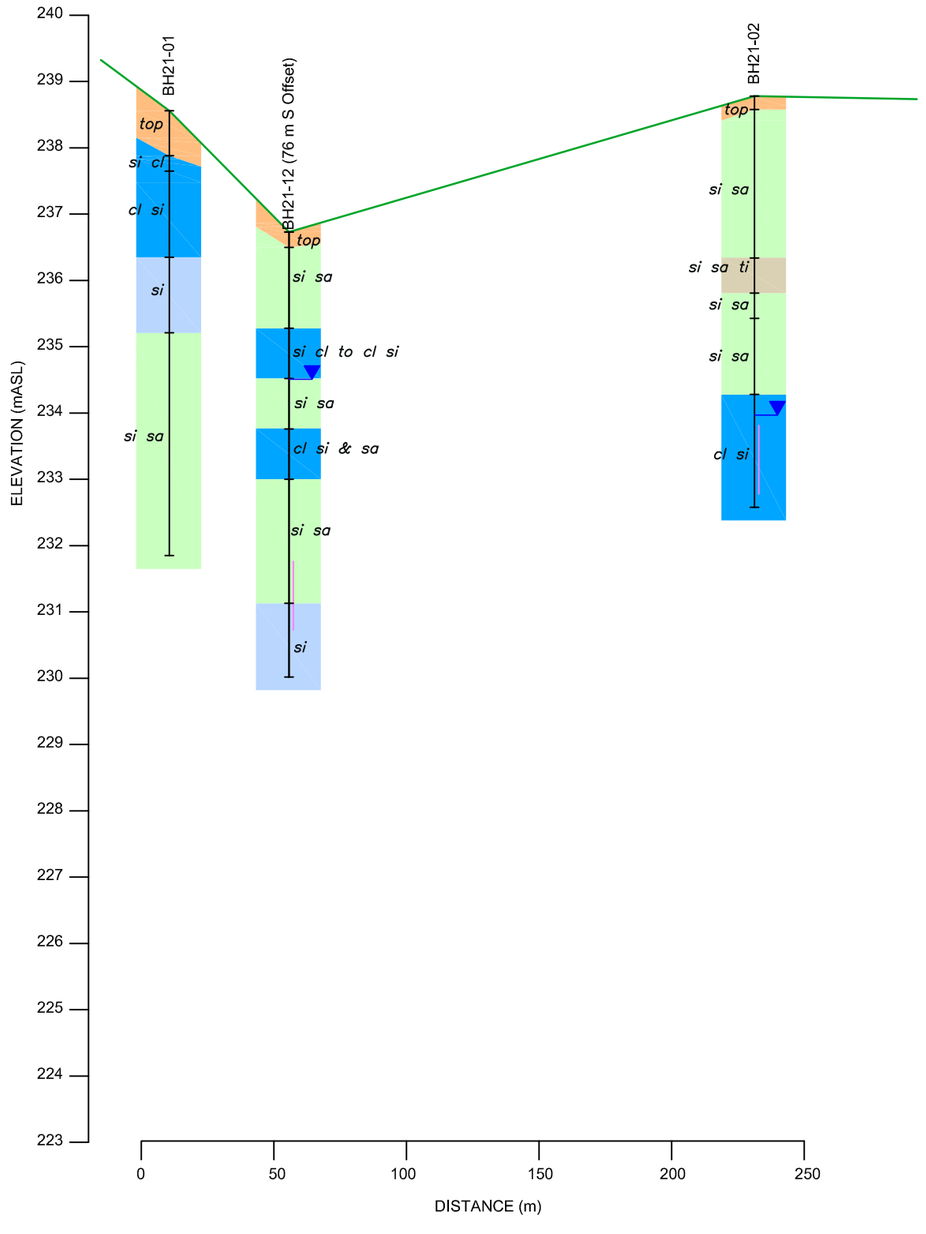
PROJECT: 211-13079-00

WSP GOLDER

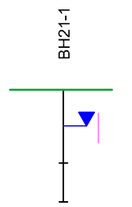
FIGURE **8**

C
East

C'
West



LEGEND



WELL ID

GROUND SURFACE

WATER LEVEL / WELL SCREEN

CHANGE IN STRATIGRAPHY

END OF BORING (mBGL)

SOIL DESCRIPTION:

top - TOPSOIL
si - SILT
sa - SAND
cl - CLAY
gr - GRAVEL

TOPSOIL

SAND

SILT

SAND / SILT

SAND / SILT TILL

SILTY CLAY / CLAYEY SILT

SILTY CLAY TILL

Note:
No vertical exaggeration has been applied to the cross sections, therefore topography is considered as apparent

NOTE:
THE ACTUAL SOIL STRATIFICATION HAS BEEN VERIFIED FROM DATA OBTAINED AT THE WELL LOCATIONS ONLY. THE INFERRED CONTACTS SHOWN ARE BASED ON GEOLOGICAL EVIDENCE AND THESE MAY VARY FROM THOSE SHOWN BETWEEN BORINGS. WELL DATA IS PROJECTED ONTO THE SECTION WHICH ALSO MAY CREATE SOME IRREGULARITIES IN CONTACT DEPTHS.

CROSS SECTION C-C'

HYDROGEOLOGICAL INVESTIGATION
DELHI GOLF COURSE REDEVELOPMENT
DELHI, ONTARIO

DATE: **DECEMBER 2022**

PROJECT: 211-13079-00

SCALES: AS SHOWN

WSP GOLDER

FIGURE
9

3.2.1 HYDRUALIC CONDUCTIVITY TESTING

Single well response testing was completed in six (6) monitoring wells between December 21, 2021 and January 14, 2022 to provide estimates of hydraulic conductivity of the soils at the Site. Prior to testing, three well volumes were purged from the well using Waterra tubing and foot valves, and allowing the water level to recover prior to testing. The hydraulic conductivity testing included both falling head and rising head tests employing the use of a physical slug or bailer. Tests involved rapidly inserting a solid cylinder (slug) with a known volume into the well to displace the water and measuring the water level drop with time (Falling Head Test). After the water level had stabilized, the slug was removed, and a rising head test was performed and the water in the well rises to equilibrate with the water level in the surrounding formation. A bailer was employed at select wells to remove a volume of water and measuring recovery. Water levels were recorded by a combination of manual measurements using a water level tape and through the use of electronic dataloggers. Recovery data was analyzed using the Bouwer & Rice (1976) method using Aquifer Test Pro software. A summary of the results is provided in Table 2, with the full set of calculations provided in **Appendix C**.

Table 2: Hydraulic Conductivity Estimates from Single Well Response Testing

BH ID	TESTING METHOD	SCREENED INTERVAL (MASL)	MATERIAL SCREENED	ESTIMATED HYDRAULIC CONDUCTIVITY (M/S)
BH21-7	Rising Head	224.85 – 222.85	Sand, some gravel. Soil grades to a silty sand at depth. Wet. Blow counts 13-17	2.1×10^{-6}
	Falling Head			1.8×10^{-6}
BH21-3	Rising Head	231.21 – 229.71	Sandy Silt, some clay. Blow Counts 26 - 45	2.6×10^{-7}
BH21-8	Rising Head	226.67 – 225.17	Silt to Clayey Silt, some sand. Blow counts 17	7.9×10^{-7}
BH21-11-S (B)	Rising Head	224.32 – 222.82	Brown to Grey Silt. Blow Counts 6-16	1.2×10^{-6}
BH21-12	Rising Head	230.63 – 229.13	Brown Silty Sand, wet, some clay. Blow Counts 16-35	3.6×10^{-6}

Results of single well response tests across the Site estimate a range of a hydraulic conductivity between 2.6×10^{-7} m/sec and 3.6×10^{-6} m/sec with a geometric mean for all tests of 1.2×10^{-6} m/sec. Three of the six tests were carried out in sand or silty sand, with a geometric mean of 2.4×10^{-6} m/sec. The remaining three tests were carried out in a sandy silt, silt, or clayey silt with a geometric mean of 6.3×10^{-7} m/sec. Given the low blow counts observed during drilling, sandy soil material is interpreted to be generally loose, with hydraulic conductivity values that may be under-estimated. Hazen approximations from soil samples (see Section 3.2.2) estimate hydraulic conductivity values in the magnitude of 10-5 m/sec, which is an expected response. Hydraulic conductivity estimates between 10^{-7} m/sec and 10^{-6} m/sec should be re-assessed to confirm results (see Recommendations Section).

3.2.2 GRAIN SIZE ANALYSIS

A total of fourteen (14) soil samples were collected by Golder Associates during the borehole drilling program in December 2021 and sent for particle size distribution analysis to assess grain size ranges. The results of these analyses have been reviewed and used to provide estimates of hydraulic conductivity and soil classification for use in the water balance assessment. Seven (7) of the fourteen (14) samples were collected from silty sand and sandy soils, while the remaining seven (7) samples were collected from sandy silt, silt, silty clay, and till. Samples were collected between 2.3 mbgs and 6.8 mbgs, with six samples representing the infiltration zone at less than 3 mbgs. Table 3 presents the location and depth of soil samples that were tested for grain size distribution and the estimated hydraulic conductivity. Full results of analysis can be found in **Appendix D**.

Table 3: Hydraulic Conductivity Estimates based on the Hazen Approximation

BOREHOLE /SAMPLE LOCATION	DEPTH (MBGS)	SOIL DESCRIPTION	D_{10} (MM)	HAZEN ESTIMATE (M/S)
BH21-1 / S6	3.8 - 4.4	Silty Sand, some gravel	0.0070	4.9E-07
BH21-2 / S4B	2.3 - 2.9	Silty Sand, some Gravel, trace till	0.0100	1.0E-06
BH21-3 / S4	2.3 - 2.9	Sandy Silt, some clay	0.0018	3.2E-08
BH21-3 / S8	6.1-6.7	Sandy Silt, some clay	0.0080	6.4E-07
BH21-5 / S6	3.8 - 4.4	Silty Sand to Sand, trace clay	0.0390	1.5E-05
BH21-6 / S5	3.1 - 3.7	Sandy Silt (TILL), some sand	0.0017	2.9E-08
BH21-7 / S6A	3.8 - 4.4	Sand, some gravel to Silty Sand	0.0700	4.9E-05
BH21-8 / S5A	3.1 - 3.7	Sand and Gravel, some silt	0.0900	8.1E-05
BH21-9 / S5	3.1 - 3.7	Silt, some sand	0.0800	6.4E-05
BH21-10 / S3	1.5 - 2.1	Silty Sand, trace clay	0.0100	1.0E-06
BH21-10 / S7	4.6 - 5.2	Silty Clay to Clayey Silt	0.0009	8.1E-09
BH21-11 / S6	3.8 - 4.4	Silt	0.0080	6.4E-07
BH21-11 / S9A	7.6 - 8.2	Sand	0.0570	3.2E-05
BH21-13 / S8	6.1 - 6.78	Sandy Silt, some clay	0.0026	6.8E-08
Geometric Mean in Silty Sand and Sandy Soils				**9.4×10^{-6}**
Geometric Mean in Silt, Sandy Silt, Clay, and Till Soils				**7.7×10^{-8}**

The estimates of hydraulic conductivity presented in Table 3 were obtained based on grain size results using the Hazen approximation:

$K = 0.01 \times Cd_{10}^2$ (m/s)

Where:

K = bulk hydraulic conductivity (m/s);

d_{10} = grain size at which point 10% of the soil passes the sieve (mm); and

C = a constant generally set at 1 for these units.

Results of the Hazen approximation show a range between 8.1 x 10^{-9} m/sec and 8.1 x 10^{-5} m/sec. A geometric mean of estimates based on silty sand and sandy soils is 9.4 x 10^{-6} m/sec, while the geometric mean of estimates based on fine-grained materials (silt, sandy silt, clay, and till) is 7.7 x 10^{-8} m/sec. While the overall geometric means of Hazen approximations are relatively consistent to hydraulic conductivity testing, it is observed that Hazen approximations carried out from sandy soils are typically an order of magnitude higher than hydraulic conductivity tests performed in sandy soils (10^{-5} m/sec vs 10^{-6} m/sec), and likely better represent the soil conditions at the Site. In consideration of identifying a representative hydraulic conductivity appropriate to use in the dewatering assessment, a geometric mean of values has been used for both single well response testing and the Hazen approximation per soil type. A total of ten (10) estimates of hydraulic conductivity combined from the Hazen method and single well response testing were conducted in silty sand to sandy soils, with a geometric mean of 7.8 x 10^{-6} m/sec. Similarly, a total of nine (9) estimates of hydraulic conductivity combined from the Hazen method and single well response testing were conducted in silt, sandy silt, clay or till soils, with a geometric mean of 1.5 x 10^{-7} m/sec. The dewatering assessment has used a hydraulic conductivity of **7.8 x 10^{-6} m/sec** for excavations in sandy soils and a hydraulic conductivity of **1.5 x 10^{-7} m/sec** for excavations in fine-grained soils (silts, clayey silt, and till).

The tri-linear soil classifications obtained through the grain size analyses were used to derive the soil classification for estimating infiltration input into the water balance analysis. The percentage composition of soils was categorized as percentages of sand, silt, and clay, and compared against classification in a tri-linear soil classification chart. The results are presented on Table 4, and provided along with the tri-linear plot in **Appendix D**.

Table 4: Soil Classification based on Grain Size Analysis

BOREHOLE ID	DEPTH (MBGS)	SOIL DESCRIPTION	% SAND	% SILT	% CLAY	SOIL CLASSIFICATION
BH21-1 / S6	3.8 - 4.4	Silty Sand, some gravel	54.5	39.8	5.7	Sandy Loam
BH21-2 / S4B	2.3 - 2.9	Silty Sand, some Gravel	50.6	44.6	4.8	Sandy Loam
BH21-3 / S4	2.3 - 2.9	Sandy Silt, some clay	33.3	56.6	10.1	Silty Loam
BH21-3 / S8	6.1-6.7	Sandy Silt, some clay	26.0	69.0	5.0	Silty Loam
BH21-5 / S6	3.8 - 4.4	Silty Sand to Sand, trace clay	74.7	22.2	3.0	Sandy Loam
BH21-6 / S5	3.1 - 3.7	Sandy Silt (TILL), some sand	37.8	48.9	13.3	Medium Loam
BH21-7 / S6A	3.8 - 4.4	Sand to Silty Sand	88.6	10.2	1.1	Sand
BH21-8 / S5A	3.1 - 3.7	Sand and Gravel, some silt	91.9	7.1	1.0	Sand
BH21-9 / S5	3.1 - 3.7	Silt, some sand	18.0	77.0	5.0	Silty Loam
BH21-10 / S3	1.5 - 2.1	Silty Sand, trace clay	65.7	29.3	5.1	Sandy Loam
BH21-10 / S7	4.6 - 5.2	Silty Clay to Clayey Silt	15.8	65.3	18.9	Silty Loam

BH21-11 / S6	3.8 - 4.4	Silt	2.0	94.0	4.0	Silty Loam
BH21-11 / S9A	7.6 - 8.2	Sand	84.3	13.5	2.2	Loamy Sand
BH21-13 / S8	6.1 - 6.78	Sandy Silt, some clay	38.1	52.6	9.3	Silty Loam

Notes:
The percentages expressed in the table above are based on the proportions of Clay, Silt, and Sand sized particles only, excluding gravel content

Grain size distributions from soil samples collected at the Site plotted on a tri-linear classification graph has shown a wide range of soil types between Sand, Sandy Loam, Medium Loam, and Silty Loam with approximately equal soils showing sandy loam as to silty loam. Seven soil classifications show sandy loam, while six (6) soil classifications show silty loam. Given that a medium loam is composed of equal parts sandy loam and silty loam, the soil classification used in the water balance is assessed as a **Medium Loam** (discussed further in Section 4.3.1).

3.3 GROUNDWATER LEVEL MONITORING

Groundwater levels from monitoring wells at the Site were measured on five occasions between December 14, 2021 and October 7, 2022, which represents approximately one year of measurements. Therefore, the assessment is able to estimate the seasonal fluctuation of the water table for 2022 conditions, including the seasonally high and seasonally low levels across the Site. Results of water level measurements from monitoring wells is presented in Table 5, with the full results of groundwater monitoring provided in **Appendix E**.

Table 5: Summary of Groundwater Monitoring

MONITORING WELL ID	SWL DEC 14, 2021 (MBGS/MASL)	SWL DEC 22, 2021 (MBGS/MASL)	SWL JAN 14, 2022 (MBGS/MASL)	SWL MAY 2, 2022 (MBGS/MASL)	SWL OCT 7, 2022 (MBGS/MASL)
BH21-02	ND	4.9/233.9	4.9/233.9	4.8/234.0	5.7/233.1
BH21-03	ND	3.1/234.2	3.4/234.0	3.5/233.8	4.3/233.0
BH21-05	DRY @ 6.2m	DRY @ 6.2m	DRY @ 6.2 m	6.0/233.9	6.0/233.9
BH21-07	0.9/230.7	1.3/230.2	1.3/230.2	1.1/230.4	2.6/228.9
BH21-08	0.6/232.2	0.7/232.1	0.6/232.2	0.8/232.0	2.4/230.4
BH21-09	1.1/228.7	1.2/228.7	1.1/228.7	1.0/228.8	2.2/227.6
BH21-10	FLOWING	FLOWING	FLOWING	FLOWING	FLOWING
BH21-11-D (A)	0.4/228.4	0.4/228.3	0.5/228.3	0.2/228.5	1.1/227.7
BH21-11-S (B)	0.5/228.2	0.8/228.0	0.9/227.9	0.5/228.2	2.0/226.8
BH21-12	ND	2.2/234.5	2.3/234.5	2.2/234.5	3.1/233.6

Notes:

SWL = Static Water Level Measurements are referenced as depth below ground surface (mbgs) and are also shown as an elevation above sea level (masl). Monitoring wells were drilled and installed by Golder Associates in December 2021. Water level measurements have been rounded to one decimal place. ND= well is not drilled at this time.

Groundwater monitoring at the Site has identified the presence of a continuously flowing well (BH21-10) at the southwest corner of the Site and one monitoring well towards the north of the Site adjacent to the wetland (BH21-5) as being predominantly dry through much of the year. Excluding these monitors, the water table was observed to have a water level measurement between 0.2 mbgs and 5.7 mbgs based on monitoring between December 2021 and October 2022. The average seasonal fluctuation of the water table across the site was 1.8 m[6]. Seasonally high groundwater elevations were observed during the January and May 2022 events (water levels were comparable between events), which is expected given the spring is associated with rapid recharge from the spring freshet. Seasonally high groundwater levels ranged from 0.2 mbgs (228.5 masl) at the south end of the site (BH21-11) to 4.9 mbgs (233.9 masl) at the north end of the Site (BH21-2). Water levels are observed to be the deepest at the north end of the site at monitoring wells BH21-2, BH21-3, and BH21-12 with seasonally high levels between 2.2 mbgs (234.5 masl) and 4.9 mbgs (233.9 masl) [7]. Seasonally high groundwater is observed to be much shallower in the central and southern ends of the Site (typically less than 1 m below ground), with groundwater levels recorded between 0.2 mbgs (228.5 masl) at BH21-11 and 1.1 mbgs (230.4 masl) at the centre of the Site (BH21-7). Groundwater shallows considerably towards the south, with seasonally high levels recorded between 20 cm and 90 cm at the southernmost monitoring wells (BH21-8 to BH21-11), and flowing conditions at BH21-10. For much of the proposed redevelopment south of the Tisdale extension, groundwater is expected to be encountered at less than 1 m below existing ground surface during the seasonally high periods (typically between January and June), with a decline in the seasonally low periods (typically the summer and fall when conditions are the driest) to levels between 1.1 mbgs and 2.6 mbgs.

Static groundwater levels collected from monitoring wells in May 2022 have been used to produce an interpreted groundwater flow pattern (see **Figure 10**). Groundwater is interpreted to flow in a southerly direction towards Stoney Creek at a horizontal gradient estimated to be 0.014 m/m (a groundwater decline of 6 m in a distance of 434.2 m). Groundwater flow generally follows topography, as lands slope to the south, however as groundwater shallows to the south, aquifer stratigraphy does not likely follow ground surface consistently across the Site.
In addition to collecting manual water levels from monitoring wells at each event, water levels were collected from the two mini-piezometer (MP) stations and staff gauges (SG) installed within the wetlands. Staff gauge readings within each wetland shows standing water in all events except October with water depths in the northern wetland that ranges between 20 cm and 26 cm, and water depths in the southern wetland that ranges between 10 cm and 26 cm. Both surface water monitoring stations were observed to be dry on October 7, 2022.

Vertical hydraulic gradients have been calculated from the one nested piezometer on-site (BH21-11) and both MP stations for each monitoring event between December 2021 and October 2022. Upwards hydraulic gradients at BH21-11 were observed at all monitoring events with a gradient range between 0.04 m/m and 0.19 m/m. Similarly, upwards hydraulic gradients were observed at the MP stations in the wetlands with a gradient between 0.02 m/m and 0.05 m/m[8]. Given that MP and SG readings were dry in October 2022, however upwards gradients are estimated the

---

[6] Determined by averaging the depth below ground readings from all wells (including BH21-10 and BH21-5) for each monitoring event and averaging those values for the full year to arrive at 1.8 m of water table fluctuation for 2022.

[7] Water level ranges presented in this report exclude BH21-10 and BH21-5 unless otherwise indicated. Water levels at BH21-5 were dry for three of the five events, with the other two events showing 6 mbgs at both the May and October events. Given this well was predominantly dry and doesn't respond to seasonal trends, it is not considered representative of shallow groundwater at the Site. Water levels at BH21-10 were flowing for all events.

[8] A downward gradient was calculated for the first monitoring event on December 14, 2021, however as the stations were installed on the same day a few hours prior, these readings are not considered representative of groundwater conditions and are excluded from the interpretation. Gradients were not calculated from January 2022 readings as the MP stations were frozen.

rest of the year suggests that groundwater is discharging to the wetlands for most of the year but declines sufficiently in the fall where discharge is intermittent. The presence of a continuously flowing well at the south of the Site (BH21-10), relatively strong upwards gradients identified at monitoring well BH21-11, and the interpretation that a fine-grained layer of clayey silt and till is acting to confine the lower aquifer intermittently across the Site suggests artesian pressures exist at the south end of the Site, particularly at the proposed location of the SWMP. Monitoring wells BH21-10 and BH21-11 are observed to have both upwards head gradients and artesian conditions, while soil stratigraphy at borehole BH21-13 located within the footprint area of the SWMP is the same as both BH21-10 and BH21-11. This assessment interprets that artesian pressures may be encountered at the location of the SWMP (discussed further in Section 5).

The complete results of groundwater monitoring, including manual water level measurements from all monitoring wells, mini-piezometer stations, and surface water monitoring stations, as well as vertical gradient calculations are provided in **Appendix E**.

Prepared By: Tanya.Peterson

N

WILSON AVENUE

BH21-01

BH21-12
234.51

BH21-04

BH21-08
232.18

MP1

BH21-09
228.83

BH21-05
233.92

ST MICHAELS STREET

BH21-02
233.97

BH21-03
234.18

MP2

BH21-06

BH21-07
230.42

BH21-11-S
228.19

BH21-11-D
228.52

Stony Creek

BH21-13

BH21-10
Flowing

VIOLA COURT

TISDALE DRIVE

JAMES STREET

HIGHWAY 3

PINEGROVE ROAD

DALTON ROAD

ALPHA STREET

235 234 233 232 231 230 229 228

0 30 60 120 180 Metres

LEGEND:

- SITE BOUNDARY
- WATERCOURSE
- PROVINCIALLY SIGNIFICANT WETLAND
- WATERBODIES
- BOREHOLE LOCATION
- MONITORING WELL
- MINI-PIEZOMETER STATION
- GROUNDWATER CONTOURS
- INFERRED GROUNDWATER FLOW DIRECTION

Note:
Groundwater contours are based on readings collected during the May 2022 monitoring event, which is interpreted to represent seasonally high conditions in 2022.

TITLE:
INTERPRETED GROUNDWATER CONTOURS

PROJECT:
HYDROGEOLOGICAL INVESTIGATION
DELHI GOLF COURSE REDEVELOPMENT
DELHI, ONTARIO

CLIENT:
DELHI DEVELOPMENT INC. C/O GERANIUM

wsp GOLDER

PROJECT NO.:	REVIEWED BY:
211-13079-00	LH
DATE: NOVEMBER 2022	FIGURE: 10

C:\aProjects\211-13079-00\MXD\211-13079-00 Figure 6 GW Contours.mxd

4 WATER BALANCE

A monthly water balance analysis was prepared for the Site, examining the pre-development condition against the post-development condition under the proposed redevelopment plan. The main focus of a water balance is to examine the effects of the proposed redevelopment on the overall water budget, specifically on changes to infiltration to the groundwater system. The basic assumption of a water budget analysis is that there is a balance between water inputs and outputs, which is typically represented in a simple form as:

$$P = ET + I + RO + \Delta S$$

Where:
P = Precipitation
ET = Evapotranspiration
I = Infiltration Recharge
RO = Runoff
ΔS = Change in Storage of the Soil

The objective of the water budget is to quantify the water budget equation for existing and future conditions, and to illustrate that there is either no significant change (i.e., a water balance) between the existing or future conditions, or that mitigation methods can be employed to minimize the estimated change.

4.1 WATER BALANCE METHOLODOLOGY

The MOE Stormwater Planning and Design Manual (2003) offers a method to estimate the infiltration on the site, based on a local infiltration factor “i", which is applied to the available water surplus to determine the groundwater recharge for a given area with pervious cover. The methodology considers factors such as the soil type, topography, and vegetation to arrive at the infiltration factor that is then applied against the water surplus to provide an estimate of the amount of water infiltrating into the ground. The remaining water surplus is considered runoff.

Under the post-development conditions, the infiltration factor is recalculated to account for changes in soil types, vegetation and topography after development, and the infiltration and runoff at the pervious land areas are recalculated. As the land after development will have impervious surfaces that prevent infiltration, such as building footprints, roads and parking areas, the pervious area available for infiltration is reduced. Furthermore, there is limited opportunity for evapotranspiration (ETR) on these impervious surfaces, other than evaporative losses from wetting and ponding of water in shallow depressions (estimated at 10% of total precipitation), and so total precipitation is applied to these surfaces instead of the water surplus. The 10% evaporative losses represent interception losses due to puddling, soaking into asphalt, roof shingles, and irregular coating of impervious surfaces. A 10% evaporation rate is considered a standard estimate, which is based on the Wet Weather Flow Management Guidelines (2006) published by the City of Toronto.

4.2 CLIMATE AND WATER SURPLUS

The inputs used for the water balance calculations are based on information provided by Environment Canada using climate data from the Delhi meteorological station (42º52’ N, 80º33’W) at elevation 231.6 masl for the period 1981-2010. This climate station is considered to be representative of climatic conditions at the subject property, which is approximately 6.8 km northwest of the Site. The Thornthwaite-Mather method was used to estimate potential and actual evapotranspiration on a monthly basis. This approach is based on an empirical relationship between potential

evapotranspiration and mean air temperature. The method takes into account the water holding capacity for the soil to compute the actual evapotranspiration and the resulting moisture surplus that is available for infiltration and runoff. The water holding capacity (WHC) of the soil depends on the soil type and structure, and type of vegetation growing on the surface. Different types of soil will retain different amounts of moisture storage capacity, while different species of vegetation will send roots into the soil to different depths and therefore retain varying amounts of moisture. The WHC for each soil / vegetation type combination found on the Site was determined from the Ministry of Environment (MOE) Environmental Design Criteria of the Stormwater Management Planning and Design Manual (2003). Climate tables that document the details of the Thornthwaite-Mather analysis for combinations of soil type and land-use are provided in **Appendix F**.

In the pre-development condition, the site is occupied primarily by an operational golf course, which consists of landscaped fairways and golf greens considered as short-rooted vegetative cover, however areas of woodlands and large areas of wetlands exist throughout the Site. Areas of short-rooted vegetation and lawns were analyzed using a WHC of 100 mm, while the woodland areas were assessed using a WHC of 350 mm. The wetlands at the Site exist as wooded wetlands at the south of the Site to areas of long grass and shrubs at the north of the Site, with some standing water. This initial water balance assessment has considered all wetland areas as consistent and have been assessed using a WHC of 200. In the post-development condition, urban landscaped lawns, wetlands, and woodland areas will continue to be assessed using WHC's of 100 mm, 200 mm, and 350 mm respectively.

The Site is located in an area of temperate climate with a mean annual temperature of 8.0 C and a mean annual precipitation of 1,036 mm. The potential evapotranspiration estimate based on the Thornthwaite approach is 598 mm per year for each WHC of 100 mm, 200 mm, and 350 mm. The mean actual evapotranspiration at the Site (pervious areas excluding existing imperviousness runoff contributions) is 568.2 mm for soils with a WHC of 100 mm, 581.2 mm for a WHC of 200 mm, and 588.2 mm for a WHC of 350 mm which reflect periods of soil moisture deficiency. The water surplus, the water available for infiltration and runoff, is estimated to range between 448 mm/year (for WHC's of 350 mm) to 468 mm/year (for WHC's of 100 mm).

4.3 INPUTS TO THE WATER BALANCE

Site specific inputs used in the water balance analysis for the pre- and post-development conditions are summarized in Table 6 and described in further detail in Sections 4.3.1, 4.3.2, and 4.3.3. The infiltration factors and WHCs presented in Table 6 have been categorized according to areas of the site with differing soil, vegetative cover, and topographic conditions to arrive at a total infiltration factor for each area of the site.

Topographic infiltration factors (i_{topo}) were evaluated using three sources of topographic survey data. A spot elevation survey was conducted by R-PE Surveying Limited on May 2, 2022 (Job 21-406) at monitoring stations around the Site. Fourteen (14) slope calculations between known stations were calculated and averaged to determine pre-development slopes across the Site, which is estimated at 1.3%. As stations were primary located in level areas (i.e., within the tablelands or at low-lying areas adjacent to wetlands), slopes calculated from this survey are considered representative of wetland areas, but not for the remainder of the developable lands as the Site contains areas of hilly topography which are not captured using the R-PE spot survey data. To ascertain a representative pre-development slope across the Site to be used for areas that reside outside of wetlands, an additional ten (10) slope calculations were performed from existing topographic contours presented on the Grading Plan (Plan G1 and G2, Project 053741.05 dated November 15, 2022) provided by Burnside. Slope calculations using this survey were averaged with calculations from the R-PE survey which estimated an average slope of 3.48% in the pre-development condition. Post-development slopes were determined using the same grading plan.

Soil infiltration factors (i_{soil}) have been determined by plotting the results of grain size distribution onto a soil ternary diagram for soil classification and matching the soil facies to an infiltration factor provided by the MOE (2003). Infiltration factors for vegetative cover in the pre-development condition have been estimated based on aerial photography of the Site, while pervious areas for post-development condition is based on development designs provided to WSP by the GSP Group (Concept Drawings 21208 dated October 21, 2022) and using Imperviousness percentages based on the Norfolk County Design Criteria Standards for Developments (2017).

Table 6: Infiltration Factors Used in the Water Balance

SITE AREAS	WHC (MM)	TOPOGRAPHY (I_{TOPO})	SOILS (I_{SOIL})	VEGETATIVE COVER (I_{COVER})	TOPSOIL STORAGE CAPACITY	SUM
PRE-DEVELOPMENT						
Wetlands	200	0.15	0.25	0.15	-	**0.55**
Woodlands and Forest Blocks	350	0.10	0.25	0.20	-	**0.55**
Landscaped Lawns and Golf Greens	100	0.10	0.25	0.05	-	**0.40**
POST-DEVELOPMENT (NO MITIGATION)						
Wetlands	200	0.15	0.25	0.15	-	**0.55**
Woodlands and Forest Blocks	350	0.10	0.25	0.20	-	**0.55**
Landscaped Lawns and Amenity Areas	100	0.11	0.25	0.05	-	**0.41**
POST-DEVELOPMENT (WITH MITIGATION)						
Wetlands	200	0.15	0.25	0.15	-	**0.55**
Woodlands and Forest Blocks	350	0.10	0.25	0.20	-	**0.55**
Landscaped Lawns and Amenity Areas	100	0.11	0.25	0.05	0.05	**0.46**

Notes:

Water Holding Capacity of Soils is based on values presented on Table 3.1 from the MOE Stormwater Management Manual (2003)

4.3.1 PRE-DEVELOPMENT CONDITIONS

In the pre-development condition, the Site is considered 97.2% pervious with only 2.8% of impervious land cover (1.5 ha) from the Golf Clubhouse, Patio, Roads, impervious features in the golf course, and Parking facilities. In the existing condition, the Site is assessed at having 32.8 ha of golf course fairways and greens, 10.7 ha of existing wetlands, 10.2 ha of woodlands, 0.4 ha of ornamental ponds in the golf course, and 1.1 ha of buildings and parking (see **Figure 11**). Based on Table 3.1 of the MOE Stormwater Planning and Design Manual (2003), areas of short-rooted lawns are given an infiltration factor for vegetative cover (i_{cover}) of 0.05, while areas of forest are assigned an infiltration factor of 0.20. Wetland areas have been assigned an infiltration factor for vegetative cover of 0.15.

The soils at the site are considered primarily sandy soil with a mix of silty loam observed in approximately half of the soil samples collected (see Section 3.2.2) and is therefore classified as a medium loam based on plotting the results of grain size analysis on a soil ternary diagram (see **Appendix D**). A medium loam is considered a mixture of Silty Loam and Sandy Loam with roughly equal percentages of Silt and Sand. Soil infiltration factors (i_{soil}) based on Table 3.1 of the MOE Stormwater Planning and Design Manual (2003) for a Silty Loam and Sandy Loam are 0.2

and 0.3 respectively. This assessment has considered medium loam as 0.25.

Topography on site is characterized overall as gentle rolling landscape with areas of relatively flat landscape in the tablelands (Golf fairways), with hilly sections adjacent to natural areas. (see Sections 2.3 and 4.3). Gradients of slope were determined using topographic surveys provided by R-PE Surveying Limited and presented on the Grading plans provided by Burnside (see Section 4.3). An average slope of 1.3% was used for wetland areas, which corresponds to an infiltration factor for topography (i_{topo}) of 0.15 based on the MOE i-factor approximation for slope (MOE 1995). An average slop of 3.5% was used for the remainder of the Site in the pre-development condition, including wooded areas and the golf course, which corresponds to an i_{topo} of 0.10.

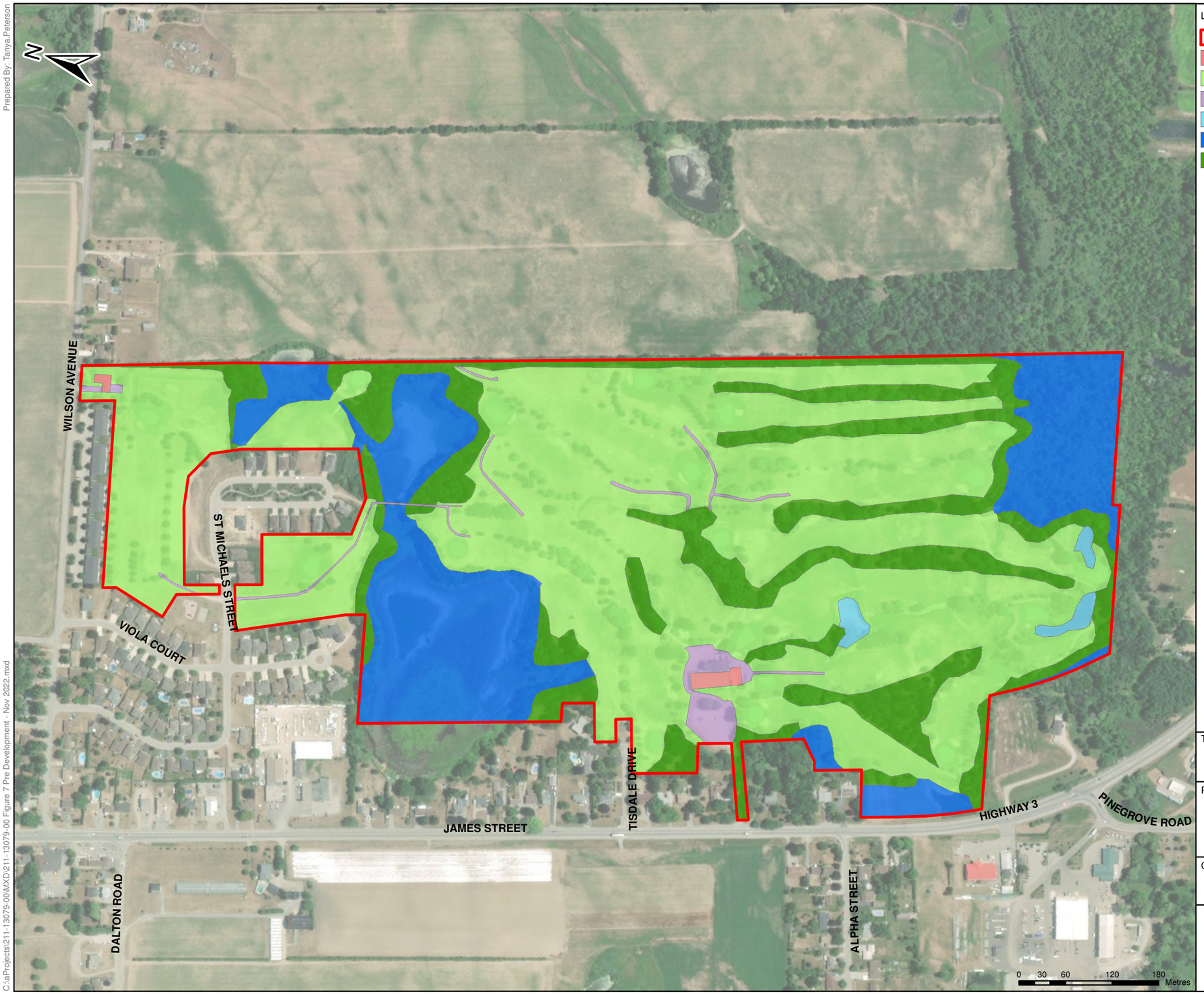
The overall pre-development infiltration factors "i" for the site are calculated as follows:

- The **Wetland** areas of the site is calculated to be **0.55** based on the following:
  - An average slope of 1.3% equates to an i_{topo} of 0.15 per the MOE i-factor approximation for slope;
  - Soils are assessed as a medium loam with an i_{soil} of 0.25; and,
  - Vegetative cover is considered to be a mix of long grass, shrubs, and trees, with an i_{cover} of 0.15.

- The **Forested** areas are calculated to be **0.55** based on the following:
  - An average slope of 3.5% equates to an i_{topo} of 0.10 per the MOE i-factor approximation for slope;
  - Soils are assessed as a medium loam with an i_{soil} of 0.25; and,
  - Vegetative cover is comprised of mature tree growth with an i_{cover} of 0.20.

- The **Golf Greens and Landscaped Areas** is calculated to be **0.40** based on the following:
  - An Average slope of 3.5% equates to an i_{topo} of 0.10 per the MOE i-factor approximation for slope;
  - Soils are assessed as a medium loam with an i_{soil} value of 0.25; and,
  - Vegetative cover is comprised of landscape lawns with an i_{cover} of 0.05

Prepared By: Tanya.Peterson



LEGEND:

- SITE BOUNDARY
- BUILDING
- LAWNS AND AREAS OF SHORT-ROOT VEGETATION
- PAVEMENT / TRAIL
- POND
- WETLAND
- WOODLAND

Note:
Pre-development land use has been based on aerial photography from Google Earth

TITLE:
PRE DEVELOPMENT LANDUSE

PROJECT:
HYDROGEOLOGICAL INVESTIGATION
DELHI GOLF COURSE REDEVELOPMENT
DELHI, ONTARIO

CLIENT:
DELHI DEVELOPMENT INC. C/O GERANIUM

WSP GOLDER	PROJECT NO.: 211-13079-00	REVIEWED BY: LH
	DATE: DECEMBER 2022	FIGURE: **11**

C:\aProjects\211-13079-00\MXD\211-13079-00 Figure 7 Pre Development - Nov 2022.mxd

4.3.2 POST-DEVELOPMENT CONDITIONS WITHOUT MITIGATION MEASURES

The future redevelopment of the Site will change the lands from its existing condition to a residential development which includes approximately 16.2 ha of residential homes, 1.2 ha dedicated to a retirement home, 8.1 ha of internal roads, sidewalks, and paved trails, and 11.7 ha of community parkland and amenity space (see Table 7). Residential units are proposed to be a mix of single- and semi-detached units with four lot sizes between 25 feet and 60 feet in length, and townhouse units. All residential homes are assumed to have standard 9-foot basements. The development will preserve approximately 10.5 ha of wetlands and 5.3 ha of forested areas (see **Figure 2**).

The post-development condition will change the evapotranspiration, runoff, and infiltration conditions by adding hard surfaces such as roads, sidewalks and roofs that are effectively impervious. Connected imperviousness is defined as those impervious areas that are directed to the stormwater management system for frequent minor storms. Imperviousness associated with roads, parking areas and driveways are typically considered as connected imperviousness. Non-connected imperviousness is defined as impervious areas that do not necessarily have to be directed to the stormwater management system but may be used to provide a source of relatively clean water for mitigation. Roof areas on residential units and the retirement facility have potential to be unconnected imperviousness and source of clean water available for infiltration. As pervious areas are reduced, there is limited opportunity for evapotranspiration, other than evaporative losses from wetting and ponding of water in shallow depressions (estimated at 10% of total precipitation falling upon the impervious area) on impervious surfaces.

The redevelopment parcel is expected to decrease pervious area from 53.8 ha (97.2%) in the pre-development condition to 38.4 ha (69.4%) in the post-development. The redevelopment is proposing a total of 16.9 ha of impervious surfaces, which includes building footprints, roads, sidewalks, and parking areas. Impervious areas for residential units in this assessment have been estimated using an impervious ratio based on the Norfolk County Design Criteria Standards (2017). Stormwater management for the development is proposed to be managed by a SWMP with a total area of 2.3 ha. The water balance assessment has considered the permanent pool will likely need to be lined based on groundwater levels, and as such an impervious percentage of 41% is estimated based on impervious areas (access roads and the permanent pool) using the SWMP design plan (dated November 7, 2022) provided by Burnside. The impervious areas for the proposed retirement centre is based on taking the average impervious percentage using three (3) existing retirement homes in the vicinity of Delhi as case studies, which is estimated at 49%.[9] Table 7 presents the land-use areas and imperviousness used in the water balance.

The following assumptions have been made for the post-development water balance:

- An impervious footprint of 20% has been assumed for the Community Commons area to account for benches, paved playgrounds, walking paths and other recreational facilities;
- An impervious footprint of 57% has been used for single and semi-detached residential units smaller than 40 feet and 36% for lots larger than 40 feet based on the Norfolk County Design Criteria Standards. Similarly, an impervious area of 79% has been used on Townhouse units;
- The water balance has assumed that the roof area of all single and semi-detached units is 70% of the total imperviousness of the lot, while the driveway, patio, and pathways on the lot make up the remaining 30% of the total imperviousness. This has been based on calculating modern examples of other residential units in the area;

[9] The impervious percentage for the proposed retirement centre is based on using three case studies from the vicinity of Delhi. The Delrose Retirement Centre in Delhi showed an impervious percentage of 31.9%, the Simcoe Heritage Retirement Centre showed an impervious percentage of 62.7%, and the Walnut Grove Retirement Centre in Norwich showed an impervious percentage of 52.1%. The average was taken to use in this assessment.

- Vegetative cover within wetland parcels across the site vary between areas of wooded wetlands, open water sections, and areas of long grass and shrubs. The water balance treated all areas of wetlands equally in terms of infiltration and runoff;
- The water balance has assumed that rear lawns in all single and semi-detached residential lots are rear-draining. While the initial grading plan identifies a small portion of lots as front-draining, the initial assessment has not separated those units;
- Areas of the existing golf course not being proposed for redevelopment will remain in its existing condition, including the presence of ornamental ponds;
- The water balance has assumed that any pervious areas in the front of semi-detached and townhouse units are too small to accommodate additional infiltration from front roof runoff to the front lawns;
- The area earmarked for the pumphouse has been considered as 100% impervious; and,
- Any fill that is brought into the Site will have a similar soil composition to existing soils

Table 7: Land-Use Areas used in the Development

	PRE-DEVELPMENT				POST-DEVELOPMENT			
LAND-USE	**AREA (ha)**	**% of TOTAL AREA**	**IMP %**	**IMP Area (ha)**	**AREA (ha)**	**% of TOTAL AREA**	**IMP %**	**IMP Area (ha)**
Wetlands	10.7	19.4	0	0	10.5	19.1	0	0
Golf Greens and Lawns	32.8	59.3	0	0	-	-	-	-
Ornamental Ponds	0.4	0.8	100	0.4	0.2	0.5	100	0.2
Existing Buildings	0.2	0.3	100	0.2	-	-	-	-
Existing Paved Areas	1.0	1.7	100	0.9	-	-	-	-
Forested Areas	10.2	18.5	0	0	5.3	9.5	0	0
Road Allowances	-	-	-	-	7.7	13.8	80	6.1
Residential Lots (25' & 36')	-	-	-	-	8.6	15.5	57	4.9
Residential Lots (44' & 60')					6.3	11.4	36	2.2
Townhouse Lots	-	-	-	-	1.5	2.6	79	1.0
SWMP Block	-	-	-	-	2.3	4.1	41	1.3
Pumping Station					0.06	0.1	100	0.06
Community Commons Park	-	-	-	-	1.7	3.1	20	0.3
Retirement Home					1.2	2.2	49	0.6
Sidewalks and Trails					0.3	0.5	100	0.3
Amenity and Parkland					9.7	17.6	0	0
Total Site	**55.3 ha**	**100.0 %**			**55.3ha**	**100.0 %**		
Total Impervious	**1.5 ha**	**2.8 %**			**16.9 ha**	**30.6%**		
Total Pervious	**53.8 ha**	**97.2 %**			**38.4 ha**	**69.4 %**		

Notes: Impervious percentages for residential units is based on lot coverage % outlined in the Norfolk County Design Criteria Standards (2017). Impervious coverage for the SWMP is based on designs provided by Burnside (dated November 7, 2022). Impervious coverage for the retirement home is based on taking an average impervious coverage for three case studies in neighboring retirement homes. Values have been rounded to one decimal place and therefore rounding errors may exist. The water balance was based on previous designs (October 2022). The updated development designs shown in Figures 2 and 12 are not representative of water balance land use areas.

Two post-development water balance conditions will be examined. In the first instance, a post-development scenario where there is no attempt to mitigate runoff or infiltration will be considered. In this scenario, all runoff generated from hard surfaces is assumed to be directed towards the SWMP facility. All roof runoff from residential properties and impervious surfaces across the Site is assumed to be directed towards the SWMP. The second post-development water balance scenario will examine design strategies to promote infiltration, which includes directing a portion of residential roof runoff to lawns and the addition of thicker topsoil for soil moisture retention. This is discussed further in Section 4.3.3.

Under post-development conditions, the soil composition of the redevelopment area has been assumed to remain similar to existing soil composition of a medium loam. Based on Table 3.1 of the MOE Stormwater Planning and Design Manual (2003), a medium loam has an i_{soil} of 0.25, which is a mixture of sandy loam (i_{soil} of 0.30) and silty loam (i_{soil} of 0.25). Post-development slopes of the redevelopment have been determined using the grading plans provided by Burnside (dated November 15, 2022). The average slope assessed across the developable areas of the Site is estimated at 2.9%, which corresponds to an infiltration factor for slope of 0.108 based on the MOE factor approximation for slope. The assessment has assumed the topography of the wetland areas have remained the same as in pre-development. The vegetative cover of the pervious areas within the redevelopment parcel is expected to be primarily landscaped lawns. Based on Table 3.1 from the MOE Stormwater Management Manual (2003), medium loams with short-rooted vegetation such as lawns are shown to have a WHC of 100 mm. Therefore, under the post-development scenarios, the local climate data provided by Environment Canada for soils with a WHC of 100 mm was used to estimate the future water surplus for the redeveloped areas of the site, which includes pervious areas in residential lots, the retirement centre, community commons park area, amenity space, and parkland areas.

The overall post-development (without mitigation) infiltration factors "i" for the site are calculated as follows:

- The landscaped areas of the redevelopment site are calculated to be **0.41** based on the following:
  - Site grading plans have identified an average slope of 2.9 %, which equates to an i_{topo} of 0.11 per the MOE i-factor approximation for slope;
  - Soils have been determined to be comprised of medium loam fill with an i_{soil} of 0.25; and,
  - Vegetative cover is comprised of landscaped lawns with an i_{cover} of 0.05.

Overall infiltration factors for wetlands and forested areas remain consistent with pre-development conditions at 0.55.

4.3.3 POST-DEVELOPMENT WITH MITIGATION MEASURES

The second post-development water balance was then carried out for the site with consideration of mitigation measures in place to promote infiltration. The following mitigation measures are recommended on the Site:

- Rear roof runoff from single and semi-detached houses will be directed onto the ground rather than to the SWMP by the use of disconnected drain spouts for additional infiltration. This additional water has been presumed to raise evapotranspiration from 568 mm/year (AET) to its full potential of 598 mm/year (PET). The excess roof runoff directed to the lawns in then treated as water surplus that will infiltrate and runoff in the same proportion as natural precipitation falling upon the lawns; and,
- Thicker placement of topsoil (0.25 m to 0.40 m thickness) in landscaped areas will provide additional retention of water. The infiltration factor of the vegetative cover to account for this additional retention of water has been raised by 0.05 to reflect this condition.

The post-development (with mitigation measures) infiltration factors "i" for the site are calculated as follows:

- The landscaped areas of the redevelopment site are calculated to be **0.46** based on the following:
  - Site grading has identified an average slope of 2.9 %, which equates to an i_{topo} of 0.11;
  - Soils have been determined to be comprised of medium loam fill with an i_{soil} of 0.25;
  - Vegetative cover is comprised of landscaped lawns with an i_{cover} of 0.05; and,
  - Thicker placement of topsoil has increased the infiltration factor by 0.05.

Overall infiltration factors for wetlands and forested areas remain consistent with pre-development conditions at 0.55.

4.4 WATER BALANCE CALCULATIONS

A water balance analysis has been performed, which has included a pre-development and two post-development water balance analyses. The first post-development water balance is a base-case calculation scenario with no mitigation measures applied, and the second post-development water balance is a calculation that considers several mitigation measures. The results for the water balance are described in Sections 4.4.1, 4.4.2, and 4.4.3, and are summarized on Table 8. The detailed calculations for the water balance are presented in Tables WB-1 to WB-4 found in **Appendix F**.

Table 8: Water Balance Summary Results for the Entire Site

	PRE-DEVELOPMENT (EXISTING GOLF COURSE)		POST-DEVELOPMENT (NO MITIGATION)		POST-DEVELOPMENT (WITH MITIGATION)	
PARAMETERS	**(MM/YEAR)**	**(M^3/YEAR)**	**(MM/YEAR)**	**(M^3/YEAR)**	**(MM/YEAR)**	**(M^3/YEAR)**
Delhi GC						
Precipitation	1035.8	572,972	1035.8	572,972	1035.8	572,972
Total Water IN		**572,972**		**572,972**		**572,972**
Total AET	558.5	308,965	399.2	220,805	401.7	222,220
Evaporative Losses at 10% Precipitation	2.9	1,598	31.6	17,485	31.6	17,485
Infiltration (MOE Methodology)	204.5	113,096	148.9	82,375	194.7	107,710
Runoff (MOE Methodology)	269.9	149,313	456.1	252,307	407.8	225,558
Total OUT		**572,972**		**572,972**		**572,972**

4.4.1 PRE-DEVELOPMENT CONDITIONS

Under pre-development conditions, the site is considered pervious over 53.8 ha of area (97.2%). The clubhouse at the golf course, parking lots, patio area, and trails in the golf course represent the only impervious footprints at the Site. The water surplus under pre-development conditions was calculated at 474.4 mm/year (262,409 m^3/year) across the site, with an annual infiltration of 204.5 mm/year (volumetrically 113,096 m^3/year). Most groundwater recharge occurs during the spring melt period when the soil moisture is high. The remaining 269.9 mm/year of surplus water (149,313 m^3/year) would be available for surface runoff, most of which occurs during the spring melt period. Runoff in the pre-development condition is estimated to generally flow southwards towards Stoney Creek, however local slopes around the northern wetland will receive runoff from lands bordering the wetland. The northern wetland is interpreted to flow towards Stoney Creek via a drainage channel that connects the two wetland areas along the west side of the property.

The major contribution of water from the property occurs in the late winter and spring. Water surpluses during the summer growing season (July through October) are very low, as the evapotranspiration is high during these months, and the soil moisture goes into a deficit (see Table WB-1 in **Appendix F**). Soil moistures start to become replenished in October. The pre-development water balance for the site is summarized in Table 8, with detailed water balance calculations presented in Table WB-2 in **Appendix F**.

4.4.2 POST-DEVELOPMENT CONDITIONS WITHOUT MITIGATION

The first of the post-development water balances carried out for the site assumed no mitigation measures are put into place. Essentially all hard surface runoff is considered to be directed to the stormwater management system in this scenario, which serves as a worst-case assessment of the impact of development on the groundwater system. The following assumptions have been made to estimate this post-development water balance scenario:

- There will be no infiltration occurring on hard surfaces, and evapotranspiration will be significantly lower than that under pre-development conditions;
- A 10% evaporation rate has been applied to impervious surfaces, which is considered a standard estimate for evaporation on impervious surfaces, which is based on the Wet Weather Flow Management Guidelines (2006) published by the City of Toronto;
- Total imperviousness of residential developable lots is assumed to be 36%, 57%, and 79% for residential units over 40 feet, residential units under 40 feet, and townhouse units respectively, which is based on the Norfolk County Design Criteria Standards (2017) and conversations with Burnside;
- The fill placed within the developable areas is assumed to match the grain size distribution from pre-development soil characterization, and will be classified as a medium loam material;
- This scenario assumes that all impervious area runoff (less impervious surface losses to evaporation), including roof runoff which would otherwise be expected to be discharged to pervious ground surface, is directed to the stormwater management system. This scenario considers that groundwater infiltration is supplied only by precipitation which falls upon pervious areas; and
- The redevelopment design is based on plans provided by GSP Group; designs dated October 21, 2022.

Table 9: Pre and Post Development Water Balance Without Mitigation

	PRE-DEVELOPMENT		POST-DEVELOPMENT		CHANGE	
PARAMETERS	**(MM/YEAR)**	**(M^3/YEAR)**	**(MM/YEAR)**	**(M^3/YEAR)**	**(M^3/YEAR)**	**(%)**
Delhi GC						
Precipitation	1035.8	572,972	1035.8	572,972	0	0.0%
Total AET	558.5	308,965	399.2	220,805	-88,160	-28.5%
Evaporative Losses at 10% Precipitation	2.9	1,598	31.6	17,485	+15,887	+994.2%
Infiltration (MOE Methodology)	204.5	113,096	148.9	82,375	-30,721	-27.2%
Runoff (MOE Methodology)	269.9	149,313	456.1	252,307	+102,993	+69.0%

Notes:
Evaporative losses are losses of precipitation though simple evaporation on impervious surfaces (such as from ponding at puddles).

As shown in Table 9 under this worse-case scenario, the water balance has estimated a 27.2% reduction in groundwater infiltration, whereas runoff to the stormwater management system is estimated to increase about 69.0%. The volumetric decrease in infiltration is estimated at 30,721 m^3/year, while an increase of 102,993 m^3/year is expected to flow into the stormwater management system. The impervious area of the site is expected to increase from 2.8% in the pre-development condition to 30.6% in the post-development.

4.4.3 POST-DEVELOPMENT CONDITIONS WITH MITIGATION

The second of the post-development water balances was carried out considering mitigation measures in place, described in Section 4.3.3 including, directing roof runoff from residential houses to the lawns, and the addition of topsoil for soil moisture retention. Although the Site offers additional opportunities for LIDs employing engineering methods (infiltration trenches, bioswales, etc.,), the initial assessment has considered the impact to post-development infiltration through the use of non-engineering solutions. The assumptions outlined in Section 4.4.2 are applicable in this water balance, with the following additions:

- Only the rear-roof runoff from single and semi-detached properties have been considered to add additional infiltration. While front lawns on larger properties may be sufficiently large to accommodate additional infiltration, smaller properties (units less than 40 feet and townhouse units) often have insufficient pervious area. The water balance has assumed the total length of rear lawns are greater than 5 m from the edge of the impervious footprint. Best practices from Lake Simcoe Regional Conservation Authority (LSRCA) document that additional infiltration from roof runoff is unlikely to occur if the flow path is small (less than 5 m as a rule of thumb);
- The roof area of residential units is 70% of the total lot imperviousness; and,
- The water balance has assumed that additional topsoil in pervious areas of the Site will not be altered by landowners in the post-development condition.

Table 10 summarizes the water balance where mitigation measures are considered.

Table 10: Pre and Post Development Water Balance With Mitigation

	PRE-DEVELOPMENT		POST-DEVELOPMENT		CHANGE	
PARAMETERS	**(MM/YEAR)**	**(M^3/YEAR)**	**(MM/YEAR)**	**(M^3/YEAR)**	**(M^3/YEAR)**	**(%)**
Delhi GC						
Precipitation	1035.8	572,972	1035.8	572,972	0	0.0%
Total AET	558.5	308,965	401.7	222,220	-86,745	-28.1%
Evaporative Losses at 10% Precipitation	2.9	1,598	31.6	17,485	+15,887	+994.2
Infiltration (MOE Methodology)	204.5	113,096	194.7	107,710	-5,386	-4.8%
Runoff (MOE Methodology)	269.9	149,313	407.8	225,558	+76,244	+51.1%

Notes:
Evaporative losses are losses of precipitation though simple evaporation on impervious surfaces (such as from ponding at puddles).

Allowing rear roof runoff from single and semi-detached properties to flow to the lawns for additional infiltration and adding 0.25 m to 0.4 m of additional topsoil is expected to improve the post-development infiltration deficit from 27.2% in the unmitigated scenario to 4.8% with mitigation measures. The use of these measures across the site has estimated the 4.8% infiltration deficit at 5,386 m^3/year, from 113,096 m^3/year (204.5 mm/year) in the pre-development to 107,710 m^3/year (197.4 mm/year) in the post-development. Surface runoff to the SWMP is expected to increase by 51.1% (+76,244 m^3/year) in the post-development, however this represents a reduction of 17.9% compared to the unmitigated scenario.

Should additional mitigation measures be required at the Site to increase infiltration, the assessment has identified the following opportunities:

- Directing front roof runoff from the larger (greater than 40 feet) single-detached units to the front lawns for additional infiltration is possible, providing the front lawn area is greater than 5 m in length, and the driveway occupies 10% or less of the total site;
- Directing clean roof runoff from the retirement home to the lawns or collecting this water into cisterns for irrigation may reduce municipal water demand at the site and improve infiltration;
- Implementing shallow infiltration swales at select areas of the Site, including the retirement centre, in community parkland, and in the rear yards of some residential lots to capture runoff. However, it should be noted that the exact location and sizing needs to conform with areas where groundwater levels are deeper than 1 m. Groundwater is expected to be less than 1 m at most of the south end of the Site and implementing swales at these locations may not be feasible. Further assessment at detail design should be carried out;
- Designing the Community Commons Parkland to maximize the pervious footprint through the use of pervious materials in recreational facilities will reduce runoff and allow for additional infiltration; and
- The consideration of permeable pavers in light vehicle parking facilities in select areas of the Site;

Consultation with the Conservation Authority and a review of practicality, feasibility, and costs of engineering options should be carried out at the detail design to appropriately select mitigation measures.

5 DEWATERING ASSESSMENT

5.1 DEWATERING POTENTIAL

A preliminary dewatering assessment was carried out at the Site to provide an estimate of pumping rates for construction excavations in proposed municipal servicing, residential basements, and the SWMP in order to identify the type of water handling permit likely required during construction. The redevelopment is proposed to be serviced with municipal water and sewers excavated in utility trenches along the 7.7 ha of roads across the Site. Residential basements are proposed for all units, including single and semi-detached properties as well as townhouse units, which have been assumed to be standard 9-foot (2.7 m) basements.

Dewatering potential has been assessed on the depths of excavations, types of soils anticipated to be encountered at the foundation levels, and the interpreted seasonally high groundwater levels. Table 11 provides elevation range comparisons between excavation types, expected seasonally high groundwater, and proposed grades to provide an overview of potential dewatering at the Site.

Table 11: Summary of Elevation Ranges at the Site

ELEVATIONS	LOW (MASL)	HIGH (MASL)	COMMENTS
MAIN DEVELOPMENT SOUTH OF THE WETLAND			
Proposed Grades	228.1	239.5	Northern side of the Site is highest adjacent to the wetland, with a decrease towards the south consistent with existing topography. Lowest grades are along properties bordering the SWMP along the east.
Groundwater	228.0	235.0	Highest groundwater is observed to the north, declining southerly toward Stoney Creek.
Utility Trench Inverts	225.8	236.0	The Sanitary Sewer is proposed as the deepest service with the lowest elevations along Street H adjacent to the SWMP.
Residential Basements	224.6	236.8	Finished Floors for Basements have been assumed to be 2.7 m below proposed grades
SWMP Bottom of Pond	226.0		Permanent Pool and Forebay are proposed at 1.2 m below the permanent pool

Note: Elevations shown are approximate only and intended to show regional trends. The dewatering assessment is based on location specific elevations. Proposed grades are based on the grading plan provided by Burnside (dated November 15, 2022 Figures G1 and G2). Groundwater elevations are based on interpreted groundwater contours prepared by WSP from May 2022 water level readings. Utility trench and SWMP excavations is based on SWMP Pond Plans and site servicing plans provided by Burnside (dated November 7 and November 3, 2022 respectively). Invert elevations of Utility Trenches are based on the range of the deepest service (Sanitary Sewer).

Table 11 demonstrates that seasonally-high groundwater is anticipated to be very close to proposed grades at the south end of the Site, with residential basements expected to extend to approximately 3.4 m into groundwater. The

north end of the Site (north end of the main parcel and all of the development north of the wetland) shows that proposed grades are likely to remain above seasonally-high groundwater by up to 4 m with basement foundations likely to remain above groundwater by about 1.5 m. A comparison of utility service excavation and groundwater is consistent, which shows that excavations at the south end of the Site is expected to extend below groundwater by about 2.2 m[10], while several sections around the Site are proposed to remain above groundwater (see **Figure 12**). Servicing along Street H shows excavations may extend below groundwater by up to 4 m, while the northeast end of the Site will be above groundwater or within groundwater by between 1 and 2 m. Excavation of the SWMP is anticipated to extend below groundwater by up to 1.5 m, with the base of the permanent pool below groundwater on a long-term basis by about 1 m.

As discussed in Sections 2.5 and 3.2, the soils at the site are predominantly silty sand to sand with a hydraulic conductivity (geometric mean) of 7.8 x 10^{-6} m/sec. A silt to clay aquitard is observed to separate the sandy layers into an upper and lower unit in the majority of boreholes drilled at the site[11]. Excavations for residential basements, the SWMP, and majority of the utility servicing is expected to be contained above this confining layer, with limited sections of utility trench excavations at the north end of the main redevelopment parcel that is anticipated to penetrate the confining layer. Although artesian pressures are identified in the area of the SWMP, the permanent pool is anticipated to remain above the confined aquifer by approximately 4 m. The majority of excavations west of Street D and south of Tisdale Drive are likely to require both short-term construction dewatering and long-term water management.

The preliminary dewatering assessment is intended to predict the type of permitting that may be required for the proposed redevelopment. If dewatering rates exceed 50,000 litres/day, permitting will be required. An Environmental Activity and Sector Registry (EASR) is required if the combined rates are less than 400,000 litres/day, while a Permit to Take Water (PTTW) would be required if the rates exceed 400,000 litres/day. The application requirements for a PTTW requires the applicant to address how much water will be withdrawn, over what time-period, where it will be discharged to, the water quality discharge parameters that are to be met, the expected zones of influence and the potential effects on natural features and other water users, among other things. Monitoring and mitigation measures would also be required and would be identified in the application. Permit to Take Water applications are submitted after detailed design and in advance of the construction works. PTTW applications may require up to 90 days for the MECP to complete their review. EASR registration requires dewatering and discharge plans be prepared by qualified professionals and can be submitted shortly prior to the start of dewatering without agency review.

5.2 DEWATERING APPROACH AND ASSUMPTIONS

For the purpose of this preliminary investigation, the dewatering assessment approach is based on estimating dewatering rates for representative sample sections[12] for each excavation type (excluding the SWMP) to obtain

[10] This assessment compares spring-time water levels estimated to be the seasonally high levels. Should excavation work be carried out during the seasonally low period (fall), lower groundwater levels may be encountered which may differ from results presented.

[11] The confining layer was observed at the north end of the main development and at the south end of the Site. The central area within the development was not observed to have an aquitard.

[12] The assessment has examined a select number of individual excavation elements, including two properties for single detached, 3 properties for townhouse units, and four 50m long segments of utility trench excavations as representative sample segments (referred to as "sample sections"). These sample sections are a localized dewatering analysis based on that property or trench location that may or may not fully represent other sample

provisional rates in order to determine the required water handling permit for construction. The selected assessment sections include four 50-m long servicing trenches (as it is assumed that excavations in municipal trenches will likely be restricted to a 50 m section at one time), two single-detached lots and three townhouse units in different areas of the Site. The aim of using these representative sample sections (herein referred to as sample selections) is to estimate dewatering volumes per excavation type which can be cumulatively added depending on the number of open excavations planned. Estimated rates from each excavation type are based upon the local conditions at that block or trench segment and may or may not be fully representative of other places of the Site. The aim of the preliminary dewatering assessment is to estimate provisional rates in order to establish a likely water handling permit type. It should be noted that this approach is preliminary, and a more comprehensive assessment should be undertaken at the detail design stage. In addition to the sample sections for residential basements and service trenching, the assessment has included an estimate of dewatering rates from the SWMP. **Figure 12** presents the locations of these sample sections and the locations of the SWMPs.

The dewatering assessment has estimated horizontal flow through the till using construction dewatering methods by Powers (1992) in an unconfined condition for all excavations at the Site, with the exception of one utility servicing section (Sample section 1 on Figure 12), which has been assessed as penetrating the confined layer. In this case, a confined condition has been used. Given the observations of upwards vertical gradients and the presence of a flowing well, the assessment has considered both lateral flow and vertical flow (using Darcy's Law), regardless of the vertical distance between the base of the excavation and the top of the underlying sand. While the assessment provides an estimate of volumetric vertical flow, the assessment has not quantified uplift or buoyancy pressures acting on the base of the SWMP or other excavations. We recommend that a geotechnical engineer be engaged to assess uplift pressures prior to any excavation activity in order to ascertain if depressurization pumping may be required or to provide input into a SWMP liner.

The assessment provides both a steady-state rate and an initial rate. The initial rate is presumed to be 1.5 times the steady-state rate to account for increased drawdown during initial stages of pumping. The assessment has provided initial and steady-state rates for two conditions:

1) The anticipated condition (interpreted seasonally high water levels and an appropriate hydraulic conductivity); and,
2) A conservative factor of safety (FoS) approach, which is based on increasing the hydraulic conductivity by one order of magnitude (10 x hydraulic conductivity). The FoS approach accounts for unforeseen groundwater and soil conditions and is intended to provide a worst-case rate to assess appropriate permits.

The dewatering assessment has made the following assumptions in the calculations:

- Groundwater levels used in the assessment have been based on interpretive groundwater contours generated from water level measurements collected on May 2, 2022 (see **Figure 10**). Groundwater elevations are seen to vary across the site between about 228 masl in the southwest to 225 masl in the northeast adjacent to the northern wetland. The assessment has assumed that groundwater levels from May 2022 represent typical seasonally high levels, however it should be noted that the assessment has not carried out long-term monitoring, nor has compared 2022 precipitation with other years to ascertain if May 2022 is representative of typical conditions;

---

sections around the Site. It is intended as a generalized cross section of expected dewatering rates for that excavation type.

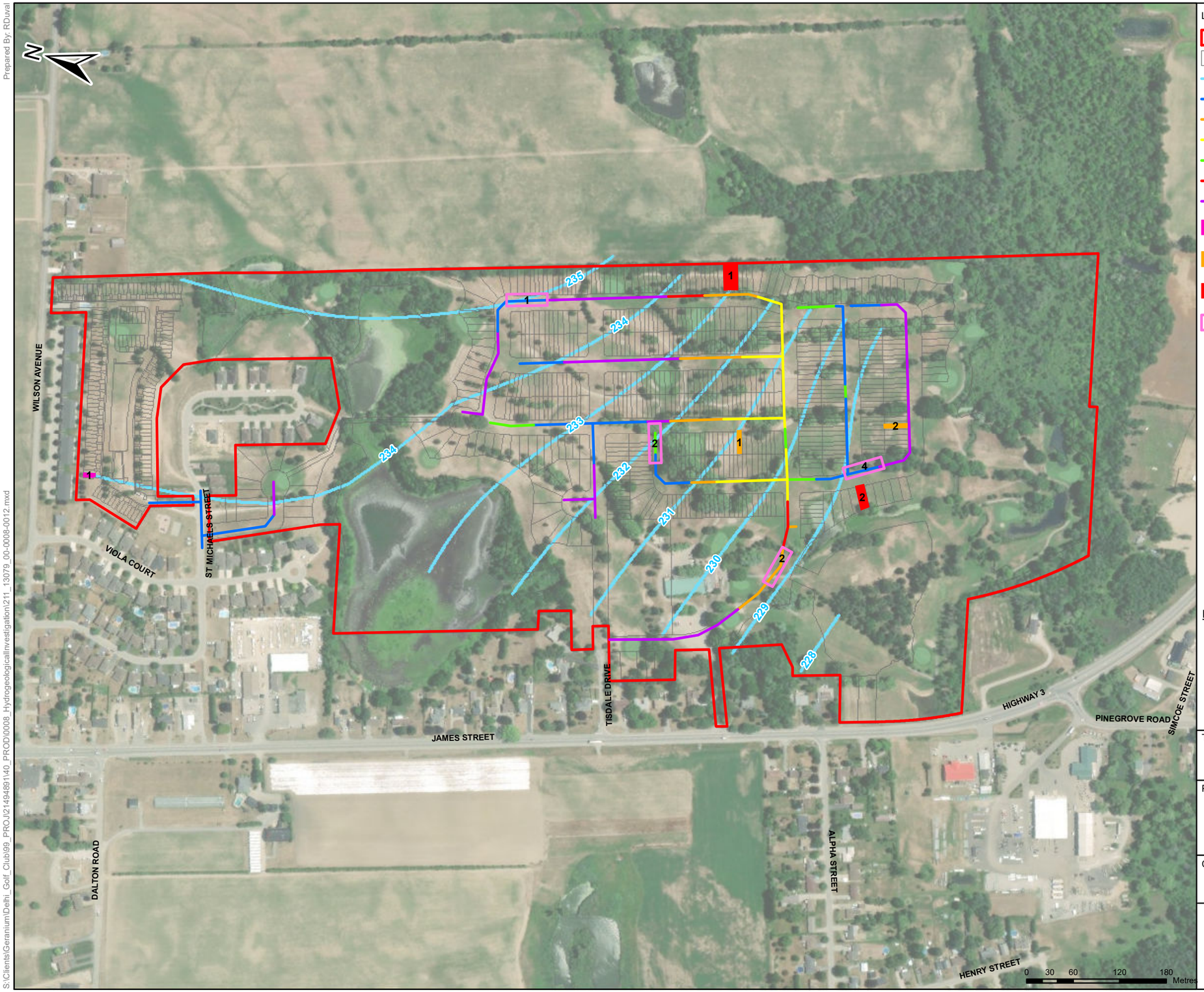
- Excavation depths for construction elements is based on design plans (SWMP Plan and Grading Plans) provided by Burnside, dated November 7, 2022 and November 3, 2022 respectively);
- The dewatering assessment has used an anticipated hydraulic conductivity for excavations in silty sand to sandy soils of Site is 7.8 x 10^{-6} m/sec and an anticipated hydraulic conductivity for excavations in fine-grained materials, including silt, sandy silt, and clay of 1.5 x 10^{-7} m/sec. These hydraulic conductivities represent geometric mean values from fourteen (14) Hazen Approximation estimates and six (6) single well response tests. The hydraulic conductivity for vertical flow has been assessed as $1/10^{th}$ of K_h;
- All excavations are carried out with an unconfined condition with the exception of Section 1 of utility trenching, which has used a confined condition. This is based on the soil stratigraphy from borehole log BH21-4, which shows the excavation in this part of the site to extend below a silty clay (TILL) layer;
- Dewatering estimates do not consider uplift pressures from confining layers;
- Vertical flow has used a gradient of 1;
- Given the blow counts recorded during borehole drilling are reasonably low, the assessment has assumed a vertical flow contribution for all excavations. For excavations deemed to remain above groundwater but are within 1 m from an underlying sandy aquifer, the assessment has documented dewatering volumes that represent the vertical contribution only assuming the aquifer was penetrated. As uplift pressures are not known and blow counts are low, the assessment has assumed that vertical flow may discharge into the excavation. This assumption should be confirmed with a geotechnical engineer;
- The proposed base of the SWMP is assumed to be 226.0 masl, which is 1.2 m below the permanent pool elevation based on the SWMP plan design provided by Burnside. The base of excavation for the SWMP is considered 0.5 m below the base to account for the installation of a liner, to an elevation of 225.5 masl. The assessment has used a rectangular model (141 m x 111 m) to provide area input into the calculations;
- Excavations for residential basements are assumed to extend a total of 3.2 m below the proposed grade, which includes the standard 9-foot (2.7 m) basements, and an additional 0.5 m for the placement of foundations;
- Excavations for municipal serving trenches are assumed to be 50 m long and 3 m wide with an additional 0.5 m added to the invert elevation as a final dewatering base; and,
- Pumping rates at single-lot residential basements are estimated as a standalone excavation, and therefore long-term foundation drain collector (FDC) rates are assuming that each property has segregated perimeter drainage, without consideration of combined flow.

5.3 DEWATERING FLOW RATES

The preliminary dewatering assessment including an estimation of short-term initial and steady-state pumping rates for sample segments of municipal service trenching, residential basements, and the proposed SWMP is presented in Table 12, with the full calculations provided in **Appendix G**. Table 12 provides both the anticipated condition (estimated hydraulic conductivity and seasonally high groundwater levels) and the factor of safety rates (10 times the hydraulic conductivity), as well as the expected zone of influence (ZOI) from the edge of each excavation element, the assumed aquifer base, and dimensions of excavation.

Prepared By: RDuval

S:\Clients\Geranium\Delhi_Golf_Club\99_PROJ\21494891\40_PROD\0008_Hydrogeologicallnvestigation\211_13079_00-0008-0012.mxd



LEGEND:

- SITE BOUNDARY
- PROPOSED DEVELOPMENT
- GROUNDWATER CONTOURS
- 0-1 M BELOW GROUNDWATER
- 1-2 M BELOW GROUNDWATER
- 2-3 M BELOW GROUNDWATER
- 3-4 M BELOW GROUNDWATER
- >4 M BELOW GROUNDWATER
- ABOVE GROUNDWATER
- SAMPLE SECTION FOR DEWATERING ASSESSMENT ON 18-FOOT TOWNHOUSE UNITS
- SAMPLE SECTION FOR DEWATERING ASSESSMENT ON 20-FOOT TOWNHOUSE UNITS
- SAMPLE SECTION FOR DEWATERING ASSESSMENT ON SINGLE DETACHED UNITS
- SAMPLE SECTION FOR DEWATERING ASSESSMENT ON MUNICIPAL SERVICING

NOTES:

THE DEVELOPMENT PLAN IS BASED ON DESIGNS PROVIDED BY THE GSP GROUP (PROJECT 21208) DATED FEBRUARY 23, 2023

TITLE:
REPRESENTATIVE DEWATERING ELEMENTS

PROJECT:
HYDROGEOLOGICAL INVESTIGATION
DELHI GOLF COURSE REDEVELOPMENT
DELHI, ONTARIO

CLIENT:
GOLFNORTH PROPERTIES INC. C/O GERANIUM

	PROJECT NO.: 211-13079-00	REVIEWED BY: LH
wsp	DATE: MARCH 2023	FIGURE: 12

Table 12: Summary of Estimated Dewatering Rates

Geranium Delhi

Reference Area	Single Detached Lot (60' Lot)		Townhouse Units Lot (20' Lot)		Townhouse (18 ft)	SWMP	Utility Service Trenching			
Location	Lot 1 (Street E, East)	Lot 2 (Street E, by SWMP)	Lot 1 (Street C)	Lot 2 (Street E, south)	Lot 1 (north)	Southeast	Section 1	Section 2	Section 3	Section 4
Dimensions *(m)*	16.0 x 11.0	16.0 x 11.0	5.0 m x 17.0 m	5.0 m x 17.0 m	5.0 m x 10.0 m	141m x 111 m	3 m x 50 m	3 m x 50 m	3 m x 50 m	3 m x 50 m
Construction Element	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Linear	Linear	Linear	Linear	Linear
Aquifer Type	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Confined	Unconfined	Unconfined	Unconfined
Hydraulic Conductivity *(m/sec)*	7.8E-06	7.8E-06	7.8E-06	7.8E-06	7.8E-06	7.8E-06	7.8E-06	7.8E-06	7.8E-06	7.8E-06
Excavation Elevation *(masl)*	225.7	230.7	229.2	228.7	236.1	225.5	234.4	230.3	225.3	227.6
Initial Groundwater Elevation *(masl)*	228.5	233.0	230.8	228.5	234.0	227.2	235.0	232.0	229	228.5
Aquifer Base *(masl)*	224.2	229.0	224.2	224.2	236.3	224.2	233.2	229.9	224	226.5
ZOI *(m)*	31.2	26.4	19.8	NA	NA	91.6	30.9	21.1	37.7	14.5
Short-Term Steady State Rate "Q" *(LPD)*	24,423	33,587	32,835	11,818*	No Dewatering	124,860	28,993	30,181	60,879	33,256
Short-Term Initial Rate "Q" *(LPD)*	36,635	50,381	49,253	20,988	No Dewatering	187,290	43,490	45,272	91,319	49,884
Steady-State Factor of Safety Rate "Q" *(LPD)* Approach (one order of Magnitude Higher for Hydraulic Conductivity	146,222	243,214	197,520	NA	No Dewatering	617,606	126,182	164,437	261,513	162,767
Long-Term FDC Rate *(litres/sec/dwelling)*	0.283	0.389	0.380	-	-	-	-	-	-	-

* Shows an excavation base above groundwater. Rates documents are estimated as the vertical contribution from underlying sand

SWMP DEWATERING

Results from the dewatering assessment has estimated a short-term initial and steady-steady state pumping rate for the SWMP under anticipated conditions at 187,290 litres per day (LPD) and 124,860 LPD respectively. The factor of safety (FoS) pumping rate is estimated at 617,606 LPD, which is based on using one order of magnitude increase in hydraulic conductivity. As the excavation of the SWMP is not anticipated to extend to 221.6 masl (the top of the confined aquifer interpreted to be the source of artesian pressure), pumping rates have been assessed in an unconfined condition, however it should be noted that the short-term construction pumping rates has been based on having approximately 3.9 m of fine-grained materials separating the base of the excavation and the confined aquifer. The nearest monitoring well to the SWMP (BH21-10) is a continuously flowing well and therefore the base of the SWMP is interpreted to be under uplift pressure. A geotechnical engineer should assess if 3.9 m of material is sufficient to withstand buoyancy during excavation.

The finished base of the pond is proposed to be at 226 masl, which is interpreted to be up to 2 m below seasonally high groundwater. The proposed location of the SWMP resides between a continuously flowing well to the west (BH21-10) and a nested well (BH21-11) showing upwards gradients and a shallow aquifer that ranges between 226.8 masl during the seasonally low period (October 2022) and 228.2 masl during the seasonally high period (May 2022). This suggests that the base of the SWMP will reside permanently below groundwater throughout the year (based only on one year of monitoring in 2022), and therefore the need for a liner at the base of the SWMP is likely required and should be evaluated by a geotechnical engineer. Given this, a long-term water management system at the base of the pond may be required to dewater groundwater during periods of SWMP maintenance or seasonal draining of the pond.

RESIDENTIAL UNIT DEWATERING

The preliminary assessment has considered construction dewatering rates for two individual single-detached residential lots, two townhouse units in the central area of the site, and one townhouse located north of the wetland (See **Figure 12**). The assessment has estimated initial and steady-state rates for basement excavations at individual single-detached lots under anticipated conditions of 36,635 LPD and 24,423 LPD respectively for Lot 1 (located at the east side of the property east of Street E), and 50,381 LPD and 33,587 LPD respectively for Lot 2 (located along Street E adjacent to the SWMP). The southern lot is assessed as marginally higher due to higher groundwater in that area of the site. Factor of Safety rates for Lot 1 and Lot 2 are estimated at 146,222 LPD and 243,214 LPD respectively. Long-term water management flow rates through an FDC have been estimated to range between 0.28 and 0.39 litres per second per dwelling based on a finished floor elevation of 2.7 m below proposed grade.

Results from the dewatering assessment has estimated a short-term initial and steady-state flow rate for a townhouse unit located near the intersection of Street C and Street H (Lot 1) to be 49,253 LPD and 32,835 LPD respectively, with an estimated long-term flow rate through an FDC system of 0.38 litres/sec/dwelling. A second location (Lot 2) for a townhouse lot was considered at the south end of the site along Street E, which showed that the proposed basement excavation will remain higher than groundwater in that area of the site, and therefore dewatering may not be required for lots in this area. As summarized in the assumptions in Section 5.2, the soils are shown to have low blow counts and are predominantly sandy with known upwards vertical gradients, and therefore it is possible that groundwater seepage may occur at the base of the excavation. The assessment has estimated a vertical contribution of upwards seepage assuming the underlying sand was penetrated of approximately 11,818 LPD, which may be

expected at this lot. The base of the excavation is proposed to be 228.7 masl with a sandy aquifer expected at 228.5 masl, therefore it is likely that groundwater seepage will be encountered during excavation during the spring, when groundwater levels are anticipated at 228.5 masl.

One additional townhouse unit was evaluated at the north end of the site (Lot 1, 18-foot, Figure 12), which was shown to have a proposed basement excavation approximately 2 m above seasonally high groundwater, and therefore this lot has been assessed as not likely requiring dewatering activities during construction. While the excavation is proposed to be within a surficial sand described as moist and non-cohesive, groundwater monitoring from BH21-2 located adjacent to the sample section shows the highest groundwater levels at 4.7 mbgs (233.9 masl), well below proposed excavation (236 masl). Furthermore, the underlying soil material shows a silty sand till with a blow count of 63, which suggests that vertical groundwater seepage into excavations is unlikely.

MUNICIPAL SERVICING DEWATERING

The dewatering assessment considered four (4) locations of utility trench excavation dewatering across the main development parcel as invert elevations and groundwater levels considerably varied (see Figure 12). Several sections of proposed trenching are expected to remain above groundwater, while some sections are anticipated to be within groundwater by up to 4 m. The east-west portion of Street H from the SWMP to the east side of the site shows the highest dewatering rates (Section 3) with initial and steady-state rates estimated at 91,319 LPD and 60,879 LPD respectively, with a FoS rate estimated at 261,513 LPD. Dewatering rates for the other three utility trench sections were estimated to range between 43,490 LPD and 49,884 LPD (initial rates), with steady-state rates estimated to range between 28,993 LPD and 33,256 LPD.

DEWATERING DISCUSSION

While anticipated pumping rates for each individual element are estimated to be less than 400,000 LPD (the limit to which a PTTW is needed), the combination of multiple excavations may exceed the 400,000 LPD threshold requiring a PTTW. Given the FoS rate for the SWMP was estimated at 617,606 LPD, it is likely that a PTTW for the excavation work will be required, however the dewatering assessment should be reassessed at the detail design stage to confirm permitting requirements.

Prior to excavation work, a geotechnical engineer should be engaged to assess uplift and buoyancy pressures that may be encountered, and to re-evaluate the soil conditions given the low blow counts observed during drilling. Additionally, an evaluation of the design and location of a potential liner and appropriate sub-drainage system for the SWMP should be carried out by a qualified geotechnical engineer.

6 DISCUSSION AND RECOMMENDATIONS

A Hydrogeological Assessment has been conducted for the proposed redevelopment of the Delhi Golf Club, located at 905 James Street in the Community of Delhi, Ontario to accompany an official plan amendment (for an urban boundary expansion and redesignation), zoning by-law amendment and draft plans of subdivision and condominium applications. The following conclusions and recommendations are presented based on the assessment carried out:

- In the existing condition, the Site is primarily characterized by rolling topography dominated by an operational golf course. Lands are generally flat along the golf course fairways (average slope of 1.3%), however hilly lands exist adjacent to natural areas and wetlands. The average slope across the site is assessed at 3.5%, with a topographic decline towards Stoney Creek valley lands in the south. Two main wetland areas are present on-site, connected by a drainage channel that flows to the south into Stoney Creek. The northern wetland is an area of shrubs and long grasses, while the southern wetland bordering Stoney Creek is a wooded wetland;
- There is evidence of artesian pressures on the Site, with the presence of a continual flowing well at the South of the Site (BH21-10), and upwards vertical gradients identified at both wetlands and at the nested piezometer BH21-11 south of Tisdale Road. Seasonally high groundwater is identified as being less than 1 m below ground surface for all redevelopment areas south of the northern wetland area, with a seasonal fluctuation that varies by approximately 1.8 m;
- Soil composition at the Site has been determined to be a mix of sandy soils with some areas of fine-grained silts and clayey silts. Glaciolacustrine sand layers are found at surface in half the boreholes drilled on-site, and in discrete layers at depth. Silt and Clayey silt layers are found at surface in some boreholes. The geometric mean of hydraulic conductivities for areas of sandy soil is estimated at 7.8×10^{-6} m/sec, while the geometric mean of hydraulic conductivities for finer grained soils is estimated at 1.5×10^{-7} m/sec. The investigation identified a silty clay and till aquitard that may be the cause of artesian pressures at the south of the Site. Shallow and deep sandy aquifers are observed in seven boreholes, primary at the south of the site;
- The assessment has interpreted that upwards groundwater flow will be present in the location of the SWMP, as well as some residential units. It is likely that a subdrainage system will be required at both the SWMP and at residential basements;
- A preliminary dewatering assessment has estimated that a PTTW is likely to be needed for construction of the SWMP and may be required for a combination of other excavation elements if construction is carried out during periods when groundwater is higher (winter and spring). Anticipated steady-state pumping rates at individual residential lots considered in this assessment shows a range between 11,818 LPD and 36,736 LPD, with initial pumping rates encounter during the start of dewatering at up to 50,381 LPD. Anticipated steady-state pumping rates for a 50 m long by 3 m wide utility servicing trench at four locations through the site have estimated a range between 28,993 LPD and 60,879 LPD, with initial rates up to 91,319 LPD; and,
- A water balance assessment for the proposed redevelopment has estimated a 27.2% deficit in groundwater recharge and a 69% increase in runoff to the SWMP in the post-development condition without implementing mitigation measures. The addition of 0.25 m of topsoil and disconnecting roof leaders on single and semi-detached properties to allow rear roof runoff to flow to the rear yards for additional infiltration will reduce the post-development infiltration deficit to 4.8%, creating a near balance with the pre-development condition. The

redevelopment is proposing a decrease of pervious cover from 97.2% in the pre-development condition to 69.4% in the post-development condition.

Upon completion of the hydrogeological assessment, the following recommendations are presented:

- We recommend a long-term groundwater monitoring program be initiated at the site that includes measuring water levels on a quarterly basis to establish seasonal variations and trends in groundwater levels. While the groundwater monitoring data collected has been sufficient for the development applications, further groundwater monitoring should be carried out in preparation for detail design. Long-term monitoring across subsequent years will allow a comparison between years to establish refined average conditions at the site. Furthermore, we recommend that dataloggers be instrumented in up to four locations in monitoring wells and at both surface water monitoring stations at the site to better understand the variable groundwater conditions observed at the site;

- We recommend additional hydraulic conductivity testing be carried out in preparation for detail design in order to refine dewatering estimates. Estimates of hydraulic conductivity for the preliminary assessment are thought to be underestimated (as compared to Hazen Approximations), and therefore a more comprehensive program of well development and testing be carried out to ascertain a better representative hydraulic conductivity that can be used in the revised dewatering assessment;

- This preliminary dewatering assessment should be re-assessed based upon new findings of hydraulic conductivity and groundwater monitoring at the detail design stage. Furthermore, an investigation on potential uplift pressures from artesian pressures should be carried out on excavation elements prior to construction, specifically at the location of the SWMP where observed flowing conditions are noted;

- We recommend that the design and location of a potential liner and appropriate sub-drainage system for the SWMP be carried out by a qualified geotechnical engineer. If a subdrainage system at the SWMP is determined by a geotechnical engineer as a requirement and designs have been prepared, we recommend conducting a dewatering assessment for water management in the subdrainage system to estimate long-term pumping rates;

- Additional work should be carried out to compare groundwater conditions to the cut/fill plan once these designs are finalized. The hydrogeological assessment for draft plan submission has compared groundwater to proposed grades at sample segments for the purpose of estimating dewatering discharge volumes, however as it was noted that some areas of the site are being lowered to elevations close to groundwater, further investigation should be carried out to identify the vertical distance between seasonally high groundwater and finished grades on all areas of the site;

- The water balance should be reassessed at detail design to refine roof runoff contributions to additional post-development infiltration on rear lawns, specifically to differentiate on a lot by lot basis between front and rear-draining lots. The initial assessment has assumed all lots are rear-draining, which should be reassessed. Additionally, locations of potential infiltration measures should be assessed in the event that further infiltration is deemed required by reviewing agencies; and,

- Appropriate water quality sampling will be required closer to detail design in preparation for obtaining a water handling permit, which may include suitable sewer-use bylaws and PWQO.

7 STANDARD LIMITATIONS

("WSP") prepared this report solely for the use of the intended recipient, Delhi Development Inc. c/o Geranium in accordance with the professional services agreement between the parties. In the event a contract has not been executed, the parties agree that the WSP General Terms for Consultant shall govern their business relationship which was provided to you prior to the preparation of this report.

The report is intended to be used in its entirety. No excerpts may be taken to be representative of the findings in the assessment.

The conclusions presented in this report are based on work performed by trained, professional and technical staff, in accordance with their reasonable interpretation of current and accepted engineering and scientific practices at the time the work was performed.

The content and opinions contained in the present report are based on the observations and/or information available to WSP at the time of preparation, using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by WSP and other engineering/scientific practitioners working under similar conditions, and subject to the same time, financial and physical constraints applicable to this project.

WSP disclaims any obligation to update this report if, after the date of this report, any conditions appear to differ significantly from those presented in this report; however, WSP reserves the right to amend or supplement this report based on additional information, documentation, or evidence.

WSP makes no other representations whatsoever concerning the legal significance of its findings.

The intended recipient is solely responsible for the disclosure of any information contained in this report. If a third party makes use of, relies on, or makes decisions in accordance with this report, said third party is solely responsible for such use, reliance, or decisions. WSP does not accept responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken by said third party based on this report.

WSP has provided services to the intended recipient in accordance with the professional services agreement between the parties and in a manner consistent with that degree of care, skill and diligence normally provided by members of the same profession performing the same or comparable services in respect of projects of a similar nature in similar circumstances. It is understood and agreed by WSP and the recipient of this report that WSP provides no warranty, express or implied, of any kind. Without limiting the generality of the foregoing, it is agreed and understood by WSP and the recipient of this report that WSP makes no representation or warranty whatsoever as to the sufficiency of its scope of work for the purpose sought by the recipient of this report.

In preparing this report, WSP has relied in good faith on information provided by others, as noted in the report. WSP has reasonably assumed that the information provided is correct and WSP is not responsible for the accuracy or completeness of such information.

Benchmark and elevations used in this report are primarily to establish relative elevation differences between the specific testing and/or sampling locations and should not be used for other purposes, such as grading, excavating, construction, planning, development, etc.

Design recommendations given in this report are applicable only to the project and areas as described in the text and then only if constructed in accordance with the details stated in this report. The comments made in this report on potential construction issues and possible methods are intended only for the guidance of the designer. The number of

testing and/or sampling locations may not be sufficient to determine all the factors that may affect construction methods and costs. We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.

Overall conditions can only be extrapolated to an undefined limited area around these testing and sampling locations. The conditions that WSP interprets to exist between testing and sampling points may differ from those that actually exist. The accuracy of any extrapolation and interpretation beyond the sampling locations will depend on natural conditions, the history of Site development and changes through construction and other activities. In addition, analysis has been carried out for the identified chemical and physical parameters only, and it should not be inferred that other chemical species or physical conditions are not present. WSP cannot warrant against undiscovered environmental liabilities or adverse impacts off-Site.

The original of this digital file will be kept by WSP for a period of not less than 10 years. As the digital file transmitted to the intended recipient is no longer under the control of WSP, its integrity cannot be assured. As such, WSP does not guarantee any modifications made to this digital file subsequent to its transmission to the intended recipient.

This limitations statement is considered an integral part of this report.

8 REFERENCES

Barnett, P.J., and Girard, C.K., 1982, *Quaternary Geology of the Tillsonburg Area*; Ontario Geological Survey. Map 2473, Quaternary Geology Series, Scale 1:50,000 Geology 1976

Chapman, L.J. and Putnam, D.F., 1984, *The Physiography of Southern Ontario*. Ontario Geological Survey Special Volume 2. Accompanied by Map P.2715, scale 1:600,000.

City of Toronto, Water Infrastructure Management, 2006. *Wet Weather Flow Management Guidelines*. Prepared by Toronto Water. Toronto, Ontario.

Credit Valley Conservation and Toronto and Region Conservation, 2010. *Low Impact Development Stormwater Management Planning and Design Guide*.

Corporation of Norfolk County, 2017., *Norfolk County Design Criteria Standards*.

Johnstone, K., and Louis, P. 1983. *Water Balance Tabulations for Canadian Climate Stations*. Hydrometeorology Division, Canadian Climate Centre, Atmospheric Environment Services, DS8-83

Lake Erie Source Protection Region (LESPR), January 2008., *Long Point Region Watershed Characterization Report*.

Ontario Ministry of the Environment, Conservation, and Parks, 2022. *Source Protection Information Atlas*. Open Source Online Portal. Access: *https://www.lioapplications.lrc.gov.on.ca/SourceWaterProtection/index.html?viewer=SourceWaterProtection.SWPViewer&locale=en-CA*.

Ontario Ministry of Natural Resources, Geological Branch, 1978. *Quaternary Geology of the Simcoe Area, Southern Ontario*. Barnett, P.J. Geoscience Report 162

Ontario Ministry of the Environment, 1995. *Hydrogeological Technical Information Requirements for Land Development Applications*. Queen's Printer for Ontario

Ontario Ministry of the Environment. 2020. *Long Point Region Source Protection Plan, Volume 1 and 2*. Clean Water Act 2006.

Ontario Geological Survey, Ministry of Natural Resources, 1982. Quaternary Geology of the Tillsonburg Area, Southern Ontario, P.J. Barnett. Report 220.

Ontario Geological Survey, 2003. *Surficial Geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release - Data 128*.

Ontario Geological Survey, 1984. *Physiography of Southern Ontario. Map Sheet P. 2715*. Physiography by Chapman and Putnam.

Ontario Ministry of the Environment, 2003. *Stormwater Planning and Design Manual*.

Wilson., C.B., April 2014. *Gravel Roads, Pads, and Infiltration Characteristics.* Emmons & Olivier Resources

APPENDIX

A BOREHOLE LOGS AND GRAIN SIZE CURVES

PROJECT: 21494891

LOCATION: N 4743379.45; E 542372.04

RECORD OF BOREHOLE: 21-1

SHEET 1 OF 1

BORING DATE: December 15, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected) 100 200 300 400	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected) 100 200 300 400	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}	WATER CONTENT PERCENT Wp W Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
		GROUND SURFACE		238.56									
0	Power Auger 108 mm I.D. Hollow Stem Auger	TOPSOIL (680 mm)		0.00	1	SS	2	ND					
				237.88									
		(CL) SILTY CLAY, some sand; brown-grey; cohesive, w>PL, firm		0.68	2A	SS	5	ND					
1		(ML) CLAYEY SILT, some sand; brown; cohesive, w<PL, very soft to firm		237.65 0.91	2B			ND					
								ND					
					3	SS	2	ND					
2				236.35									
		(ML) Sandy SILT, some clay, trace gravel; brown; non-cohesive, moist, compact to very dense		2.21	4	SS	24	ND					
3					5A	SS							
				235.21		SS	56	ND					
		(SM) SILTY SAND, some gravel, trace clay; brown; cohesive, moist, compact to very dense		3.35	5B			ND					
								ND					
4					6	SS	93	ND				MH	
5					7	SS	77	ND					
6													▽ December 15, 2021
					8	SS	17	ND					
				231.85									
		END OF BOREHOLE		6.71									
7		NOTE:											
		1. Groundwater measured at 6.10 m below ground surface upon completion of drilling.											
8													
9													
10													

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 6/17/22

PROJECT: 21494891

LOCATION: N 4743312.99; E 542139.04

RECORD OF BOREHOLE: 21-2

SHEET 1 OF 1

BORING DATE: December 16, 2021

DATUM: Geodetic

DRILL RIG: GT8

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected (100 200 300 400) / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ ND = Not Detected (100 200 300 400)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		238.78							GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Auger	TOPSOIL (200 mm)		0.00 / 238.58	1A			ND			Concrete; Sand
		(SM) SILTY SAND, contains cobbles; orange-brown; non-cohesive, moist, loose to dense		0.20	1B	SS	4	ND			
1					2	SS	27	ND			
2					3	SS	31	ND			Bentonite
				236.34	4A	SS	42	ND			
		(SM) SILTY SAND, some gravel, trace clay; brown (TILL); non-cohesive, moist, dense		2.44	4B			ND		MH	
3		(SM) SILTY SAND, some gravel; brown; non-cohesive, moist, very dense		235.81 / 2.97	5A	SS					
				235.43		SS	63	ND			
		(SM) SILTY SAND, some clay; brown; non-cohesive, moist, dense		3.35	5B			ND			
4					6	SS	36	ND			Sand
				234.28							
		(ML) Sandy CLAYEY SILT, contains cobbles; brown; cohesive, w<PL, stiff		4.50	7	SS	13	ND			May 2, 2022
5											Screen
6				232.58	8	SS	50	ND			
		END OF BOREHOLE		6.20							
7											
8											
9											
10											

NOTES:

1. Groundwater measured at 6.10 m below ground surface upon completion of drilling.

2. Auger refusal at 6.20 m.

3. Water levels measured in monitoring well:

Date	Depth (m)	Elev. (m)
16-Dec-21	6.1	232.7
22-Dec-21	4.8	233.9
14-Jan-22	4.8	233.9
02-May-22	4.7	234.0

DEPTH SCALE

1 : 50

LOGGED: JD

CHECKED: MWK

GOLDER

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 6/17/22

PROJECT: 21494891

LOCATION: N 4743136.09; E 542136.97

RECORD OF BOREHOLE: 21-3

SHEET 1 OF 1

BORING DATE: December 15, 2021

DATUM: Geodetic

DRILL RIG: GT8

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ND = Not Detected	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ND = Not Detected	HYDRAULIC CONDUCTIVITY, k, cm/s	WATER CONTENT PERCENT Wp W Wl	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		237.31									GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Auger	TOPSOIL (250 mm)		0.00 / 237.06	1A								Concrete
		(SM) SILTY SAND; orange-brown; non-cohesive, moist, very loose		0.25 / 236.63	1B	SS	3	ND					Sand
		(ML) CLAYEY SILT, some sand; brown; cohesive, w>PL, firm		0.68 / 236.24	2A			ND					
1		(SM) SILTY SAND; brown; non-cohesive, moist, loose		1.07 / 235.86	2B	SS	5	ND					
		(ML) Sandy SILT, some clay, slight plasticity; brown; non-cohesive, moist, loose to dense		1.45	3	SS	7	ND					
2					4	SS	26	ND				MH	Bentonite
3					5	SS	29	ND					May 2, 2022
4					6	SS	45	ND					Sand
5					7	SS	35	ND					Screen
6					8	SS	52	ND				MH	
				230.60 / 6.71									
7		END OF BOREHOLE											
8		NOTES:											
9		1. Groundwater measured at 6.10 m below ground surface upon completion of drilling.											
10		2. Water levels measured in monitoring well:											

Date	Depth (m)	Elev. (m)
15-Dec-21	Dry	-
22-Dec-21	3.1	234.2
14-Jan-22	3.4	234.0
02-May-22	3.5	233.8

DEPTH SCALE

1 : 50

LOGGED: JD

CHECKED: MWK

GOLDER

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 6/17/22

PROJECT: 21494891

LOCATION: N 4742884.02; E 542492.94

RECORD OF BOREHOLE: 21-4

BORING DATE: December 3, 2021

DRILL RIG: D70

SHEET 1 OF 1

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		238.86							GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Auger	TOPSOIL (150 mm)		0.00	1A						
		(SP) CLAYEY SAND, trace organics; brown; cohesive, w~PL, soft		0.15	1B	SS	2				
				238.18							
1		(ML) CLAYEY SILT, some sand and gravel; brown; cohesive, w~PL, firm to stiff		0.68	2	SS	6				
					3	SS	14				
2				236.65							
		(SP/GP) SAND and GRAVEL, some clay, cobbles/boulders; brown; non-cohesive, moist, compact		2.21	4	SS	26				
				235.89							
3		(Cl) SILTY CLAY, some sand and gravel; brown (TILL); cohesive, w<PL, very stiff to hard		2.97	5	SS	24				
					6A						
4				234.75							
		(SM) SILTY SAND, trace gravel; brown; non-cohesive, moist, dense		4.11	6B	SS	41				
				234.36							
		(ML) Sandy SILT, some clay and gravel; brown; cohesive, w<PL, very dense		4.50	7	SS	46				
5											▽ December 15, 2021
				233.26							
		(SP) SAND, some silt, trace gravel; brown; non-cohesive, moist, dense		5.60							
6					8	SS	38				
				232.15							
		END OD BOREHOLE		6.71							
7		NOTE:									
		1. Groundwater measured at 5.33 m below ground surface upon completion of drilling.									
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: JD

CHECKED: MWK

GOLDER

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 6/17/22

PROJECT: 21494891

LOCATION: N 4742921.12; E 542349.29

RECORD OF BOREHOLE: 21-5

SHEET 1 OF 1

BORING DATE: December 3, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		239.92							GR SA SI CL
0	Power Auger; 108 mm I.D. Hollow Stem Auger	TOPSOIL (250 mm)		0.00 239.67	1A						
		(SP) SAND, trace organics; brown; non-cohesive, moist, very loose		0.25 239.24	1B	SS	3				
1		(SP) SAND, some silt; brown to light brown; non-cohesive, moist, very loose		0.68	2	SS	2				
					3	SS	2				
2				237.71							Bentonite
		(SP) SAND; brown; non-cohesive, moist, compact		2.21	4	SS	22				
3				236.72	5A						
		(ML) SILT, some sand; brown; non-cohesive, moist, very stiff		3.20	5B	SS	17				
		(SP) SILTY SAND to SAND, some silt, trace clay; brown; non-cohesive, moist to wet, compact		3.35							
4					6	SS	15			MH	
											Sand
5					7	SS	21				Screen
6											May 2, 2022
					8	SS	21				
				233.21							
7		END OF BOREHOLE		6.71							
		NOTE:									
		1. Water levels measured in monitoring well:									
8		Date / Depth (m) / Elev. (m) 03-Dec-21 / 5.8 / 234.1 14-Dec-21 / Dry / - 22-Dec-21 / Dry / - 14-Jan-22 / Dry / - 02-May-22 / 6.0 / 233.9									
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: MC

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 6/17/22

PROJECT: 21494891

LOCATION: N 4742746.92; E 542281.29

RECORD OF BOREHOLE: 21-6

SHEET 1 OF 1

BORING DATE: December 15, 2021

DATUM: Geodetic

DRILL RIG: GT8

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected (100 200 300 400) / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ ND = Not Detected (100 200 300 400)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		238.55							GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Auger	TOPSOIL (200 mm)		0.00 / 238.35	1A			ND			
		(ML) Sandy CLAYEY SILT to CLAYEY SILT , some sand; brown; cohesive, w~PL to w>PL, soft to hard		0.20	1B	SS	3	ND			
1					2	SS	5				
					3A						
2					3B	SS	46				
		(ML) Sandy SILT, some clay and gravel; (TILL); non-cohesive, moist, dense to very dense		2.21 / 236.34							
3					4	SS	31				
					5	SS	50			MH	
		(ML) CLAYEY SILT, some sand and gravel; brown (TILL); cohesive, w<PL, hard		3.73 / 234.82							
4					6	SS	36				
		(SM) SILTY SAND, trace gravel; brown to grey; non-cohesive, moist, very dense		4.50 / 234.05							
5					7	SS	83				
6					8	SS	50				
		END OF BOREHOLE		6.17 / 232.38							
		NOTE:									
7		1. Auger refusal at 6.17 m on probable boulder.									
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: MC

CHECKED: MWK

GOLDER

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 6/17/22

PROJECT: 21494891

LOCATION: N 4742552.19; E 542338.33

RECORD OF BOREHOLE: 21-7

SHEET 1 OF 1

BORING DATE: December 1, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected; 100 200 300 400) / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected; 100 200 300 400)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		231.55						GR SA SI CL
0	Power Auger; 108 mm I.D. Hollow Stem Auger	TOPSOIL (200 mm)		0.00 / 231.35	1A			ND		Concrete
		(SM) SILTY SAND; brown; non-cohesive, moist, very loose to compact		0.20	1B	SS	2	ND		
1					2	SS	1			May 2, 2022
				229.95	3A					
		(SP) SAND, some gravel and silt to (SM) SILTY SAND; brown; non-cohesive, moist to wet, compact to dense		1.60	3B	SS	15			
2		- CLAYEY SILT pockets			4A					Bentonite
					4B	SS	13			
3					5	SS	14			
					6A					
4					6B	SS	13			MH
					7A					Sand
5					7B	SS	17			
										Screen
6					8	SS	30			
				224.84						
		END OF BOREHOLE		6.71						
7		NOTE:								
		1. Water levels measured in monitoring well:								
8		Date / Depth (m) / Elev. (m) 01-Dec-21 / 3.0 / 228.6 14-Dec-21 / 0.9 / 230.7 22-Dec-21 / 1.3 / 230.2 14-Jan-22 / 1.3 / 230.2 02-May-22 / 1.1 / 230.4								
9										
10										

DEPTH SCALE

1 : 50

GOLDER

LOGGED: MC

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 6/17/22

PROJECT: 21494891

LOCATION: N 4742578.17; E 542590.19

RECORD OF BOREHOLE: 21-8

SHEET 1 OF 1

BORING DATE: December 3, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W WI; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		232.77							GR SA SI CL
0	Power Auger; 108 mm I.D. Hollow Stem Auger	(ML) Sandy SILT and organics; brown; cohesive, w~PL, firm		0.00	1	SS	3		○		
				231.86	2A	SS	6				May 2, 2022
1		(CL) SILTY CLAY, some sand; brown; cohesive, w~PL, firm		0.91	2B						
				231.32							
		(ML) Sandy SILT, trace gravel; brown; non-cohesive, wet, compact		1.45	3	SS	10				
2				230.56							Bentonite
		(SP) SAND, trace silt and gravel; brown; non-cohesive, wet, compact to dense		2.21	4	SS	28				
3					5A	SS	25		○	MH	
		(SP/GP) SAND and GRAVEL, some silt; brown; non-cohesive, wet, dense		3.43	5B						
				229.04							
		(ML) SILT, some sand; grey; cohesive w>PL, very stiff		3.73	6	SS	22				
4				228.27							Sand
		(ML) CLAYEY SILT; grey; cohesive, w>PL, very stiff to stiff		4.50	7	SS	17				
5											Screen
6					8	SS	13		○		
				226.06							
		END OF BOREHOLE		6.71							
7		NOTE:									
		1. Water levels measured in monitoring well:									
8		Date / Depth (m) / Elev. (m) 03-Dec-21 / 2.3 / 230.4 14-Dec-21 / 0.6 / 232.2 22-Dec-21 / 0.7 / 232.1 14-Jan-22 / 0.6 / 232.2 02-May-22 / 0.8 / 232.0									
9											
10											

DEPTH SCALE

1 : 50

LOGGED: MC

CHECKED: MWK

GOLDER

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 6/17/22

PROJECT: 21494891

LOCATION: N 4742424.81; E 542539.11

RECORD OF BOREHOLE: 21-9

BORING DATE: December 2, 2021

DRILL RIG: D70

SHEET 1 OF 1

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa — nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		229.82									GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Auger	TOPSOIL (300 mm)		0.00 / 229.52	1A	SS	5						
		(SP) SILTY SAND; brown; non-cohesive, moist, loose		0.30 / 229.14	1B								
1		(SP) SAND, some silt; brown; non-cohesive, moist, loose		0.68 / 228.37	2	SS	9						May 2, 2022
2		(ML) Sandy SILT; brown; non-cohesive, wet, compact		1.45 / 227.61	3	SS	18						Bentonite
3		(ML) SILT, some sand, trace gravel, trace clay; brown to grey; cohesive, w>PL, stiff to very stiff to firm		2.21	4	SS	14						
					5	SS	15					MH	
4					6	SS	10						
					7	SS	10						Sand
5													Screen
6					8	SS	7						
		END OF BOREHOLE		223.11 / 6.71									
7		NOTE:											
		1. Water levels measured in monitoring well:											
8		Date / Depth (m) / Elev. (m) 02-Dec-21 / 4.6 / 225.2 14-Dec-21 / 1.1 / 228.7 22-Dec-21 / 1.2 / 228.7 14-Jan-22 / 1.1 / 228.7 02-May-22 / 1.0 / 228.8											
9													
10													

DEPTH SCALE

1 : 50

GOLDER

LOGGED: MC

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 6/17/22

PROJECT: 21494891

LOCATION: N 4742381.52; E 542147.79

RECORD OF BOREHOLE: 21-10

BORING DATE: December 21, 2021

DRILL RIG: D70

SHEET 1 OF 2

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected (100 200 300 400) / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ ND = Not Detected (100 200 300 400)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		227.72							GR SA SI CL
0	Power Auger; 108 mm I.D. Hollow Stem Auger	TOPSOIL (200 mm)		0.00 / 227.52	1A			ND			
		(ML) CLAYEY SILT, some sand; brown; cohesive, w~PL, soft		0.20	1B	SS	3	ND			
				227.04							
		(SM) SILTY SAND, trace clay and gravel, slight plasticity; brown; non-cohesive, moist to wet, compact		0.68	2A	SS					
1					2B	SS	8				
2					3	SS	16			MH	
					4	SS	16				
3					5	SS	28				Bentonite
				223.99							
		(CL) SILTY CLAY to CLAYEY SILT, some sand, trace gravel; grey; cohesive, w>PL, firm to stiff		3.73	6	SS	8				
4											
5					7	SS	9			MH	
6					8	SS	11				
7											Sand
8					9	SS	13				Screen
9											
					10	SS	3				
				217.97							
		END OF BOREHOLE		9.75							
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

WSP GOLDER

LOGGED: JD

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 6/17/22

PROJECT: 21494891

LOCATION: N 4742381.52; E 542147.79

RECORD OF BOREHOLE: 21-10

SHEET 2 OF 2

BORING DATE: December 21, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected; 100 200 300 400) / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected; 100 200 300 400)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		--- CONTINUED FROM PREVIOUS PAGE ---								GR SA SI CL
10		NOTE:								
		1. Water levels measured in monitoring well:								
		Date / Depth (m) / Elev. (m) 21-Dec-21 / 5.2 / 222.5 22-Dec-21 / -0.2 / 227.6 14-Jan-22 / -0.2 / 227.6 02-May-22 / -0.2 / 227.6								
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

DEPTH SCALE

1 : 50

LOGGED: JD

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 6/17/22

PROJECT: 21494891

LOCATION: N 4742390.79; E 542406.70

RECORD OF BOREHOLE: 21-11

BORING DATE: December 2, 2021

DRILL RIG: D70

SHEET 1 OF 2

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		228.72							GR SA SI CL
0	Power Auger; 108 mm I.D. Hollow Stem Auger	TOPSOIL (150 mm)		0.00	1A						Concrete; May 2, 2022
		(SP) SAND, some silt; brown; non-cohesive, wet, very loose		0.15	1B	SS	2				
				228.04							
		(ML) Sandy SILT; brown; non-cohesive, moist to wet, compact		0.68	2	SS	11				
1											
					3	SS	16				
2				226.52							
		(ML) SILT; brown to grey; cohesive w>PL, stiff to firm		2.20	4	SS	10				
3											
					5	SS	5				
											Bentonite
4					6	SS	6			MH	
				224.22							
		(ML) Sandy SILT to CLAYEY SILT; grey; cohesive, w>PL, firm		4.50	7	SS	5				
5											
6					8	SS	5				
7				221.56							
		(SP) SAND, some clay and gravel; brown; non-cohesive, wet, very loose		7.16	9A					MH	Sand
				220.72							
8		(ML) Sandy SILT; grey; cohesive, w>PL, firm		8.00	9B	SS	2				Screen
				220.03							
		(CL) SILTY CLAY; grey; cohesive, w>PL, firm		8.69							
9					10	SS	5				
				218.97							
		END OF BOREHOLE		9.75							
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

LOGGED: MC

CHECKED: MWK

GOLDER

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 6/17/22

PROJECT: 21494891

LOCATION: N 4742390.79; E 542406.70

RECORD OF BOREHOLE: 21-11

SHEET 2 OF 2

BORING DATE: December 2, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		--- CONTINUED FROM PREVIOUS PAGE ---									GR SA SI CL
10		NOTE: 1. Water levels measured in monitoring well: Date — Depth (m) — Elev. (m) 02-Dec-21 — 3.0 — 225.7 14-Dec-21 — 0.3 — 228.4 22-Dec-21 — 0.4 — 228.3 14-Jan-22 — 0.5 — 228.3 02-May-22 — 0.2 — 228.5									
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

LOGGED: MC

CHECKED: MWK

GOLDER

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 6/17/22

PROJECT: 21494891

LOCATION: N 4742389.29; E 542406.70

RECORD OF BOREHOLE: 21-11B

BORING DATE: December 2, 2021

DRILL RIG: D70

SHEET 1 OF 1

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		0.00									GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Auger												Concrete
1													May 2, 2022
2													Bentonite
3													Sand
4													Screen
4		END OF BOREHOLE		4.42									
5		NOTE:											
6		1. Water levels measured in monitoring well:											
7		Date / Depth (m) / Elev. (m) 02-Dec-21 / 3.0 / 225.7 14-Dec-21 / 0.5 / 228.2 22-Dec-21 / 0.8 / 228.0 14-Jan-22 / 0.9 / 227.9 02-May-22 / 0.5 / 228.2											
8													
9													
10													

DEPTH SCALE

1 : 50

LOGGED: MC

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 6/17/22

PROJECT: 21494891

LOCATION: N 4743293.71; E 542345.65

RECORD OF BOREHOLE: 21-12

SHEET 1 OF 1

BORING DATE: December 16, 2021

DATUM: Geodetic

DRILL RIG: GT8

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected (100 200 300 400) / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ ND = Not Detected (100 200 300 400)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		236.73							GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Augers	TOPSOIL (230 mm)		0.00 / 236.50	1A			ND			Concrete
		(SM) SILTY SAND, some clay; orange-brown; non-cohesive, moist to wet, very loose to loose		0.23	1B	SS	5	ND			Sand
1					2	SS	0	ND			Bentonite
		(CL-ML) Sandy SILTY CLAY to CLAYEY SILT; brown; cohesive, w>PL, very soft		235.28 / 1.45	3		0	ND			
2		(SM) SILTY SAND, some clay; brown; non-cohesive, moist, compact		234.52 / 2.21	4	SS	18	ND			May 2, 2022
3		(ML) CLAYEY SILT and SAND; brown; cohesive, w<PL, hard		233.76 / 2.97	5	SS	45	ND			
		(SM) SILTY SAND; brown; non-cohesive, moist to wet, compact to dense		233.00 / 3.73	6	SS	35	ND			
4											Sand
5					7	SS	18	ND			Screen
		(ML) Sandy SILT, some clay; brown; cohesive, w>PL, very stiff		231.13 / 5.60	8	SS	16	ND			
6											
		END OD BOREHOLE		230.02 / 6.71							
7											
8											
9											
10											

NOTES:

1. Groundwater measured at 2.13 m below ground surface upon completion of drilling.

2. Water levels measured in monitoring well:

Date	Depth (m)	Elev. (m)
16-Dec-21	2.1	234.6
22-Dec-21	2.2	234.5
14-Jan-22	2.3	234.5
02-May-22	2.2	234.5

DEPTH SCALE

1 : 50

LOGGED: JD

CHECKED: MWK

GOLDER

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 6/17/22

PROJECT: 21494891

LOCATION: N 4742348.68; E 542243.38

RECORD OF BOREHOLE: 21-13

SHEET 1 OF 1

BORING DATE: December 3, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		229.34							GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Auger	TOPSOIL (230 mm)		0.00 229.11	1A						
		(SM) SILTY SAND; brown; non-cohesive, moist, loose		0.23 228.66	1B	SS	3				
1		(ML) Sandy CLAYEY SILT; brown; cohesive, w<PL to w>PL, soft to stiff		0.68	2	SS	4				
2					3	SS	14				
					4	SS	10				▽ December 3, 20221
3		(SM) SILTY SAND; brown; non-cohesive, wet, loose		226.37 2.97 225.61	5	SS	5				
4		(CL) Sandy SILT, some clay, trace gravel; grey; cohesive, w>PL, firm to stiff		3.73	6	SS	5				
5					7	SS	10				
6					8	SS	6				
		END OF BOREHOLE		222.63 6.71							
7		NOTE:									
		1. Groundwater measured at 2.60 m. below ground surface upon completion of drilling.									
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: MC

CHECKED: MWK

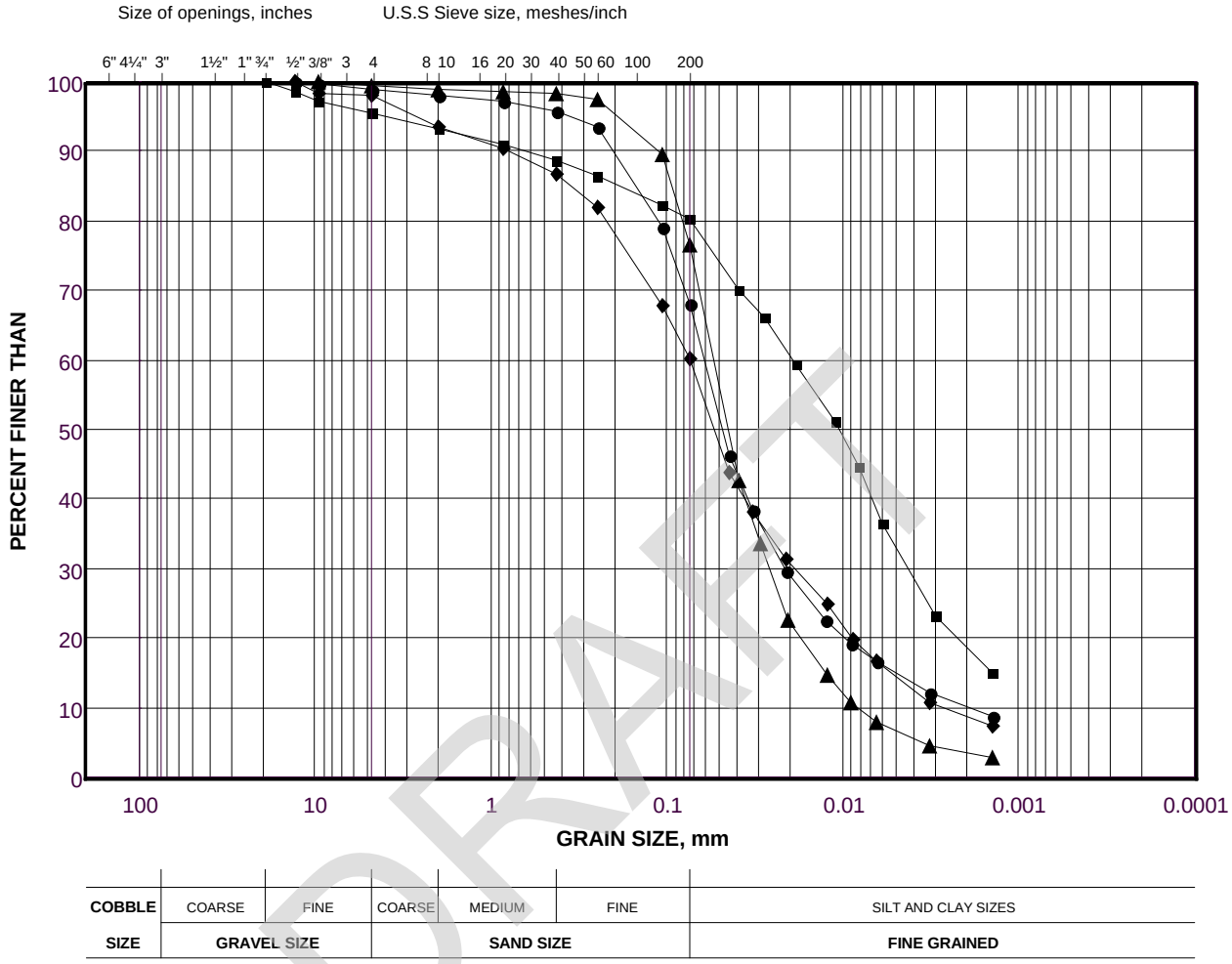
GOLDER

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 6/17/22

GRAIN SIZE DISTRIBUTION

(CL-ML) SILTY CLAY-CLAYEY SILT to (ML) SILT

FIGURE C1



DRAFT

LEGEND

SYMBOL	Borehole	SAMPLE	DEPTH(m)
●	21-3	4	2.29 - 2.90
■	21-10	7	4.57 - 5.18
◆	21-13	8	6.10 - 6.71
▲	21-3	8	6.10 - 6.71

Project Number: 21494891 (1000)

Checked By:

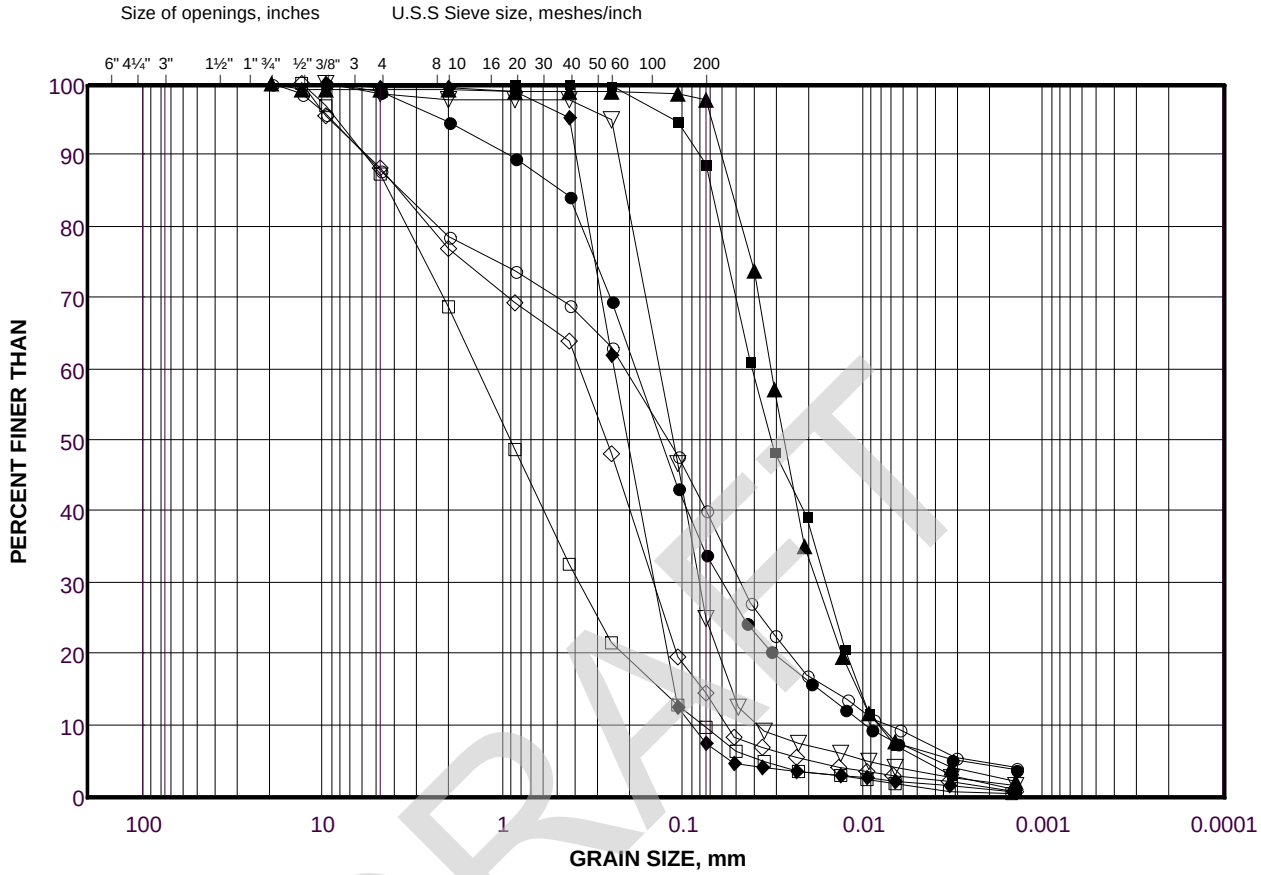
Golder Associates

Date: 29-Mar-22

GRAIN SIZE DISTRIBUTION

(ML) SILT TO (SM) silty SAND to (SP) SAND

FIGURE C3



DRAFT

LEGEND

SYMBOL	Borehole	SAMPLE	DEPTH(m)
●	21-10	3	1.52 - 2.13
■	21-9	5	3.05 - 3.66
◆	21-8	5A	3.05 - 3.66
▲	21-11	6	3.81 - 4.42
▽	21-5	6	3.81 - 4.42
❍	21-1	6	3.81 - 4.42
□	21-7	6A	3.81 - 4.42
△	21-11	9A	7.62 - 8.23

Project Number: 21494891

Checked By: _____

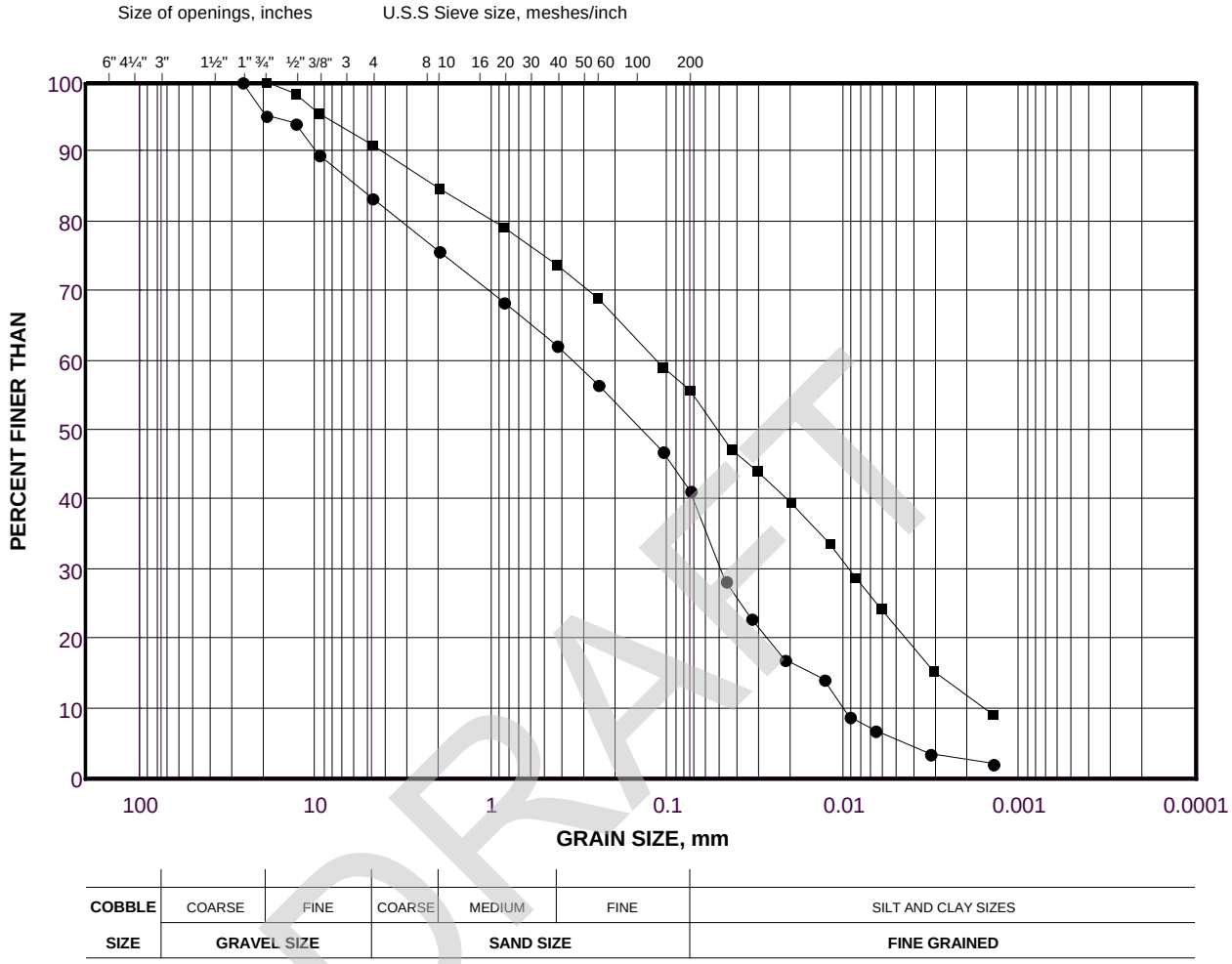
Golder Associates

Date: 29-Mar-22

GRAIN SIZE DISTRIBUTION

(ML) Sandy SILT TILL

FIGURE C4



DRAFT

LEGEND

SYMBOL	Borehole	SAMPLE	DEPTH(m)
●	21-2	4B	2.29 - 2.90
■	21-6	5	3.05 - 3.66

Project Number: 21494891 (1000)

Checked By:

Golder Associates

Date: 29-Mar-22

APPENDIX

B MECP WATER WELL RECORDS

MECP Water Well Records

Well Record #

4400440 Lot Conc **DELHI TOWN / NORFOLK**

Date 3/11/1961 DD/MM/YYYY

Elev (masl) Easting 541629 Northing 4743223

/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m

Water Found 12.2 (mbgs) (masl) FRESH

Casing Diameter 2 inch Casing Material: STEEL

Top of Screen (mbgs) Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	9.8	(mbgs)	(masl)
Pumping WL	10.4	(mbgs)	(masl)
Pump Rate	18.2	(LPM)	2 / 0
Spec. Cap.	29.83	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
13.7			MEDIUM SAND / /

4400443 Lot Conc **DELHI TOWN / NORFOLK**

Date 12/9/1961 DD/MM/YYYY

Elev (masl) Easting 541739 Northing 4743623

/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m

Water Found 17.7 (mbgs) (masl) FRESH

Casing Diameter 5 inch Casing Material: STEEL

Top of Screen 18.9 (mbgs) Bottom of Screen 21.3 (mbgs)

Screen Interval 2.4 (m)

Flowing? N

SWL	11.9	(mbgs)	(masl)
Pumping WL	19.8	(mbgs)	(masl)
Pump Rate	31.8	(LPM)	4 / 0
Spec. Cap.	4.02	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
2.4		YELLOW	MEDIUM SAND / BOULDERS /
4.0			GRAVEL / /
17.7		YELLOW	MEDIUM SAND / /
21.3			FINE SAND / /

4400444 Lot Conc **DELHI TOWN / NORFOLK**

Date 12/5/1962 DD/MM/YYYY

Elev (masl) Easting 541874 Northing 4743758

/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m

Water Found 13.4 (mbgs) (masl) FRESH

Casing Diameter 5 inch Casing Material: STEEL

Top of Screen 13.1 (mbgs) Bottom of Screen 14.6 (mbgs)

Screen Interval 1.5 (m)

Flowing? N

SWL	10.7	(mbgs)	(masl)
Pumping WL	11.9	(mbgs)	(masl)
Pump Rate	27.3	(LPM)	1 / 30
Spec. Cap.	22.37	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.9			FILL / /
6.1			CLAY / MEDIUM SAND / BOULDERS
10.7			CLAY / MEDIUM SAND /
16.2			MEDIUM SAND / /

4400912 Lot 047 Conc 02 **MIDDLETON TOWNSHIP / NORFOLK**

Date 7/10/1956 DD/MM/YYYY

Elev (masl) Easting 541729 Northing 4742952

/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m

Water Found 12.8 (mbgs) (masl) FRESH

Casing Diameter 4 inch Casing Material: STEEL

Top of Screen (mbgs) Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	4.0	(mbgs)	(masl)
Pumping WL		(mbgs)	(masl)
Pump Rate	36.4	(LPM)	/
Spec. Cap.		(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
12.8		GREY	CLAY / /
13.1			GRAVEL / /

Well Record #

4400913 — **Lot 047 Conc 02 MIDDLETON TOWNSHIP / NORFOLK**

Date 7/13/1956 (DD/MM/YYYY) | Elev (masl) | Easting 541771 | Northing 4742930 | UTM RC 5 margin of error : 100 m - 300 m

/ Domestic | Water Supply | FRESH

Water Found 9.8 (mbgs) (masl)

Casing Diameter 4 inch | Casing Material: STEEL

Top of Screen (mbgs) | Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? Y

SWL (mbgs) (masl)

Pumping WL (mbgs) (masl)

Pump Rate (LPM) /

Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
9.8		CLAY /	GRAVEL /

4400914 — **Lot 047 Conc 02 MIDDLETON TOWNSHIP / NORFOLK**

Date 7/13/1956 (DD/MM/YYYY) | Elev (masl) | Easting 541779 | Northing 4742957 | UTM RC 5 margin of error : 100 m - 300 m

/ Domestic | Water Supply | FRESH

Water Found 9.4 (mbgs) (masl)

Casing Diameter 4 inch | Casing Material: STEEL

Top of Screen (mbgs) | Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? Y

SWL (mbgs) (masl)

Pumping WL (mbgs) (masl)

Pump Rate (LPM) /

Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
9.4		CLAY /	/
9.8		GRAVEL /	/

4400915 — **Lot 047 Conc 02 MIDDLETON TOWNSHIP / NORFOLK**

Date 7/19/1956 (DD/MM/YYYY) | Elev (masl) | Easting 541899 | Northing 4742535 | UTM RC 5 margin of error : 100 m - 300 m

/ Domestic | Water Supply | FRESH

Water Found 9.1 (mbgs) (masl)

Casing Diameter 4 inch | Casing Material: STEEL

Top of Screen (mbgs) | Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL 0.3 (mbgs) (masl)

Pumping WL 0.6 (mbgs) (masl)

Pump Rate 36.4 (LPM) /

Spec. Cap. 119.32 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
9.1		CLAY /	GRAVEL /

4400916 — **Lot 047 Conc 02 MIDDLETON TOWNSHIP / NORFOLK**

Date 8/9/1956 (DD/MM/YYYY) | Elev (masl) | Easting 541624 | Northing 4742999 | UTM RC 5 margin of error : 100 m - 300 m

/ Domestic | Water Supply | FRESH

Water Found 6.1 (mbgs) (masl)

Casing Diameter 6 inch | Casing Material:

Top of Screen (mbgs) | Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL 2.4 (mbgs) (masl)

Pumping WL 3.7 (mbgs) (masl)

Pump Rate 9.1 (LPM) /

Spec. Cap. 7.46 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
5.8		CLAY /	/
6.1		GRAVEL /	/

4400917 — **Lot 047 Conc 02 MIDDLETON TOWNSHIP / NORFOLK**

Date 8/4/1958 (DD/MM/YYYY) | Elev (masl) | Easting 541604 | Northing 4742982 | UTM RC 5 margin of error : 100 m - 300 m

/ Domestic | Water Supply | FRESH

Water Found 9.8 (mbgs) (masl)

Casing Diameter inch | Casing Material:

Top of Screen (mbgs) | Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL 5.5 (mbgs) (masl)

Pumping WL 6.1 (mbgs) (masl)

Pump Rate 54.6 (LPM) 5 / 0

Spec. Cap. 89.49 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
1.5		PREVIOUSLY DUG /	/
8.2		CLAY /	BOULDERS /
9.8		BOULDERS /	/

Well Record #

					12.2	GRAVEL /		/	

4400918 — **Lot 047 Conc 02 MIDDLETON TOWNSHIP / NORFOLK**

Date 5/14/1959 (DD/MM/YYYY) — Elev (masl) — Easting 541704 — Northing 4743052 — / Domestic — Water Supply — UTM RC 5 — margin of error : 100 m - 300 m

Water Found 13.1 (mbgs) (masl) FRESH

Casing Diameter 1 inch — Casing Material: STEEL

Top of Screen 13.4 (mbgs) — Bottom of Screen 14.9 (mbgs)

Screen Interval 1.5 (m)

Flowing? N

SWL	1.2	(mbgs)	(masl)
Pumping WL	2.4	(mbgs)	(masl)
Pump Rate	18.2	(LPM)	3 / 0
Spec. Cap.	14.91	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
1.5			MEDIUM SAND /		/
6.1			CLAY /		/
14.9			GRAVEL /		/

4400920 — **Lot 047 Conc 02 MIDDLETON TOWNSHIP / NORFOLK**

Date 10/27/1959 (DD/MM/YYYY) — Elev (masl) — Easting 541564 — Northing 4742902 — / Domestic — Water Supply — UTM RC 5 — margin of error : 100 m - 300 m

Water Found 10.1 (mbgs) (masl) FRESH

Casing Diameter 5 inch — Casing Material: STEEL

Top of Screen (mbgs) — Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	3.0	(mbgs)	(masl)
Pumping WL	6.1	(mbgs)	(masl)
Pump Rate	45.5	(LPM)	2 / 0
Spec. Cap.	14.91	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
6.1			CLAY /		/
11.3			MEDIUM SAND /		/

4400925 — **Lot 047 Conc 02 MIDDLETON TOWNSHIP / NORFOLK**

Date 11/4/1960 (DD/MM/YYYY) — Elev (masl) — Easting 541574 — Northing 4742957 — / Domestic — Water Supply — UTM RC 5 — margin of error : 100 m - 300 m

Water Found 9.8 (mbgs) (masl) FRESH

Casing Diameter inch — Casing Material:

Top of Screen 12.5 (mbgs) — Bottom of Screen 13.7 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL	4.0	(mbgs)	(masl)
Pumping WL		(mbgs)	(masl)
Pump Rate	18.2	(LPM)	4 / 0
Spec. Cap.		(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
4.6			PREVIOUSLY DUG /		/
7.9			CLAY /		/
9.1			GRAVEL /		/
9.8			CLAY /		/
15.2			COARSE SAND /		/

4400927 — **Lot 047 Conc 02 MIDDLETON TOWNSHIP / NORFOLK**

Date 5/18/1961 (DD/MM/YYYY) — Elev (masl) — Easting 541622 — Northing 4742922 — / Domestic — Water Supply — UTM RC 5 — margin of error : 100 m - 300 m

Water Found 7.9 (mbgs) (masl) FRESH

Casing Diameter 1 inch — Casing Material: STEEL

Top of Screen 11.0 (mbgs) — Bottom of Screen 12.2 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL	2.7	(mbgs)	(masl)
Pumping WL		(mbgs)	(masl)
Pump Rate	31.8	(LPM)	1 / 0
Spec. Cap.		(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
1.8			MEDIUM SAND /		/
7.9			CLAY /	GRAVEL	/
12.2			GRAVEL /	MEDIUM SAND	/

Well Record #

4400930 — **Lot 046 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 9/27/1961 (DD/MM/YYYY) | Elev (masl) | Easting 542064 | Northing 4741832 | / Domestic | Water Supply | UTM RC 5 | margin of error : 100 m - 300 m

Water Found 18.0 (mbgs) (masl) FRESH

Casing Diameter 5 inch | Casing Material: STEEL

Top of Screen 18.0 (mbgs) | Bottom of Screen 18.9 (mbgs)

Screen Interval 0.9 (m)

Flowing? N

SWL	3.0	(mbgs)	(masl)
Pumping WL	18.3	(mbgs)	(masl)
Pump Rate	18.2	(LPM)	3 / 0
Spec. Cap.	1.19	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
5.2		GREY	MEDIUM SAND	/	/
18.9			MEDIUM SAND	/	/

4400932 — **Lot 047 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 6/6/1962 (DD/MM/YYYY) | Elev (masl) | Easting 541614 | Northing 4742622 | / Not Used | Abandoned-Supply | UTM RC 5 | margin of error : 100 m - 300 m

Water Found 56.4 (mbgs) (masl) SULPHUR

Casing Diameter 5 inch | Casing Material: STEEL

Top of Screen (mbgs) | Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	21.3	(mbgs)	(masl)
Pumping WL	30.5	(mbgs)	(masl)
Pump Rate	113.7	(LPM)	2 / 0
Spec. Cap.	12.43	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
7.3		YELLOW	MEDIUM SAND	/	/
8.5			GRAVEL	/	/
10.7			CLAY	/ STONES	/
12.2		GREY	MEDIUM SAND	/	/
42.1			MEDIUM SAND	/	/
54.9		GREY	CLAY	/	/
56.4			CLAY	/ STONES	/
61.0		GREY	LIMESTONE	/	/

4400933 — **Lot 047 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 8/22/1962 (DD/MM/YYYY) | Elev (masl) | Easting 541934 | Northing 4742222 | / Domestic | Water Supply | UTM RC 9 | unknown UTM

Water Found 7.3 (mbgs) (masl) FRESH

Casing Diameter 1 inch | Casing Material: STEEL

Top of Screen 6.4 (mbgs) | Bottom of Screen 7.3 (mbgs)

Screen Interval 0.9 (m)

Flowing? N

SWL	2.7	(mbgs)	(masl)
Pumping WL		(mbgs)	(masl)
Pump Rate	9.1	(LPM)	2 / 0
Spec. Cap.		(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
1.5		RED	MEDIUM SAND	/	/
2.4		BLACK	MEDIUM SAND	/	/
4.6			FINE SAND	/	/
7.3		BLACK	COARSE SAND	/	/

4400935 — **Lot 047 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 8/27/1965 (DD/MM/YYYY) | Elev (masl) | Easting 541654 | Northing 4742222 | / Domestic | Water Supply | UTM RC 5 | margin of error : 100 m - 300 m

Water Found 7.6 (mbgs) (masl) FRESH

Casing Diameter 2 inch | Casing Material: STEEL

Top of Screen 8.2 (mbgs) | Bottom of Screen 10.4 (mbgs)

Screen Interval 2.1 (m)

Flowing? N

SWL	4.6	(mbgs)	(masl)
Pumping WL	6.1	(mbgs)	(masl)
Pump Rate	9.1	(LPM)	2 / 0
Spec. Cap.	5.97	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
3.0			FINE SAND	/	/
7.6		BLUE	CLAY	/	/
10.4			FINE SAND	/	/

Well Record #

4400936 — **Lot 047 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 12/30/1965 (DD/MM/YYYY) | Elev (masl) | Easting 541654 | Northing 4742922 | / Domestic | Water Supply | UTM RC 9 unknown UTM | Water Found 12.8 (mbgs) (masl) FRESH | Casing Diameter 5 inch | Casing Material: STEEL | Top of Screen 11.3 (mbgs) | Bottom of Screen 12.5 (mbgs) | Screen Interval 1.2 (m)

Flowing? N

SWL	2.4	(mbgs)	(masl)
Pumping WL	10.7	(mbgs)	(masl)
Pump Rate	27.3	(LPM)	2 / 0
Spec. Cap.	3.31	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
4.3		YELLOW	CLAY / /
10.1			MEDIUM SAND / /
11.6		GREY	CLAY / /
12.8			MEDIUM SAND / /

4400937 — **Lot 047 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 5/10/1966 (DD/MM/YYYY) | Elev (masl) | Easting 541614 | Northing 4742252 | / Domestic | Water Supply | UTM RC 5 margin of error : 100 m - 300 m | Water Found 6.1 (mbgs) (masl) FRESH | Casing Diameter 30 inch | Casing Material: CONCRETE | Top of Screen (mbgs) | Bottom of Screen (mbgs) | Screen Interval (m)

Flowing? N

SWL	6.1	(mbgs)	(masl)
Pumping WL	8.5	(mbgs)	(masl)
Pump Rate	18.2	(LPM)	1 / 0
Spec. Cap.	7.46	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.3			TOPSOIL / /
2.7		BROWN	CLAY / /
6.1		BLUE	CLAY / /
7.0		BLUE	MEDIUM SAND / /
9.1		BLUE	CLAY / /

4400938 — **Lot 047 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 10/24/1967 (DD/MM/YYYY) | Elev (masl) | Easting 541549 | Northing 4742967 | / Domestic | Water Supply | UTM RC 5 margin of error : 100 m - 300 m | Water Found 8.5 (mbgs) (masl) FRESH | Casing Diameter 5 inch | Casing Material: STEEL | Top of Screen (mbgs) | Bottom of Screen (mbgs) | Screen Interval (m)

Flowing? N

SWL	5.2	(mbgs)	(masl)
Pumping WL	6.1	(mbgs)	(masl)
Pump Rate	22.7	(LPM)	6 / 0
Spec. Cap.	24.86	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.3			TOPSOIL / /
8.5		RED	MEDIUM SAND / /
9.1			MEDIUM SAND / /

4400939 — **Lot 047 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 4/12/1955 (DD/MM/YYYY) | Elev (masl) | Easting 541724 | Northing 4743042 | Domestic / Livestock | Water Supply | UTM RC 5 margin of error : 100 m - 300 m | Water Found 8.2 (mbgs) (masl) FRESH | Casing Diameter 2 inch | Casing Material: STEEL | Top of Screen (mbgs) | Bottom of Screen (mbgs) | Screen Interval (m)

Flowing? N

SWL	10.1	(mbgs)	(masl)
Pumping WL	10.1	(mbgs)	(masl)
Pump Rate	59.1	(LPM)	/
Spec. Cap.	9,999.99	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
3.7		RED	MEDIUM SAND / /
8.2		BROWN	MEDIUM SAND / /
19.2			MEDIUM SAND / /

Well Record #

4400940 — **Lot 047 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 4/6/1956 (DD/MM/YYYY)
Elev (masl) Easting 541744 Northing 4743012
Domestic / Irrigation Water Supply UTM RC 5 margin of error : 100 m - 300 m
Water Found 66.4 (mbgs) (masl) SULPHUR
Casing Diameter 7 inch Casing Material: STEEL
Top of Screen (mbgs) Bottom of Screen (mbgs)
Screen Interval (m)

Flowing? N
SWL 18.3 (mbgs) (masl)
Pumping WL 18.3 (mbgs) (masl)
Pump Rate 45.5 (LPM) 1 / 0
Spec. Cap. 9,999.99 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
6.1			FILL /		/
14.6			CLAY /	MEDIUM SAND	/
24.4			FINE SAND /		/
39.6			MEDIUM SAND /		/
45.7			CLAY /		/
56.4			CLAY /	MEDIUM SAND	/
64.0			CLAY /		/
67.1			LIMESTONE /		/

4400964 — **Lot 046 Conc 03** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 10/5/1962 (DD/MM/YYYY)
Elev (masl) Easting 542164 Northing 4741647
/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m
Water Found 4.0 (mbgs) (masl) FRESH
Casing Diameter 1 inch Casing Material: STEEL
Top of Screen 5.2 (mbgs) Bottom of Screen 7.6 (mbgs)
Screen Interval 2.4 (m)

Flowing? N
SWL 3.4 (mbgs) (masl)
Pumping WL (mbgs) (masl)
Pump Rate 13.6 (LPM) 1 / 0
Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
0.6			MEDIUM SAND /		/
2.4		RED	MEDIUM SAND /		/
3.7		GREY	MEDIUM SAND /		/
7.6			MEDIUM SAND /		/

4401818 — **Lot 023 Conc 12** — **WINDHAM TOWNSHIP / NORFOLK**

Date 5/7/1951 (DD/MM/YYYY)
Elev (masl) Easting 542554 Northing 4743923
/ Test Hole UTM RC 5 margin of error : 100 m - 300 m
Water Found (mbgs) (masl)
Casing Diameter Casing Material:
Top of Screen (mbgs) Bottom of Screen (mbgs)
Screen Interval (m)

Flowing?
SWL (mbgs) (masl)
Pumping WL (mbgs) (masl)
Pump Rate (LPM) /
Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
0.6			TOPSOIL /		/
5.5		GREY	MEDIUM SAND /	GRAVEL	/
6.4		GREY	CLAY /	GRAVEL	/
7.3		GREY	MEDIUM SAND /		/
22.9		GREY	CLAY /	MEDIUM SAND	/
25.6		GREY	CLAY /	BOULDERS	/
32.9		GREY	CLAY /		/

Well Record #

4401819 — **Lot 023 Conc 12** — **WINDHAM TOWNSHIP / NORFOLK**

Date 5/9/1951 (DD/MM/YYYY)
Elev (masl) Easting 542764 Northing 4743622
/ Test Hole UTM RC 9 unknown UTM
Water Found (mbgs) (masl)
Casing Diameter 4 inch Casing Material:
Top of Screen (mbgs) Bottom of Screen (mbgs)
Screen Interval (m)

Flowing? N
SWL (mbgs) (masl)
Pumping WL (mbgs) (masl)
Pump Rate 90.9 (LPM) /
Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
2.4		BROWN	MEDIUM SAND / BOULDERS /
12.5		BROWN	CLAY / BOULDERS /
18.3		GREY	MEDIUM SAND / GRAVEL /
21.3		GREY	CLAY / MEDIUM SAND /

4401820 — **Lot 023 Conc 12** — **WINDHAM TOWNSHIP / NORFOLK**

Date 12/4/1959 (DD/MM/YYYY)
Elev (masl) Easting 542689 Northing 4743572
Domestic / Livestock Water Supply UTM RC 5 margin of error : 100 m - 300 m
Water Found 17.7 (mbgs) (masl) FRESH
Casing Diameter 5 inch Casing Material: STEEL
Top of Screen 14.9 (mbgs) Bottom of Screen 16.2 (mbgs)
Screen Interval 1.2 (m)

Flowing? N
SWL 7.6 (mbgs) (masl)
Pumping WL 12.2 (mbgs) (masl)
Pump Rate 45.5 (LPM) 1 / 0
Spec. Cap. 9.94 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
1.2			PREVIOUSLY DUG / /
9.1			MEDIUM SAND / /
17.7			CLAY / /
18.6			MEDIUM SAND / /

4401849 — **Lot 023 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 10/28/1960 (DD/MM/YYYY)
Elev (masl) Easting 542714 Northing 4743422
/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m
Water Found 15.2 (mbgs) (masl) FRESH
Casing Diameter 2 inch Casing Material: STEEL
Top of Screen 14.3 (mbgs) Bottom of Screen 15.2 (mbgs)
Screen Interval 0.9 (m)

Flowing? N
SWL 11.9 (mbgs) (masl)
Pumping WL 13.4 (mbgs) (masl)
Pump Rate 4.5 (LPM) /
Spec. Cap. 2.98 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
3.4			GRAVEL / STONES /
6.1			GRAVEL / /
7.0			CLAY / /
15.2			GRAVEL / /

4401850 — **Lot 023 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 12/29/1960 (DD/MM/YYYY)
Elev (masl) Easting 542614 Northing 4743497
/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m
Water Found 7.6 (mbgs) (masl) FRESH
Casing Diameter 5 inch Casing Material: STEEL
Top of Screen 8.8 (mbgs) Bottom of Screen 10.1 (mbgs)
Screen Interval 1.2 (m)

Flowing? N
SWL 3.0 (mbgs) (masl)
Pumping WL 4.3 (mbgs) (masl)
Pump Rate 45.5 (LPM) 4 / 0
Spec. Cap. 37.29 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
1.8			FILL / /
7.6			GRAVEL / /
10.1			MEDIUM SAND / /

Well Record #

4401851 — **Lot 023 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 4/2/1962 (DD/MM/YYYY)
Elev (masl) Easting 542414 Northing 4743472
Domestic / Livestock Water Supply UTM RC 5 margin of error : 100 m - 300 m
Water Found 18.3 (mbgs) (masl) FRESH
Casing Diameter 5 inch Casing Material: STEEL
Top of Screen 20.4 (mbgs) Bottom of Screen 21.9 (mbgs)
Screen Interval 1.5 (m)

Flowing? N
SWL 5.8 (mbgs) (masl)
Pumping WL 19.8 (mbgs) (masl)
Pump Rate 18.2 (LPM) 3 / 0
Spec. Cap. 1.30 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
11.3		YELLOW	MEDIUM SAND / /
14.0		WHITE	MEDIUM SAND / /
21.9			FINE SAND / /

4401852 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 12/18/1946 (DD/MM/YYYY)
Elev (masl) Easting 542114 Northing 4742047
/ Test Hole UTM RC 5 margin of error : 100 m - 300 m
Water Found (mbgs) (masl)
Casing Diameter Casing Material:
Top of Screen (mbgs) Bottom of Screen (mbgs)
Screen Interval (m)

Flowing?
SWL (mbgs) (masl)
Pumping WL (mbgs) (masl)
Pump Rate (LPM) /
Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6			TOPSOIL / /
2.4		BROWN	CLAY / /
24.7		BROWN	MEDIUM SAND / /
28.7		BLUE	CLAY / /

4401853 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 5/3/1951 (DD/MM/YYYY)
Elev (masl) Easting 541939 Northing 4742872
/ Test Hole UTM RC 5 margin of error : 100 m - 300 m
Water Found (mbgs) (masl)
Casing Diameter Casing Material:
Top of Screen (mbgs) Bottom of Screen (mbgs)
Screen Interval (m)

Flowing?
SWL (mbgs) (masl)
Pumping WL (mbgs) (masl)
Pump Rate (LPM) /
Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6			TOPSOIL / /
8.2		BROWN	MEDIUM SAND / CLAY / BOULDERS
8.5		GREY	FINE SAND / /
14.3		GREY	FINE SAND / GRAVEL /
17.4		GREY	CLAY / MEDIUM SAND /

4401854 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 4/20/1953 (DD/MM/YYYY)
Elev (masl) Easting 542064 Northing 4743373
/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m
Water Found 6.4 (mbgs) (masl) FRESH
Casing Diameter 3 inch Casing Material: STEEL
Top of Screen 11.3 (mbgs) Bottom of Screen (mbgs)
Screen Interval (m)

Flowing? N
SWL 6.1 (mbgs) (masl)
Pumping WL (mbgs) (masl)
Pump Rate (LPM) /
Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
1.2			TOPSOIL / MEDIUM SAND /
10.7			CLAY / STONES /
12.2			COARSE SAND / STONES /

Well Record #

4401855 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 5/27/1953 (DD/MM/YYYY)
Elev (masl) Easting 542064 Northing 4742572
/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m
Water Found 5.8 (mbgs) (masl) FRESH
Casing Diameter 2 inch Casing Material: STEEL
Top of Screen (mbgs) Bottom of Screen (mbgs)
Screen Interval (m)

Flowing? N
SWL 2.7 (mbgs) (masl)
Pumping WL 2.7 (mbgs) (masl)
Pump Rate (LPM) 1 / 0
Spec. Cap. 9,999.99 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
1.2			MEDIUM SAND /		/
5.5			CLAY /	STONES	/
11.0			MEDIUM SAND /		/

4401856 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 4/20/1954 (DD/MM/YYYY)
Elev (masl) Easting 541989 Northing 4742572
/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m
Water Found 6.7 (mbgs) (masl) FRESH
Casing Diameter 2 inch Casing Material: STEEL
Top of Screen (mbgs) Bottom of Screen (mbgs)
Screen Interval (m)

Flowing? N
SWL 4.9 (mbgs) (masl)
Pumping WL 4.9 (mbgs) (masl)
Pump Rate 27.3 (LPM) 24 / 0
Spec. Cap. 9,999.99 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
1.8			MEDIUM SAND /		/
6.7			CLAY /		/
13.1			MEDIUM SAND /		/

4401857 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 3/4/1960 (DD/MM/YYYY)
Elev (masl) Easting 541664 Northing 4743097
/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m
Water Found 13.7 (mbgs) (masl) FRESH
Casing Diameter 5 inch Casing Material: STEEL
Top of Screen 13.7 (mbgs) Bottom of Screen 14.6 (mbgs)
Screen Interval 0.9 (m)

Flowing? N
SWL 8.5 (mbgs) (masl)
Pumping WL 11.6 (mbgs) (masl)
Pump Rate 31.8 (LPM) 2 / 0
Spec. Cap. 10.44 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
3.7		YELLOW	MEDIUM SAND /		/
6.1		GREY	CLAY /		/
13.7			MEDIUM SAND /	GRAVEL	/
15.5			MEDIUM SAND /		/

4401858 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 7/15/1960 (DD/MM/YYYY)
Elev (masl) Easting 541839 Northing 4743122
/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m
Water Found 6.1 (mbgs) (masl) FRESH
Casing Diameter 2 inch Casing Material: STEEL
Top of Screen 11.0 (mbgs) Bottom of Screen 12.5 (mbgs)
Screen Interval 1.5 (m)

Flowing? N
SWL 6.1 (mbgs) (masl)
Pumping WL (mbgs) (masl)
Pump Rate 22.7 (LPM) 12 / 0
Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
1.2			MEDIUM SAND /		/
6.1			CLAY /		/
12.5			MEDIUM SAND /		/

Well Record #

4401859 — Lot 024 Conc 13 — WINDHAM TOWNSHIP / NORFOLK

Date 7/25/1960 (DD/MM/YYYY) | Elev (masl) | Easting 541864 | Northing 4743273 | UTM RC 5 | margin of error : 100 m - 300 m

/ Domestic | Water Supply | FRESH

Water Found 9.1 (mbgs) (masl)

Casing Diameter 2 inch | Casing Material: STEEL

Top of Screen 11.6 (mbgs) | Bottom of Screen 13.1 (mbgs)

Screen Interval 1.5 (m)

Flowing? N

SWL	5.5	(mbgs)	(masl)
Pumping WL		(mbgs)	(masl)
Pump Rate	18.2	(LPM)	2 / 0
Spec. Cap.		(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
3.0			MEDIUM SAND / /
7.6		BLUE	CLAY / /
13.1			MEDIUM SAND / /

4401860 — Lot 024 Conc 13 — WINDHAM TOWNSHIP / NORFOLK

Date 10/10/1960 (DD/MM/YYYY) | Elev (masl) | Easting 542089 | Northing 4742422 | UTM RC 5 | margin of error : 100 m - 300 m

/ Domestic | Water Supply | FRESH

Water Found 10.7 (mbgs) (masl)

Casing Diameter 2 inch | Casing Material: STEEL

Top of Screen (mbgs) | Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? Y

SWL	0.0	(mbgs)	(masl)
Pumping WL		(mbgs)	(masl)
Pump Rate	22.7	(LPM)	0 / 30
Spec. Cap.		(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
3.0			MEDIUM SAND / /
10.7			CLAY / /
13.4			GRAVEL / /

4401861 — Lot 024 Conc 13 — WINDHAM TOWNSHIP / NORFOLK

Date 2/5/1962 (DD/MM/YYYY) | Elev (masl) | Easting 541914 | Northing 4742822 | UTM RC 5 | margin of error : 100 m - 300 m

Domestic / Industrial | Water Supply | FRESH

Water Found 12.2 (mbgs) (masl)

Casing Diameter 5 inch | Casing Material: STEEL

Top of Screen 14.6 (mbgs) | Bottom of Screen 15.5 (mbgs)

Screen Interval 0.9 (m)

Flowing? N

SWL	8.5	(mbgs)	(masl)
Pumping WL	10.7	(mbgs)	(masl)
Pump Rate	31.8	(LPM)	2 / 0
Spec. Cap.	14.91	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
12.2		YELLOW	MEDIUM SAND / /
16.2			MEDIUM SAND / /

4401862 — Lot 024 Conc 13 — WINDHAM TOWNSHIP / NORFOLK

Date 5/25/1962 (DD/MM/YYYY) | Elev (masl) | Easting 542189 | Northing 4742547 | UTM RC 5 | margin of error : 100 m - 300 m

/ Public | Water Supply | FRESH

Water Found 13.1 (mbgs) (masl)

Casing Diameter 5 inch | Casing Material: STEEL

Top of Screen 12.2 (mbgs) | Bottom of Screen 13.4 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL	5.5	(mbgs)	(masl)
Pumping WL	7.9	(mbgs)	(masl)
Pump Rate	31.8	(LPM)	2 / 0
Spec. Cap.	13.05	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.3			TOPSOIL / /
4.6			MEDIUM SAND / /
7.3			MEDIUM SAND / GRAVEL /
8.5			GRAVEL / /
10.7			CLAY / /
13.1			CLAY / GRAVEL /
14.6			GRAVEL / /

Well Record #

4401863 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 7/15/1962 (DD/MM/YYYY) | Elev (masl) | Easting 541964 | Northing 4742672 | UTM RC 5 | margin of error : 100 m - 300 m

/ Domestic | Water Supply

Water Found 13.1 (mbgs) (masl) FRESH

Casing Diameter 1 inch | Casing Material: STEEL

Top of Screen 13.1 (mbgs) | Bottom of Screen 14.3 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL 6.7 (mbgs) (masl)

Pumping WL (mbgs) (masl)

Pump Rate 27.3 (LPM) 1 / 0

Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
2.7			GRAVEL /	COARSE SAND	/
6.7		GREY	CLAY /		/
7.9			FINE SAND /		/
8.2			HARDPAN /		/
14.3			COARSE SAND /		/

4401864 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 10/29/1962 (DD/MM/YYYY) | Elev (masl) | Easting 541964 | Northing 4742647 | UTM RC 5 | margin of error : 100 m - 300 m

/ Domestic | Water Supply

Water Found 9.1 (mbgs) (masl) FRESH

Casing Diameter 1 inch | Casing Material: STEEL

Top of Screen 13.1 (mbgs) | Bottom of Screen 14.3 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL 9.1 (mbgs) (masl)

Pumping WL (mbgs) (masl)

Pump Rate 36.4 (LPM) 4 / 0

Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
1.8		RED	MEDIUM SAND /		/
6.1			CLAY /	GRAVEL	/
14.3			GRAVEL /		/

4401865 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 11/14/1962 (DD/MM/YYYY) | Elev (masl) | Easting 541789 | Northing 4743223 | UTM RC 5 | margin of error : 100 m - 300 m

/ Domestic | Water Supply

Water Found 11.3 (mbgs) (masl) FRESH

Casing Diameter 2 inch | Casing Material: STEEL

Top of Screen 12.2 (mbgs) | Bottom of Screen 14.0 (mbgs)

Screen Interval 1.8 (m)

Flowing? N

SWL 11.3 (mbgs) (masl)

Pumping WL (mbgs) (masl)

Pump Rate 36.4 (LPM) 2 / 0

Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
1.5			FILL /		/
			FILL /		/
3.0			MEDIUM SAND /		/
			MEDIUM SAND /		/
4.6		GREY	CLAY /		/
		GREY	CLAY /		/
14.0			FINE SAND /		/
			FINE SAND /		/

4401866 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 11/19/1962 (DD/MM/YYYY) | Elev (masl) | Easting 542014 | Northing 4742522 | UTM RC 5 | margin of error : 100 m - 300 m

/ Domestic | Water Supply

Water Found 14.0 (mbgs) (masl) FRESH

Casing Diameter 4 inch | Casing Material: STEEL

Top of Screen 12.8 (mbgs) | Bottom of Screen 14.0 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL 4.6 (mbgs) (masl)

Pumping WL 6.1 (mbgs) (masl)

Pump Rate 31.8 (LPM) 2 / 0

Spec. Cap. 20.88 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
0.9			FINE SAND /		/
7.6			GRAVEL /		/

Well Record #

8.8		BOULDERS /	/
16.2		COARSE SAND /	/

4401867 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 8/23/1963 (DD/MM/YYYY) — Elev (masl) — Easting 542014 — Northing 4742722 — UTM RC 5 — margin of error : 100 m - 300 m

/ Domestic — Water Supply — Water Found 13.4 (mbgs) (masl) FRESH

Casing Diameter 5 inch — Casing Material: STEEL

Top of Screen 13.4 (mbgs) — Bottom of Screen 14.6 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL	10.1	(mbgs)	(masl)
Pumping WL	10.7	(mbgs)	(masl)
Pump Rate	31.8	(LPM)	2 / 0
Spec. Cap.	52.20	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
0.6			TOPSOIL /		/
7.0			BOULDERS /	CLAY	/
13.4			GRAVEL /		/
16.2			COARSE SAND /		/

4401868 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 11/18/1963 (DD/MM/YYYY) — Elev (masl) — Easting 541914 — Northing 4742772 — UTM RC 5 — margin of error : 100 m - 300 m

/ Domestic — Water Supply — Water Found 11.0 (mbgs) (masl) FRESH

Casing Diameter 4 inch — Casing Material: STEEL

Top of Screen 11.6 (mbgs) — Bottom of Screen 12.8 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL	10.1	(mbgs)	(masl)
Pumping WL	10.4	(mbgs)	(masl)
Pump Rate	27.3	(LPM)	2 / 0
Spec. Cap.	89.49	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
0.6			TOPSOIL /		/
3.7		YELLOW	MEDIUM SAND /		/
7.6			MEDIUM SAND /	GRAVEL	/
9.1			BOULDERS /	HARDPAN	/
11.0			CLAY /	GRAVEL	/
14.0			COARSE SAND /		/

4401869 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 11/20/1963 (DD/MM/YYYY) — Elev (masl) — Easting 541914 — Northing 4742882 — UTM RC 5 — margin of error : 100 m - 300 m

/ Domestic — Water Supply — Water Found 10.7 (mbgs) (masl) FRESH

Casing Diameter 4 inch — Casing Material: STEEL

Top of Screen 11.0 (mbgs) — Bottom of Screen 12.2 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL	9.8	(mbgs)	(masl)
Pumping WL	10.1	(mbgs)	(masl)
Pump Rate	27.3	(LPM)	2 / 0
Spec. Cap.	89.49	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
0.3			TOPSOIL /		/
3.4		YELLOW	MEDIUM SAND /		/
7.3			GRAVEL /		/
9.1			GRAVEL /	HARDPAN	/
10.7			MEDIUM SAND /		/
13.7			COARSE SAND /	GRAVEL	/

4401870 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 4/7/1965 (DD/MM/YYYY) — Elev (masl) — Easting 542114 — Northing 4743373 — UTM RC 5 — margin of error : 100 m - 300 m

Domestic / Livestock — Water Supply — Water Found 11.9 (mbgs) (masl) FRESH

Casing Diameter 5 inch — Casing Material: STEEL

Top of Screen 11.6 (mbgs) — Bottom of Screen 13.1 (mbgs)

Screen Interval 1.5 (m)

Flowing? N

SWL	7.0	(mbgs)	(masl)
Pumping WL	10.7	(mbgs)	(masl)
Pump Rate	9.1	(LPM)	1 / 0
Spec. Cap.	2.49	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			

Well Record #															
									1.8	YELLOW	MEDIUM SAND	/		/	
									6.1		GRAVEL	/		/	
									11.9	YELLOW	MEDIUM SAND	/		/	
									13.4		MEDIUM SAND	/		/	
4401903	**Lot**	**024**	**Conc**	**14**	**WINDHAM TOWNSHIP / NORFOLK**								**Flowing?**	**N**	
Date	**5/15/1959**	**Elev**		**(masl)**	**Easting**	**542239**	**Northing**	**4741772**					**SWL**	**4.9**	**(mbgs)** **(masl)**
	DD/MM/YYYY	**/ Domestic**			**Water Supply**		**UTM RC**	**5**	**margin of error : 100 m - 300 m**				**Pumping WL**	**5.5**	**(mbgs)** **(masl)**
		Water Found	**7.3**	**(mbgs)**		**(masl)**		**FRESH**					**Pump Rate**	**18.2**	**(LPM)** **3 / 0**
		Casing Diameter	**1**	**inch**	**Casing Material:**	**STEEL**				**Depth (m)**	**Elev (masl)**		**Spec. Cap.**	**29.83**	**(LPM/m)** **Hour / Minute**
		Top of Screen	**7.6**	**(mbgs)**	**Bottom of Screen**	**9.1**	**(mbgs)**			**0.0**	**Color**	**Soil Descriptions**			
		Screen Interval	**1.5**	**(m)**											
									9.1		MEDIUM SAND	/		/	
4401905	**Lot**	**024**	**Conc**	**14**	**WINDHAM TOWNSHIP / NORFOLK**								**Flowing?**	**N**	
Date	**11/20/1959**	**Elev**		**(masl)**	**Easting**	**542464**	**Northing**	**4741872**					**SWL**	**3.0**	**(mbgs)** **(masl)**
	DD/MM/YYYY	**/ Commerical**			**Water Supply**		**UTM RC**	**5**	**margin of error : 100 m - 300 m**				**Pumping WL**	**7.9**	**(mbgs)** **(masl)**
		Water Found	**7.6**	**(mbgs)**		**(masl)**		**FRESH**					**Pump Rate**	**18.2**	**(LPM)** **3 / 0**
		Casing Diameter	**5**	**inch**	**Casing Material:**	**STEEL**				**Depth (m)**	**Elev (masl)**		**Spec. Cap.**	**3.73**	**(LPM/m)** **Hour / Minute**
		Top of Screen	**8.8**	**(mbgs)**	**Bottom of Screen**	**10.1**	**(mbgs)**			**0.0**	**Color**	**Soil Descriptions**			
		Screen Interval	**1.2**	**(m)**											
									7.6	YELLOW	MEDIUM SAND	/		/	
									10.1		FINE SAND	/		/	
4401906	**Lot**	**024**	**Conc**	**14**	**WINDHAM TOWNSHIP / NORFOLK**								**Flowing?**	**N**	
Date	**5/25/1963**	**Elev**		**(masl)**	**Easting**	**542289**	**Northing**	**4741822**					**SWL**	**2.4**	**(mbgs)** **(masl)**
	DD/MM/YYYY	**/ Domestic**			**Water Supply**		**UTM RC**	**5**	**margin of error : 100 m - 300 m**				**Pumping WL**		**(mbgs)** **(masl)**
		Water Found	**4.9**	**(mbgs)**		**(masl)**		**FRESH**					**Pump Rate**	**9.1**	**(LPM)** **1 / 30**
		Casing Diameter	**1**	**inch**	**Casing Material:**	**STEEL**				**Depth (m)**	**Elev (masl)**		**Spec. Cap.**		**(LPM/m)** **Hour / Minute**
		Top of Screen	**2.7**	**(mbgs)**	**Bottom of Screen**	**3.7**	**(mbgs)**			**0.0**	**Color**	**Soil Descriptions**			
		Screen Interval	**0.9**	**(m)**											
									1.2	BLACK	MEDIUM SAND	/		/	
									2.4	RED	MEDIUM SAND	/		/	
									4.9		MEDIUM SAND	/	GRAVEL	/	
4401907	**Lot**	**024**	**Conc**	**14**	**WINDHAM TOWNSHIP / NORFOLK**								**Flowing?**	**N**	
Date	**5/10/1967**	**Elev**		**(masl)**	**Easting**	**542214**	**Northing**	**4741872**					**SWL**	**1.2**	**(mbgs)** **(masl)**
	DD/MM/YYYY	**/ Domestic**			**Water Supply**		**UTM RC**	**5**	**margin of error : 100 m - 300 m**				**Pumping WL**		**(mbgs)** **(masl)**
		Water Found	**3.7**	**(mbgs)**		**(masl)**		**FRESH**					**Pump Rate**	**45.5**	**(LPM)** **2 / 0**
		Casing Diameter	**1**	**inch**	**Casing Material:**	**STEEL**				**Depth (m)**	**Elev (masl)**		**Spec. Cap.**		**(LPM/m)** **Hour / Minute**
		Top of Screen	**4.0**	**(mbgs)**	**Bottom of Screen**	**5.2**	**(mbgs)**			**0.0**	**Color**	**Soil Descriptions**			
		Screen Interval	**1.2**	**(m)**											
									3.7	RED	MEDIUM SAND	/		/	
									5.2		MEDIUM SAND	/		/	

Well Record #

4402273 — **Lot 047 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 8/28/1968 (DD/MM/YYYY)
Elev (masl) Easting 541714 Northing 4743062
/ Domestic Water Supply UTM RC 4 margin of error : 30 m - 100 m
Water Found 13.7 (mbgs) (masl) FRESH
Casing Diameter 5 inch Casing Material: STEEL
Top of Screen 12.2 (mbgs) Bottom of Screen 13.7 (mbgs)
Screen Interval 1.5 (m)

Flowing? N
SWL 9.8 (mbgs) (masl)
Pumping WL 12.8 (mbgs) (masl)
Pump Rate 22.7 (LPM) 3 / 0
Spec. Cap. 7.46 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
11.9		YELLOW	MEDIUM SAND /		/
13.7			FINE SAND /		/
15.2			MEDIUM SAND /		/

4402538 — **Lot 023 Conc 14** — **WINDHAM TOWNSHIP / NORFOLK**

Date 1/13/1947 (DD/MM/YYYY)
Elev (masl) Easting 542914 Northing 4741722
/ Test Hole UTM RC 5 margin of error : 100 m - 300 m
Water Found (mbgs) (masl)
Casing Diameter 4 inch Casing Material:
Top of Screen (mbgs) Bottom of Screen (mbgs)
Screen Interval (m)

Flowing?
SWL (mbgs) (masl)
Pumping WL (mbgs) (masl)
Pump Rate (LPM) /
Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
0.3			TOPSOIL /		/
7.9			MEDIUM SAND /		/
11.3		BLUE	CLAY /		/
22.6			CLAY /	MEDIUM SAND	/
24.1		BLUE	CLAY /		/

4402556 — **Lot 046 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 6/23/1970 (DD/MM/YYYY)
Elev (masl) Easting 541874 Northing 4742062
/ Domestic Water Supply UTM RC 4 margin of error : 30 m - 100 m
Water Found 4.9 (mbgs) (masl) FRESH
Casing Diameter 1 inch Casing Material: GALVANIZED
Top of Screen 8.5 (mbgs) Bottom of Screen 9.8 (mbgs)
Screen Interval 1.2 (m)

Flowing? N
SWL 2.4 (mbgs) (masl)
Pumping WL (mbgs) (masl)
Pump Rate 31.8 (LPM) 2 / 0
Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
0.6			PREVIOUSLY DUG /		/
4.3		BROWN	CLAY /	STONES	/
9.8		BROWN	MEDIUM SAND /		/

4402601 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 11/10/1970 (DD/MM/YYYY)
Elev (masl) Easting 542084 Northing 4742402
/ Domestic Water Supply UTM RC 4 margin of error : 30 m - 100 m
Water Found 11.6 (mbgs) (masl) FRESH
Casing Diameter 5 inch Casing Material: GALVANIZED
Top of Screen (mbgs) Bottom of Screen (mbgs)
Screen Interval (m)

Flowing? Y
SWL -0.3 (mbgs) (masl)
Pumping WL (mbgs) (masl)
Pump Rate 45.5 (LPM) 3 / 0
Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
4.9		BROWN	MEDIUM SAND /		/
6.1		RED	MEDIUM SAND /		/
10.7		BLUE	CLAY /		/
11.6			GRAVEL /		/

Well Record #

4402658 — **Lot 046 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 3/18/1971 (DD/MM/YYYY) — Elev (masl) — Easting 541909 — Northing 4742387 — UTM RC 4 — margin of error : 30 m - 100 m

/ Domestic — Water Supply — FRESH

Water Found 10.7 (mbgs) (masl)

Casing Diameter 5 inch — Casing Material: STEEL

Top of Screen 18.9 (mbgs) — Bottom of Screen 20.4 (mbgs)

Screen Interval 1.5 (m)

Flowing? N

SWL 1.5 (mbgs) (masl)

Pumping WL 7.9 (mbgs) (masl)

Pump Rate 36.4 (LPM) 15 / 0

Spec. Cap. 5.68 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
1.8		PREVIOUSLY DUG /	/
7.9		GREY	CLAY / /
8.5		BROWN	MEDIUM SAND / STONES /
10.7		GREY	CLAY / STONES /
13.4		BROWN	STONES / CLAY / SILT
18.6		GREY	CLAY / /
20.7		BROWN	MEDIUM SAND / /

4402693 — **Lot 046 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 6/16/1971 (DD/MM/YYYY) — Elev (masl) — Easting 541664 — Northing 4742232 — UTM RC 4 — margin of error : 30 m - 100 m

/ Domestic — Water Supply — FRESH

Water Found 9.4 (mbgs) (masl)

Casing Diameter 5 inch — Casing Material: STEEL

Top of Screen 9.4 (mbgs) — Bottom of Screen 10.7 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL 4.6 (mbgs) (masl)

Pumping WL 6.1 (mbgs) (masl)

Pump Rate 45.5 (LPM) 4 / 30

Spec. Cap. 29.83 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.9		YELLOW	FILL / MEDIUM SAND /
9.4		BROWN	CLAY / BOULDERS /
10.7		GREY	MEDIUM SAND / STONES /

4402772 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 7/28/1971 (DD/MM/YYYY) — Elev (masl) — Easting 541774 — Northing 4743253 — UTM RC 4 — margin of error : 30 m - 100 m

/ Domestic — Water Supply — FRESH

Water Found 17.4 (mbgs) (masl)

Casing Diameter 5 inch — Casing Material: STEEL

Top of Screen 16.8 (mbgs) — Bottom of Screen 17.7 (mbgs)

Screen Interval 0.9 (m)

Flowing? N

SWL 10.7 (mbgs) (masl)

Pumping WL 13.7 (mbgs) (masl)

Pump Rate 45.5 (LPM) 3 / 0

Spec. Cap. 14.91 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
13.7		GREY	MEDIUM SAND / /
15.2		BROWN	MEDIUM SAND / /
18.3		GREY	MEDIUM SAND / /

4402937 — **Lot 046 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 7/14/1972 (DD/MM/YYYY) — Elev (masl) — Easting 541764 — Northing 4742072 — UTM RC 4 — margin of error : 30 m - 100 m

/ Domestic — Water Supply — FRESH

Water Found 1.2 (mbgs) (masl)

Casing Diameter 30 inch — Casing Material: GALVANIZED

Top of Screen (mbgs) — Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL 1.2 (mbgs) (masl)

Pumping WL (mbgs) (masl)

Pump Rate (LPM) /

Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
1.5		BROWN	CLAY / /
4.6		GREY	CLAY / BOULDERS /
7.6		GREY	CLAY / /

Well Record #

4403014 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 11/3/1972 (DD/MM/YYYY) | Elev (masl) | Easting 542014 | Northing 4742672 | UTM RC 4 | margin of error : 30 m - 100 m

/ Domestic | Water Supply | Water Found 12.8 (mbgs) (masl) | Not stated

Casing Diameter 5 inch | Casing Material: STEEL

Top of Screen 14.3 (mbgs) | Bottom of Screen 15.2 (mbgs)

Screen Interval 0.9 (m)

Flowing? N

SWL	12.8	(mbgs)	(masl)
Pumping WL	12.8	(mbgs)	(masl)
Pump Rate	27.3	(LPM)	2 / 0
Spec. Cap.	9,999.99	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BLACK	TOPSOIL / /
4.6		BROWN	GRAVEL / /
12.8		YELLOW	CLAY / /
16.2		GREY	COARSE SAND / /

4403203 — **Lot 046 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 10/16/1973 (DD/MM/YYYY) | Elev (masl) | Easting 541814 | Northing 4742172 | UTM RC 5 | margin of error : 100 m - 300 m

/ Domestic | Water Supply | Water Found 15.8 (mbgs) (masl) | FRESH

Casing Diameter 6 inch | Casing Material: STEEL

Top of Screen 13.7 (mbgs) | Bottom of Screen 15.2 (mbgs)

Screen Interval 1.5 (m)

Flowing? N

SWL	3.0	(mbgs)	(masl)
Pumping WL	12.8	(mbgs)	(masl)
Pump Rate	36.4	(LPM)	1 / 30
Spec. Cap.	3.73	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
15.2		GREY	CLAY / GRAVEL /
16.5		BROWN	FINE SAND / /

4403249 — **Lot 046 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 4/6/1974 (DD/MM/YYYY) | Elev (masl) | Easting 542150 | Northing 4741872 | UTM RC 4 | margin of error : 30 m - 100 m

/ Domestic | Water Supply | Water Found 1.5 (mbgs) (masl) | FRESH

Casing Diameter 2 inch | Casing Material: GALVANIZED

Top of Screen 5.8 (mbgs) | Bottom of Screen 7.3 (mbgs)

Screen Interval 1.5 (m)

Flowing? N

SWL	3.7	(mbgs)	(masl)
Pumping WL		(mbgs)	(masl)
Pump Rate	13.6	(LPM)	6 / 0
Spec. Cap.		(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.9		BLACK	TOPSOIL / /
3.7		GREY	SILT / /
7.3		GREY	FINE SAND / /

4403278 — **Lot 024 Conc 14** — **WINDHAM TOWNSHIP / NORFOLK**

Date 6/11/1974 (DD/MM/YYYY) | Elev (masl) | Easting 542256 | Northing 4741871 | UTM RC 4 | margin of error : 30 m - 100 m

/ Domestic | Water Supply | Water Found 1.5 (mbgs) (masl) | FRESH

Casing Diameter 2 inch | Casing Material: STEEL

Top of Screen 5.8 (mbgs) | Bottom of Screen 6.7 (mbgs)

Screen Interval 0.9 (m)

Flowing? N

SWL	1.5	(mbgs)	(masl)
Pumping WL		(mbgs)	(masl)
Pump Rate		(LPM)	3 / 0
Spec. Cap.		(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
2.4			PREVIOUSLY DUG / /
6.7		GREY	FINE SAND / /

Well Record #

4403289 **Lot 046 Conc 02** **MIDDLETON TOWNSHIP / NORFOLK**

Date 7/17/1974 DD/MM/YYYY | Elev (masl) | Easting 541821 | Northing 4742154 | / Domestic | Water Supply | UTM RC 4 | margin of error : 30 m - 100 m

Water Found 4.9 (mbgs) (masl) FRESH

Casing Diameter 2 inch | Casing Material: GALVANIZED

Top of Screen 4.9 (mbgs) | Bottom of Screen 6.1 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL	3.0	(mbgs)	(masl)
Pumping WL	3.7	(mbgs)	(masl)
Pump Rate	45.5	(LPM)	2 / 30
Spec. Cap.	74.57	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
1.2		RED	SAND / /
3.7		RED	CLAY / /
4.9		BLUE	CLAY / GRAVEL /
6.1		GREY	COARSE SAND / /

4403417 **Lot 046 Conc 02** **MIDDLETON TOWNSHIP / NORFOLK**

Date 3/13/1975 DD/MM/YYYY | Elev (masl) | Easting 541764 | Northing 4742122 | / Domestic | Water Supply | UTM RC 5 | margin of error : 100 m - 300 m

Water Found 5.5 (mbgs) (masl) FRESH

Casing Diameter 30 inch | Casing Material: STEEL

Top of Screen (mbgs) | Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	5.5	(mbgs)	(masl)
Pumping WL	6.7	(mbgs)	(masl)
Pump Rate	22.7	(LPM)	1 / 0
Spec. Cap.	18.64	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
3.7		BROWN	CLAY / /
5.5		GREY	CLAY / /
6.7		GREY	SAND / /
7.6		GREY	CLAY / /

4403530 **Lot 024 Conc 13** **WINDHAM TOWNSHIP / NORFOLK**

Date 9/9/1975 DD/MM/YYYY | Elev (masl) | Easting 541852 | Northing 4743233 | / Domestic | Water Supply | UTM RC 4 | margin of error : 30 m - 100 m

Water Found 9.8 (mbgs) (masl) FRESH

Casing Diameter 2 inch | Casing Material: GALVANIZED

Top of Screen 11.0 (mbgs) | Bottom of Screen 12.8 (mbgs)

Screen Interval 1.8 (m)

Flowing? N

SWL	7.6	(mbgs)	(masl)
Pumping WL	8.5	(mbgs)	(masl)
Pump Rate	45.5	(LPM)	2 / 0
Spec. Cap.	49.72	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
1.2			TOPSOIL / /
1.8			BOULDERS / /
9.8		RED	SAND / /
12.8			SAND / /

4403531 **Lot 024 Conc 13** **WINDHAM TOWNSHIP / NORFOLK**

Date 9/10/1975 DD/MM/YYYY | Elev (masl) | Easting 541887 | Northing 4743106 | / Domestic | Water Supply | UTM RC 4 | margin of error : 30 m - 100 m

Water Found 9.8 (mbgs) (masl) FRESH

Casing Diameter 2 inch | Casing Material: GALVANIZED

Top of Screen 11.0 (mbgs) | Bottom of Screen 12.8 (mbgs)

Screen Interval 1.8 (m)

Flowing? N

SWL	7.9	(mbgs)	(masl)
Pumping WL	8.5	(mbgs)	(masl)
Pump Rate		(LPM)	2 / 0
Spec. Cap.		(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.9			TOPSOIL / /
9.1		RED	SAND / /
9.8		BLUE	CLAY / /
12.8			SAND / /

Well Record #

4403534 — **Lot 024 Conc 14** — **WINDHAM TOWNSHIP / NORFOLK**

Date 9/6/1975 (DD/MM/YYYY) | Elev (masl) | Easting 542327 | Northing 4741870 | UTM RC 4 | margin of error : 30 m - 100 m

/ Domestic | Water Supply | FRESH

Water Found 1.5 (mbgs) (masl)

Casing Diameter 2 inch | Casing Material: STEEL

Top of Screen 7.3 (mbgs) | Bottom of Screen 8.2 (mbgs)

Screen Interval 0.9 (m)

Flowing? N

SWL	1.5	(mbgs)	(masl)
Pumping WL		(mbgs)	(masl)
Pump Rate	22.7	(LPM)	1 / 20
Spec. Cap.		(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.9		BROWN	SAND / /
8.5		GREY	FINE SAND / /

4403568 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 11/24/1975 (DD/MM/YYYY) | Elev (masl) | Easting 541837 | Northing 4743310 | UTM RC 4 | margin of error : 30 m - 100 m

/ Domestic | Water Supply | FRESH

Water Found 12.8 (mbgs) (masl)

Casing Diameter 4 inch | Casing Material: STEEL

Top of Screen 13.4 (mbgs) | Bottom of Screen 14.6 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL	12.8	(mbgs)	(masl)
Pumping WL		(mbgs)	(masl)
Pump Rate	22.7	(LPM)	2 / 30
Spec. Cap.		(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.9		BLACK	TOPSOIL / /
4.6		BROWN	COARSE SAND / /
9.1		YELLOW	FINE SAND / /
12.8		YELLOW	SILT / /
17.7		GREY	FINE SAND / /

4403631 — **Lot 046 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 5/1/1976 (DD/MM/YYYY) | Elev (masl) | Easting 541894 | Northing 4742322 | UTM RC 4 | margin of error : 30 m - 100 m

/ Domestic | Water Supply | FRESH

Water Found 6.1 (mbgs) (masl)

Casing Diameter 4 inch | Casing Material: STEEL

Top of Screen 7.6 (mbgs) | Bottom of Screen 8.8 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL	6.1	(mbgs)	(masl)
Pumping WL		(mbgs)	(masl)
Pump Rate	68.2	(LPM)	2 / 0
Spec. Cap.		(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.9		BLACK	TOPSOIL / /
6.1		YELLOW	SAND / /
8.8		GREY	COARSE SAND / /

4403632 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 5/7/1976 (DD/MM/YYYY) | Elev (masl) | Easting 541864 | Northing 4743222 | UTM RC 5 | margin of error : 100 m - 300 m

/ Domestic | Water Supply | FRESH

Water Found 7.6 (mbgs) (masl)

Casing Diameter 5 inch | Casing Material: STEEL

Top of Screen 11.6 (mbgs) | Bottom of Screen 12.8 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL	9.1	(mbgs)	(masl)
Pumping WL		(mbgs)	(masl)
Pump Rate	22.7	(LPM)	2 / 30
Spec. Cap.		(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BLACK	TOPSOIL / /
7.6		YELLOW	SAND / /
12.8		GREY	FINE SAND / /

Well Record #

4403705 — **Lot 023 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 9/4/1976 (DD/MM/YYYY)
Elev (masl) Easting 542314 Northing 4743423
/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m
Water Found 14.6 (mbgs) (masl) FRESH
Casing Diameter 4 inch Casing Material: STEEL
Top of Screen 14.9 (mbgs) Bottom of Screen 17.1 (mbgs)
Screen Interval 2.1 (m)

Flowing? N
SWL 7.6 (mbgs) (masl)
Pumping WL 10.7 (mbgs) (masl)
Pump Rate 68.2 (LPM) 4 / 30
Spec. Cap. 22.37 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
0.6		YELLOW	TOPSOIL /		/
7.3		BROWN	SAND /		/
7.9		GREY	COARSE GRAVEL /		/
10.7		YELLOW	CLAY /		/
14.6		GREY	FINE SAND /		/
18.0		GREY	MEDIUM SAND /		/

4403708 — **Lot 023 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 9/1/1976 (DD/MM/YYYY)
Elev (masl) Easting 542814 Northing 4743472
Domestic / Livestock Water Supply UTM RC 5 margin of error : 100 m - 300 m
Water Found 61.9 (mbgs) (masl) FRESH
Casing Diameter 5 inch Casing Material: STEEL
Top of Screen (mbgs) Bottom of Screen (mbgs)
Screen Interval (m)

Flowing? N
SWL 12.2 (mbgs) (masl)
Pumping WL 15.2 (mbgs) (masl)
Pump Rate 36.4 (LPM) 1 / 20
Spec. Cap. 11.93 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
12.2		BROWN	CLAY /	SANDY	/
19.8			FINE SAND /	WATER-BEARING	/
38.1			CLAY /		/
61.0			CLAY /	HARD	/
62.2			LIMESTONE /		/

4403799 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 3/24/1977 (DD/MM/YYYY)
Elev (masl) Easting 541864 Northing 4742872
/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m
Water Found 16.8 (mbgs) (masl) FRESH
Casing Diameter 6 inch Casing Material: STEEL
Top of Screen 18.0 (mbgs) Bottom of Screen 18.9 (mbgs)
Screen Interval 0.9 (m)

Flowing? N
SWL 9.4 (mbgs) (masl)
Pumping WL 18.0 (mbgs) (masl)
Pump Rate 31.8 (LPM) 3 / 15
Spec. Cap. 3.73 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
16.8		BROWN	SAND /	SOFT	/ LOOSE
18.9		GREY	SAND /	WATER-BEARING	/

4403960 — **Lot 046 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 5/20/1978 (DD/MM/YYYY)
Elev (masl) Easting 542094 Northing 4742162
/ Domestic Water Supply UTM RC 4 margin of error : 30 m - 100 m
Water Found 11.0 (mbgs) (masl) FRESH
Casing Diameter 5 inch Casing Material: STEEL
Top of Screen 13.1 (mbgs) Bottom of Screen 14.3 (mbgs)
Screen Interval 1.2 (m)

Flowing? Y
SWL -12.8 (mbgs) (masl)
Pumping WL 2.4 (mbgs) (masl)
Pump Rate 45.5 (LPM) 2 / 0
Spec. Cap. 2.98 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
5.5		YELLOW	CLAY /	SAND	/ DRY
6.7		YELLOW	GRAVEL /	SAND	/ HARD
11.0		YELLOW	CLAY /	STONES	/ HARD
14.3		GREY	SAND /	SILT	/ WATER-BEARING

Well Record #

4404079 **Lot 045 Conc 02** **MIDDLETON TOWNSHIP / NORFOLK**

Date 11/10/1978 DD/MM/YYYY

Elev (masl) Easting 541874 Northing 4742042

/ Domestic Water Supply UTM RC 4 margin of error : 30 m - 100 m

Water Found 7.3 (mbgs) (masl) FRESH

Casing Diameter 4 inch Casing Material: STEEL

Top of Screen 7.6 (mbgs) Bottom of Screen 9.1 (mbgs)

Screen Interval 1.5 (m)

Flowing? N

SWL	5.5	(mbgs)	(masl)
Pumping WL	7.9	(mbgs)	(masl)
Pump Rate	13.6	(LPM)	6 / 30
Spec. Cap.	5.59	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
7.3		YELLOW	CLAY / STONES / HARD
9.1		YELLOW	SAND / SILT / SOFT

4404360 **Lot 046 Conc 02** **MIDDLETON TOWNSHIP / NORFOLK**

Date 7/31/1980 DD/MM/YYYY

Elev (masl) Easting 541814 Northing 4742322

/ Domestic Water Supply UTM RC 4 margin of error : 30 m - 100 m

Water Found 9.1 (mbgs) (masl) FRESH

Casing Diameter 4 inch Casing Material: STEEL

Top of Screen 12.8 (mbgs) Bottom of Screen 14.0 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL	9.1	(mbgs)	(masl)
Pumping WL	12.8	(mbgs)	(masl)
Pump Rate	45.5	(LPM)	2 / 30
Spec. Cap.	12.43	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
3.0			PREVIOUSLY DUG / /
9.1		BLUE	CLAY / /
14.0		GREY	COARSE SAND / /

4404372 **Lot 024 Conc 13** **WINDHAM TOWNSHIP / NORFOLK**

Date 10/2/1980 DD/MM/YYYY

Elev (masl) Easting 541914 Northing 4743082

/ Domestic Water Supply UTM RC 4 margin of error : 30 m - 100 m

Water Found 13.4 (mbgs) (masl) Not stated

Casing Diameter 4 inch Casing Material: STEEL

Top of Screen 15.8 (mbgs) Bottom of Screen 17.4 (mbgs)

Screen Interval 1.5 (m)

Flowing? N

SWL	9.1	(mbgs)	(masl)
Pumping WL		(mbgs)	(masl)
Pump Rate	27.3	(LPM)	1 / 30
Spec. Cap.		(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.9		BLACK	TOPSOIL / /
4.6		YELLOW	CLAY / /
13.4		BROWN	SAND / /
17.4		GREY	SAND / /

4404375 **Lot 023 Conc 13** **WINDHAM TOWNSHIP / NORFOLK**

Date 7/16/1980 DD/MM/YYYY

Elev (masl) Easting 542414 Northing 4743402

/ Domestic Water Supply UTM RC 4 margin of error : 30 m - 100 m

Water Found 13.7 (mbgs) (masl) Not stated

Casing Diameter 4 inch Casing Material: STEEL

Top of Screen 14.9 (mbgs) Bottom of Screen 17.4 (mbgs)

Screen Interval 2.4 (m)

Flowing? N

SWL	8.5	(mbgs)	(masl)
Pumping WL		(mbgs)	(masl)
Pump Rate	27.3	(LPM)	2 / 30
Spec. Cap.		(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.9		BLACK	TOPSOIL / /
4.6		YELLOW	SAND / /
6.1		YELLOW	CLAY / /
13.7		BROWN	SAND / /
17.4		GREY	SAND / /

Well Record #

4404474 **Lot 046 Conc 02** **MIDDLETON TOWNSHIP / NORFOLK**

Date 6/11/1981 DD/MM/YYYY | Elev (masl) | Easting 541814 | Northing 4742202 | / Domestic | Water Supply | UTM RC 4 | margin of error : 30 m - 100 m

Water Found 7.9 (mbgs) (masl) FRESH

Casing Diameter 4 inch | Casing Material: STEEL

Top of Screen 9.8 (mbgs) | Bottom of Screen 10.7 (mbgs)

Screen Interval 0.9 (m)

Flowing? N

SWL 7.3 (mbgs) (masl)

Pumping WL (mbgs) (masl)

Pump Rate 90.9 (LPM) 2 / 30

Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
0.6		BLACK	TOPSOIL /		/
1.8		GREY	SAND /		/
7.9		YELLOW	CLAY /		/
10.7		GREY	SAND /		/

4404800 **Lot 024 Conc 14** **WINDHAM TOWNSHIP / NORFOLK**

Date 6/14/1984 DD/MM/YYYY | Elev (masl) | Easting 542454 | Northing 4741682 | / Domestic | Water Supply | UTM RC 4 | margin of error : 30 m - 100 m

Water Found 2.4 (mbgs) (masl) FRESH

Casing Diameter 1 inch | Casing Material: GALVANIZED

Top of Screen 4.6 (mbgs) | Bottom of Screen 5.5 (mbgs)

Screen Interval 0.9 (m)

Flowing? N

SWL 2.1 (mbgs) (masl)

Pumping WL 2.4 (mbgs) (masl)

Pump Rate 90.9 (LPM) 1 / 30

Spec. Cap. 298.29 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
2.4		BROWN	SAND /		/
5.5		GREY	SAND /		/

4405376 **Lot 046 Conc 02** **MIDDLETON TOWNSHIP / NORFOLK**

Date 1/13/1989 DD/MM/YYYY | Elev (masl) | Easting 541765 | Northing 4742270 | / Domestic | Water Supply | UTM RC 9 | unknown UTM

Water Found 9.8 (mbgs) (masl) FRESH

Casing Diameter 5 inch | Casing Material: STEEL

Top of Screen 10.1 (mbgs) | Bottom of Screen 11.3 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL 2.4 (mbgs) (masl)

Pumping WL 3.7 (mbgs) (masl)

Pump Rate 45.5 (LPM) 1 / 0

Spec. Cap. 37.29 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
0.6		BLACK	TOPSOIL /		/
8.5		BLUE	CLAY /		/
9.8		GREY	SAND /	SILT	/
11.3		GREY	COARSE SAND /	WATER-BEARING	/

4405377 **Lot 046 Conc 02** **MIDDLETON TOWNSHIP / NORFOLK**

Date 1/30/1989 DD/MM/YYYY | Elev (masl) | Easting 541765 | Northing 4742270 | / Domestic | Water Supply | UTM RC 9 | unknown UTM

Water Found 9.1 (mbgs) (masl) FRESH

Casing Diameter 5 inch | Casing Material: STEEL

Top of Screen 10.4 (mbgs) | Bottom of Screen 11.6 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL 6.1 (mbgs) (masl)

Pumping WL 6.1 (mbgs) (masl)

Pump Rate 45.5 (LPM) 1 / 0

Spec. Cap. 9,999.99 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
0.6		BLACK	TOPSOIL /		/
6.1		BROWN	CLAY /		/
9.1		BLUE	CLAY /		/
11.6		GREY	COARSE SAND /	WATER-BEARING	/

Well Record #

4405577 **Lot 024 Conc 14** **WINDHAM TOWNSHIP / NORFOLK**

Date 12/13/1989 DD/MM/YYYY | Elev (masl) | Easting 542353 | Northing 4741819 | / Domestic | Water Supply | UTM RC 5 margin of error : 100 m - 300 m | Water Found 1.2 (mbgs) (masl) FRESH

Casing Diameter 1 inch | Casing Material: GALVANIZED | Top of Screen 2.4 (mbgs) | Bottom of Screen 5.5 (mbgs) | Screen Interval 3.0 (m)

Flowing? N

SWL	1.2	(mbgs)	(masl)
Pumping WL	1.2	(mbgs)	(masl)
Pump Rate	68.2	(LPM)	1 / 0
Spec. Cap.	9,999.99	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BLACK	TOPSOIL / /
1.2		BROWN	SAND / /
3.7		BROWN	MEDIUM SAND / WATER-BEARING /

4405616 **Lot 046 Conc 02** **MIDDLETON TOWNSHIP / NORFOLK**

Date 3/21/1990 DD/MM/YYYY | Elev (masl) | Easting 541765 | Northing 4742270 | / Domestic | Water Supply | UTM RC 9 unknown UTM | Water Found 12.2 (mbgs) (masl) FRESH

Casing Diameter 5 inch | Casing Material: STEEL | Top of Screen 13.1 (mbgs) | Bottom of Screen 14.0 (mbgs) | Screen Interval 0.9 (m)

Flowing? N

SWL	1.8	(mbgs)	(masl)
Pumping WL	6.1	(mbgs)	(masl)
Pump Rate	45.5	(LPM)	1 / 0
Spec. Cap.	10.65	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BLACK	TOPSOIL / /
4.0		BROWN	SAND / DRY /
9.1		BLUE	CLAY / /
12.2		BLUE	CLAY / GRAVEL /
14.0		GREY	COARSE SAND / WATER-BEARING /

4406070 **Lot 047 Conc 02** **MIDDLETON TOWNSHIP / NORFOLK**

Date 5/19/1992 DD/MM/YYYY | Elev (masl) | Easting 541818 | Northing 4742818 | / Domestic | Water Supply | UTM RC 9 unknown UTM | Water Found 10.7 (mbgs) (masl) FRESH

Casing Diameter 5 inch | Casing Material: STEEL | Top of Screen 15.5 (mbgs) | Bottom of Screen 18.3 (mbgs) | Screen Interval 2.7 (m)

Flowing? N

SWL	10.7	(mbgs)	(masl)
Pumping WL	15.2	(mbgs)	(masl)
Pump Rate		(LPM)	10 / 0
Spec. Cap.		(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BLACK	TOPSOIL / /
4.6		BROWN	SAND / GRAVEL /
10.7		BROWN	SAND / /
13.7		BROWN	SAND / HARDPAN /
18.3		BROWN	FINE SAND / WATER-BEARING /

4406109 **Lot 024 Conc 13** **WINDHAM TOWNSHIP / NORFOLK**

Date 8/20/1992 DD/MM/YYYY | Elev (masl) | Easting 541810 | Northing 4743298 | / Domestic | Water Supply | UTM RC 5 margin of error : 100 m - 300 m | Water Found 11.6 (mbgs) (masl) FRESH

Casing Diameter 5 inch | Casing Material: STEEL | Top of Screen 14.9 (mbgs) | Bottom of Screen 16.5 (mbgs) | Screen Interval 1.5 (m)

Flowing? N

SWL	11.6	(mbgs)	(masl)
Pumping WL	13.7	(mbgs)	(masl)
Pump Rate	45.5	(LPM)	1 / 0
Spec. Cap.	21.31	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BLACK	TOPSOIL / /
11.6		BROWN	SAND / /
16.5		BROWN	SAND / WATER-BEARING /

Well Record #

4406145 **Lot 047 Conc 02** **MIDDLETON TOWNSHIP / NORFOLK**

Date 6/3/1992 DD/MM/YYYY

Elev (masl) Easting 541818 Northing 4742818

/ Domestic Water Supply UTM RC 9 unknown UTM

Water Found 16.2 (mbgs) (masl) FRESH

Casing Diameter 5 inch Casing Material: STEEL

Top of Screen 13.1 (mbgs) Bottom of Screen 15.8 (mbgs)

Screen Interval 2.7 (m)

Flowing? N

SWL	11.0	(mbgs)	(masl)
Pumping WL	12.5	(mbgs)	(masl)
Pump Rate	45.5	(LPM)	3 / 0
Spec. Cap.	29.83	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
11.0		YELLOW	SAND / CLAY / DRY
16.2		RED	SAND / SILT / WATER-BEARING

4406728 **Lot 046 Conc 02** **MIDDLETON TOWNSHIP / NORFOLK**

Date 5/2/1996 DD/MM/YYYY

Elev (masl) Easting 541765 Northing 4742270

/ Domestic Water Supply UTM RC 9 unknown UTM

Water Found 5.5 (mbgs) (masl) FRESH

Casing Diameter 1 inch Casing Material: GALVANIZED

Top of Screen 4.6 (mbgs) Bottom of Screen 5.5 (mbgs)

Screen Interval 0.9 (m)

Flowing? N

SWL	0.9	(mbgs)	(masl)
Pumping WL	0.9	(mbgs)	(masl)
Pump Rate	36.4	(LPM)	1 / 0
Spec. Cap.	9,999.99	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BLACK	TOPSOIL / /
4.6		BROWN	SILT / CLAY /
5.5		GREY	MEDIUM SAND / /

4406898 **Lot 046 Conc 02** **MIDDLETON TOWNSHIP / NORFOLK**

Date 8/18/1997 DD/MM/YYYY

Elev (masl) Easting 541765 Northing 4742270

/ Domestic Water Supply UTM RC 9 unknown UTM

Water Found 24.1 (mbgs) (masl) FRESH

Casing Diameter 5 inch Casing Material: STEEL

Top of Screen 24.1 (mbgs) Bottom of Screen 25.0 (mbgs)

Screen Interval 0.9 (m)

Flowing? N

SWL	0.3	(mbgs)	(masl)
Pumping WL	22.9	(mbgs)	(masl)
Pump Rate	36.4	(LPM)	24 / 0
Spec. Cap.	1.61	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BLACK	TOPSOIL / /
2.1		BROWN	SAND / /
4.9		GREY	SILT / FINE SAND /
12.8		GREY	SILT / CLAY /
17.1		BLUE	CLAY / /
21.0		BLUE	CLAY / GRAVEL /
24.1		BLUE	CLAY / /
25.0		GREY	GRAVEL / /

4406945 **Lot 024 Conc 14** **WINDHAM TOWNSHIP / NORFOLK**

Date 11/14/1997 DD/MM/YYYY

Elev (masl) Easting 542223 Northing 4741912

/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m

Water Found 1.2 (mbgs) (masl) FRESH

Casing Diameter 1 inch Casing Material: STEEL

Top of Screen 4.0 (mbgs) Bottom of Screen 5.2 (mbgs)

Screen Interval 1.2 (m)

Flowing? N

SWL	1.2	(mbgs)	(masl)
Pumping WL	3.7	(mbgs)	(masl)
Pump Rate	9.1	(LPM)	5 / 0
Spec. Cap.	3.73	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BLACK	TOPSOIL / /
1.2		BROWN	SAND / /
3.0		GREY	SILT / /
5.2		GREY	SILT / SAND /

Well Record #

4406984 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 5/12/1998 (DD/MM/YYYY)
Elev (masl) Easting 541983 Northing 4742829
/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m
Water Found 2.1 (mbgs) (masl) FRESH
Casing Diameter 2 inch Casing Material: STEEL
Top of Screen 6.7 (mbgs) Bottom of Screen 7.9 (mbgs)
Screen Interval 1.2 (m)

Flowing? N
SWL 2.1 (mbgs) (masl)
Pumping WL 4.6 (mbgs) (masl)
Pump Rate 272.8 (LPM) 1 / 0
Spec. Cap. 111.86 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BLACK	TOPSOIL / /
2.1		BROWN	SAND / /
7.9		BROWN	MEDIUM SAND / /

4407266 — **Lot 046 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 9/20/1999 (DD/MM/YYYY)
Elev (masl) Easting 541765 Northing 4742270
/ Domestic Water Supply UTM RC 9 unknown UTM
Water Found 9.8 (mbgs) (masl) FRESH
Casing Diameter 1 inch Casing Material: GALVANIZED
Top of Screen 9.8 (mbgs) Bottom of Screen 11.0 (mbgs)
Screen Interval 1.2 (m)

Flowing? N
SWL 3.0 (mbgs) (masl)
Pumping WL (mbgs) (masl)
Pump Rate 31.8 (LPM) 1 / 30
Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.3		BROWN	TOPSOIL / /
2.7		BROWN	FINE SAND / /
7.6		BROWN	CLAY / GRAVEL / STONES
9.8		GREY	CLAY / GRAVEL / HARD
11.0		GREY	COARSE SAND / /
11.6		GREY	CLAY / GRAVEL / HARD

4407553 — **Lot Conc** — **DELHI TOWN / NORFOLK**

Date 6/15/2001 (DD/MM/YYYY)
Elev (masl) Easting 542099 Northing 4743126
/ Domestic Water Supply UTM RC 3 margin of error : 10 - 30 m
Water Found 6.4 (mbgs) (masl) FRESH
Casing Diameter 5 inch Casing Material: STEEL
Top of Screen 14.9 (mbgs) Bottom of Screen 16.2 (mbgs)
Screen Interval 1.2 (m)

Flowing? N
SWL 6.4 (mbgs) (masl)
Pumping WL 7.9 (mbgs) (masl)
Pump Rate 45.5 (LPM) 1 /
Spec. Cap. 29.83 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BLACK	TOPSOIL / /
3.0		BROWN	SAND / /
6.4		BROWN	SAND / CLAY /
14.3		BROWN	FINE SAND / SILT /
16.2		BROWN	MEDIUM SAND / /

4408136 — **Lot 024 Conc 12** — **WINDHAM TOWNSHIP / NORFOLK**

Date 5/19/2004 (DD/MM/YYYY)
Elev (masl) Easting 542087 Northing 4742446
/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m
Water Found 6.0 (mbgs) (masl) FRESH
Casing Diameter 13 cm Casing Material: STEEL
Top of Screen 13.5 (mbgs) Bottom of Screen 15.4 (mbgs)
Screen Interval 1.8 (m)

Flowing?
SWL 0.0 (mbgs) (masl)
Pumping WL 3.7 (mbgs) (masl)
Pump Rate 40.0 (LPM) 6 / 0
Spec. Cap. 10.84 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BLACK	TOPSOIL / /
3.1		BROWN	CLAY / /
6.5		BLUE	CLAY / SILT /
12.9		GREY	GRAVEL / SILT /

Well Record #

			15.4	GREY	FINE SAND /		/

4408268 — Lot 029 Conc — MIDDLETON TOWNSHIP / NORFOLK

Date 3/8/2005 (DD/MM/YYYY) | Elev (masl) | Easting 541836 | Northing 4742265 | UTM RC 4 margin of error : 30 m - 100 m

/ Domestic | Water Supply | Water Found 9.0 (mbgs) (masl) FRESH

Casing Diameter 13 cm | Casing Material: STEEL | Top of Screen 10.0 (mbgs) | Bottom of Screen 11.5 (mbgs) | Screen Interval 1.5 (m)

Flowing? | SWL 2.0 (mbgs) (masl) | Pumping WL 2.5 (mbgs) (masl) | Pump Rate 45.0 (LPM) 4 / 0 | Spec. Cap. 90.00 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color		Soil Descriptions	
0.0		Color		Soil Descriptions	
1.0		BLACK	TOPSOIL /		/
9.1		BLUE	CLAY /	BOULDERS	/
11.5		GREY	SAND /		/

4408269 — Lot 029 Conc — MIDDLETON TOWNSHIP / NORFOLK

Date 3/8/2005 (DD/MM/YYYY) | Elev (masl) | Easting 541838 | Northing 4742261 | UTM RC 4 margin of error : 30 m - 100 m

/ Abandoned-Other | Water Found (mbgs) (masl)

Casing Diameter | Casing Material: | Top of Screen (mbgs) | Bottom of Screen (mbgs) | Screen Interval (m)

Flowing? | SWL (mbgs) (masl) | Pumping WL (mbgs) (masl) | Pump Rate (LPM) / | Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color		Soil Descriptions	
0.0		Color		Soil Descriptions	
			/		/

4408380 — Lot 046 Conc 02 — MIDDLETON TOWNSHIP / NORFOLK

Date 11/15/2005 (DD/MM/YYYY) | Elev (masl) | Easting 542135 | Northing 4741848 | UTM RC 4 margin of error : 30 m - 100 m

/ Domestic | Water Supply | Water Found 47.4 (mbgs) (masl) SULPHUR

Casing Diameter 13 cm | Casing Material: STEEL | Top of Screen (mbgs) | Bottom of Screen (mbgs) | Screen Interval (m)

Flowing? Y | SWL 0.9 (mbgs) (masl) | Pumping WL 6.2 (mbgs) (masl) | Pump Rate 45.0 (LPM) 24 / 0 | Spec. Cap. 8.60 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color		Soil Descriptions	
0.0		Color		Soil Descriptions	
0.6		BLACK	TOPSOIL /		/
3.1		BROWN	SAND /	CLAY	/ SILT
6.5		GREY	SILT /	SAND	/
23.1		BLUE	CLAY /	GRAVEL	/
24.6		GREY	GRAVEL /		/
28.0		GREY	SILT /	CLAY	/
46.5		BLUE	CLAY /	GRAVEL	/
47.7		GREY	LIMESTONE /		/

7101825 — Lot 024 Conc 13 — WINDHAM TOWNSHIP / NORFOLK

Date 11/16/2007 (DD/MM/YYYY) | Elev (masl) | Easting 542271 | Northing 4743189 | UTM RC 3 margin of error : 10 - 30 m

/ Irrigation | Water Supply | Water Found 11.2 (mbgs) (masl) FRESH

Casing Diameter | Casing Material: | Top of Screen (mbgs) | Bottom of Screen (mbgs) | Screen Interval (m)

Flowing? | SWL 4.3 (mbgs) (masl) | Pumping WL 4.3 (mbgs) (masl) | Pump Rate 64.6 (LPM) 2 / | Spec. Cap. 9,999.99 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color		Soil Descriptions	
0.0		Color		Soil Descriptions	
			/		/
4.0		BROWN	SAND /		/
11.3		BLUE	CLAY /		/
15.5		GREY	FINE SAND /		/

Well Record #

7110012 — **Lot 001 Conc 03** — **WINDHAM TOWNSHIP / NORFOLK**

Date 7/11/2008 (DD/MM/YYYY)
Elev (masl) Easting 542080 Northing 4742552
/ Commerical Water Supply UTM RC 3 margin of error : 10 - 30 m
Water Found 6.4 (mbgs) (masl) FRESH
Casing Diameter 5 inch Casing Material: STEEL
Top of Screen 7.3 (mbgs) Bottom of Screen 8.5 (mbgs)
Screen Interval 1.2 (m)

Flowing? N
SWL 2.6 (mbgs) (masl)
Pumping WL 3.7 (mbgs) (masl)
Pump Rate 32.7 (LPM) 8 /
Spec. Cap. 30.68 (LPM/m) Hour / Minute

Depth (m)	Color			
0.0				
0.6	BROWN	TOPSOIL /		/ FILL
1.8	BROWN	SAND /	GRAVEL	/ BOULDERS
6.4	BROWN	SAND /	CLAY	/
8.5	BROWN	MEDIUM SAND /		/
9.4	GREY	CLAY /		/

7110013 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 7/4/2008 (DD/MM/YYYY)
Elev (masl) Easting 542078 Northing 4742552
/ Domestic Water Supply UTM RC 3 margin of error : 10 - 30 m
Water Found 8.5 (mbgs) (masl) FRESH
Casing Diameter 5 inch Casing Material: STEEL
Top of Screen 11.3 (mbgs) Bottom of Screen 12.5 (mbgs)
Screen Interval 1.2 (m)

Flowing? N
SWL 3.7 (mbgs) (masl)
Pumping WL 3.7 (mbgs) (masl)
Pump Rate 54.6 (LPM) 2 /
Spec. Cap. 9,999.99 (LPM/m) Hour / Minute

Depth (m)	Color			
0.0				
0.3	BROWN	TOPSOIL /		/
8.5	BROWN	CLAY /	BOULDERS	/
12.5	GREY	SAND /	COARSE SAND	/

7110018 — **Lot 046 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 6/23/2008 (DD/MM/YYYY)
Elev (masl) Easting 542072 Northing 4742114
/ Irrigation Water Supply UTM RC 3 margin of error : 10 - 30 m
Water Found 0.9 (mbgs) (masl) FRESH
Casing Diameter 5 inch Casing Material: STEEL
Top of Screen 6.4 (mbgs) Bottom of Screen 7.6 (mbgs)
Screen Interval 1.2 (m)

Flowing? N
SWL 0.9 (mbgs) (masl)
Pumping WL (mbgs) (masl)
Pump Rate 31.8 (LPM) 8 /
Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Color			
0.0				
0.3	BLACK	TOPSOIL /		/
1.5	BROWN	TOPSOIL /	SANDY	/ MUCK
7.6	GREY	SAND /		/ MEDIUM SAND

7176028 — **Lot 024 Conc 14** — **WINDHAM TOWNSHIP / NORFOLK**

Date 10/24/2011 (DD/MM/YYYY)
Elev (masl) Easting 542558 Northing 4741934
/ Domestic Water Supply UTM RC 4 margin of error : 30 m - 100 m
Water Found 3.0 (mbgs) (masl) FRESH
Casing Diameter 1 inch Casing Material: GALVANIZED
Top of Screen 7.6 (mbgs) Bottom of Screen 8.8 (mbgs)
Screen Interval 1.2 (m)

Flowing? N
SWL 3.0 (mbgs) (masl)
Pumping WL 4.6 (mbgs) (masl)
Pump Rate 22.7 (LPM) 2 / 0
Spec. Cap. 14.91 (LPM/m) Hour / Minute

Depth (m)	Color			
0.0				
3.0	BROWN	SAND /		/
7.6	BROWN	FINE SAND /	SILT	/ CLAY
8.8	GREY	FINE SAND /		/

Well Record #

7176544 — **Lot 023 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 9/27/2011 (DD/MM/YYYY)
Elev (masl) Easting 542472 Northing 4743484
/ Domestic Water Supply UTM RC 4 margin of error : 30 m - 100 m
Water Found 12.2 (mbgs) (masl) Not stated
Casing Diameter 5 inch Casing Material: STEEL
Top of Screen 14.3 (mbgs) Bottom of Screen 16.8 (mbgs)
Screen Interval 2.4 (m)

Flowing? N
SWL 5.5 (mbgs) (masl)
Pumping WL 13.7 (mbgs) (masl)
Pump Rate 27.3 (LPM) 12 / 0
Spec. Cap. 3.31 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BLACK	TOPSOIL / /
4.6		BROWN	TOPSOIL / SANDY /
12.2		BLUE	CLAY / /
14.3		GREY	FINE SAND / / DIRTY
16.8		GREY	MEDIUM SAND / / DIRTY

7198495 — **Lot 046 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 4/27/2012 (DD/MM/YYYY)
Elev (masl) Easting 541895 Northing 4742313
/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m
Water Found 13.7 (mbgs) (masl) FRESH
Casing Diameter 6 inch Casing Material: STEEL
Top of Screen 14.3 (mbgs) Bottom of Screen 15.8 (mbgs)
Screen Interval 1.5 (m)

Flowing? N
SWL 2.1 (mbgs) (masl)
Pumping WL 3.0 (mbgs) (masl)
Pump Rate 45.5 (LPM) 10 / 0
Spec. Cap. 49.72 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
4.6		BROWN	SAND / CLAY /
13.7		BLUE	CLAY / /
15.8		GREY	COARSE SAND / GRAVEL /

7198520 — **Lot Conc** — **DELHI TOWN / NORFOLK**

Date 9/10/2012 (DD/MM/YYYY)
Elev (masl) Easting 541778 Northing 4743497
/ Irrigation Water Supply UTM RC 4 margin of error : 30 m - 100 m
Water Found 10.7 (mbgs) (masl) FRESH
Casing Diameter 5 inch Casing Material: STEEL
Top of Screen 16.5 (mbgs) Bottom of Screen 18.6 (mbgs)
Screen Interval 2.1 (m)

Flowing? N
SWL 10.7 (mbgs) (masl)
Pumping WL 15.2 (mbgs) (masl)
Pump Rate 77.3 (LPM) 2 /
Spec. Cap. 16.90 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BROWN	TOPSOIL / /
4.6		BROWN	CLAY / /
7.0		BROWN	CLAY / /
18.6		BROWN	SAND / / FINE SAND

7225031 — **Lot 024 Conc 14** — **WINDHAM TOWNSHIP / NORFOLK**

Date 7/23/2014 (DD/MM/YYYY)
Elev (masl) Easting 542437 Northing 4741725
/ Domestic Water Supply UTM RC 4 margin of error : 30 m - 100 m
Water Found 2.4 (mbgs) (masl) FRESH
Casing Diameter 5 inch Casing Material: STEEL
Top of Screen 3.0 (mbgs) Bottom of Screen 7.3 (mbgs)
Screen Interval 4.3 (m)

Flowing?
SWL 2.4 (mbgs) (masl)
Pumping WL (mbgs) (masl)
Pump Rate 54.6 (LPM) 1 /
Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BLACK	TOPSOIL / /
6.1		BROWN	SAND / /
7.3		GREY	SAND / MEDIUM SAND /

Well Record #

7259732 Lot Conc **DELHI TOWN / NORFOLK**

Date 7/10/2015 DD/MM/YYYY | Elev (masl) | Easting 541843 | Northing 4743210 | / Domestic | Water Supply | UTM RC 4 margin of error : 30 m - 100 m | Water Found 13.4 (mbgs) (masl) FRESH | Casing Diameter 5 inch | Casing Material: STEEL | Top of Screen 15.2 (mbgs) | Bottom of Screen 16.5 (mbgs) | Screen Interval 1.2 (m)

Flowing? N
SWL 9.1 (mbgs) (masl)
Pumping WL 14.6 (mbgs) (masl)
Pump Rate 45.5 (LPM) 1 /
Spec. Cap. 8.29 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BROWN	TOPSOIL / /
9.1		BROWN	CLAY / SAND /
13.4		BROWN	SILT / CLAY /
16.5		BROWN	SAND / / FINE SAND

7280630 Lot Conc **MIDDLETON TOWNSHIP / NORFOLK**

Date 11/23/2016 DD/MM/YYYY | Elev (masl) | Easting 541995 | Northing 4742358 | / Domestic | Water Supply | UTM RC 4 margin of error : 30 m - 100 m | Water Found 14.3 (mbgs) (masl) | Casing Diameter 5 inch | Casing Material: STEEL | Top of Screen 15.2 (mbgs) | Bottom of Screen 16.8 (mbgs) | Screen Interval 1.5 (m)

Flowing?
SWL 2.1 (mbgs) (masl)
Pumping WL 5.8 (mbgs) (masl)
Pump Rate 90.9 (LPM) 2 / 0
Spec. Cap. 24.86 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BLACK	TOPSOIL / /
4.6		BROWN	SAND / CLAY /
7.6		BLACK	CLAY / /
14.3		BLACK	CLAY / GRAVEL /
16.8		GREY	FINE SAND / SAND /

7280642 Lot 046 Conc 02 **MIDDLETON TOWNSHIP / NORFOLK**

Date 7/30/2016 DD/MM/YYYY | Elev (masl) | Easting 541988 | Northing 4742374 | / Domestic | Water Supply | UTM RC 4 margin of error : 30 m - 100 m | Water Found 12.8 (mbgs) (masl) FRESH | Casing Diameter 5 inch | Casing Material: STEEL | Top of Screen 14.6 (mbgs) | Bottom of Screen 16.2 (mbgs) | Screen Interval 1.5 (m)

Flowing?
SWL 2.1 (mbgs) (masl)
Pumping WL 4.6 (mbgs) (masl)
Pump Rate 113.7 (LPM) 1 / 30
Spec. Cap. 46.61 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BLACK	TOPSOIL / /
2.4		BROWN	SAND / /
3.7		BROWN	CLAY / /
9.1		BLUE	CLAY / GRAVEL /
12.8		BLUE	CLAY / /
16.2		GREY	/ /

7283726 Lot 024 Conc 13 **WINDHAM TOWNSHIP / NORFOLK**

Date 4/18/2016 DD/MM/YYYY | Elev (masl) | Easting 542342 | Northing 4742404 | / Irrigation | Water Supply | UTM RC 4 margin of error : 30 m - 100 m | Water Found (mbgs) (masl) | Casing Diameter 7 inch | Casing Material: STEEL | Top of Screen (mbgs) | Bottom of Screen (mbgs) | Screen Interval (m)

Flowing? N
SWL 2.4 (mbgs) (masl)
Pumping WL 9.8 (mbgs) (masl)
Pump Rate 181.8 (LPM) 2 /
Spec. Cap. 24.86 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
19.2			OVERBURDEN / /

Well Record #

7306273 **Lot 023 Conc 13** **WINDHAM TOWNSHIP / NORFOLK**

Date 9/21/2017 DD/MM/YYYY

Elev (masl) Easting 542730 Northing 4743509

/ Domestic Water Supply UTM RC 4 margin of error : 30 m - 100 m

Water Found 3.4 (mbgs) (masl) FRESH

Casing Diameter 5 inch Casing Material: STEEL

Top of Screen 9.1 (mbgs) Bottom of Screen 10.7 (mbgs)

Screen Interval 1.5 (m)

Flowing?
SWL 3.4 (mbgs) (masl)
Pumping WL 4.9 (mbgs) (masl)
Pump Rate 90.9 (LPM) 2 /
Spec. Cap. 59.66 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color		Soil Descriptions		
0.0						
0.6		BLACK	TOPSOIL /		/	
7.6		GREY	SAND /	CLAY	/	
10.7		BROWN	SAND /		/	

7309038 **Lot Conc** **DELHI TOWN / NORFOLK**

Date 4/28/2017 DD/MM/YYYY

Elev (masl) Easting 541985 Northing 4742792

/ Domestic Water Supply UTM RC 4 margin of error : 30 m - 100 m

Water Found 10.7 (mbgs) (masl) FRESH

Casing Diameter 4 inch Casing Material: STEEL

Top of Screen 14.6 (mbgs) Bottom of Screen 16.2 (mbgs)

Screen Interval 1.5 (m)

Flowing? N
SWL 10.7 (mbgs) (masl)
Pumping WL 14.3 (mbgs) (masl)
Pump Rate 36.4 (LPM) 1 /
Spec. Cap. 9.94 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color		Soil Descriptions		
0.0						
			/		/	

7309048 **Lot 024 Conc 13** **WINDHAM TOWNSHIP / NORFOLK**

Date 7/10/2017 DD/MM/YYYY

Elev (masl) Easting 541938 Northing 4742891

/ Domestic Abandoned-Supply UTM RC 4 margin of error : 30 m - 100 m

Water Found 9.4 (mbgs) (masl)

Casing Diameter inch Casing Material: STEEL

Top of Screen (mbgs) Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N
SWL 9.4 (mbgs) (masl)
Pumping WL (mbgs) (masl)
Pump Rate (LPM) /
Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color		Soil Descriptions		
0.0						
			/		/	

7309049 **Lot 024 Conc 13** **WINDHAM TOWNSHIP / NORFOLK**

Date 7/10/2017 DD/MM/YYYY

Elev (masl) Easting 541936 Northing 4742887

/ Domestic Water Supply UTM RC 4 margin of error : 30 m - 100 m

Water Found 9.8 (mbgs) (masl) FRESH

Casing Diameter 5 inch Casing Material: STEEL

Top of Screen 17.7 (mbgs) Bottom of Screen 19.2 (mbgs)

Screen Interval 1.5 (m)

Flowing? N
SWL 8.2 (mbgs) (masl)
Pumping WL 11.0 (mbgs) (masl)
Pump Rate 45.5 (LPM) 1 / 0
Spec. Cap. 16.57 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color		Soil Descriptions		
0.0						
0.6		BROWN	TOPSOIL /		/	
9.8		BROWN	SAND /	SILT	/	GRAVEL
13.1		GREY	SAND /		/	WATER-BEARING
17.7		GREY	SAND /	SILT	/	
19.2		GREY	SAND /		/	FINE SAND

Well Record #

7327860 — **Lot 024 Conc 14** — **WINDHAM TOWNSHIP / NORFOLK**

Date 10/6/2018 (DD/MM/YYYY)

Elev / (masl) Easting 542445 Northing 4741842

Water Supply UTM RC 4 margin of error : 30 m - 100 m

Water Found 55.2 (mbgs) (masl) FRESH

Casing Diameter 6 inch Casing Material: STEEL

Top of Screen 53.9 (mbgs) Bottom of Screen 54.9 (mbgs)

Screen Interval 0.9 (m)

Flowing?

SWL 2.3 (mbgs) (masl)

Pumping WL 7.3 (mbgs) (masl)

Pump Rate 22.7 (LPM) 1 / Hour / Minute

Spec. Cap. 4.57 (LPM/m)

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
0.9		BROWN	TOPSOIL /	/	
18.3		BROWN	SAND /	/	
36.6		BROWN	SAND /	CLAY	/
48.2		GREY	CLAY /	GRAVEL	/
54.6		GREY	LIMESTONE /		/ FRACTURED
55.2		BROWN	LIMESTONE /		/

7366925 — **Lot 046 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 9/2/2020 (DD/MM/YYYY)

Elev / (masl) Easting 542060 Northing 4741726

Water Found (mbgs) (masl) UTM RC 4 margin of error : 30 m - 100 m

Casing Diameter Casing Material:

Top of Screen (mbgs) Bottom of Screen (mbgs)

Screen Interval (m)

Flowing?

SWL (mbgs) (masl)

Pumping WL (mbgs) (masl)

Pump Rate (LPM) /

Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
			/	/	

7379977 — **Lot 046 Conc 02** — **MIDDLETON TOWNSHIP / NORFOLK**

Date 2/7/2020 (DD/MM/YYYY)

Elev / (masl) Easting 541840 Northing 4742101

Water Found (mbgs) (masl) UTM RC 4 margin of error : 30 m - 100 m

Casing Diameter Casing Material:

Top of Screen (mbgs) Bottom of Screen (mbgs)

Screen Interval (m)

Flowing?

SWL (mbgs) (masl)

Pumping WL (mbgs) (masl)

Pump Rate (LPM) /

Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
			/	/	

7383557 — **Lot 024 Conc 13** — **WINDHAM TOWNSHIP / NORFOLK**

Date 1/13/2020 (DD/MM/YYYY)

Elev / (masl) Easting 541922 Northing 4742943

Water Found (mbgs) (masl) UTM RC 4 margin of error : 30 m - 100 m

Casing Diameter Casing Material:

Top of Screen (mbgs) Bottom of Screen (mbgs)

Screen Interval (m)

Flowing?

SWL (mbgs) (masl)

Pumping WL (mbgs) (masl)

Pump Rate (LPM) /

Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions		
0.0					
			/	/	

APPENDIX

C HYDRAULIC CONDUCTIVITY ANALYSIS

WSP Canada Group Ltd.
100 Commerce Valley Drive West
Thornhill, ON. L3T 0A1

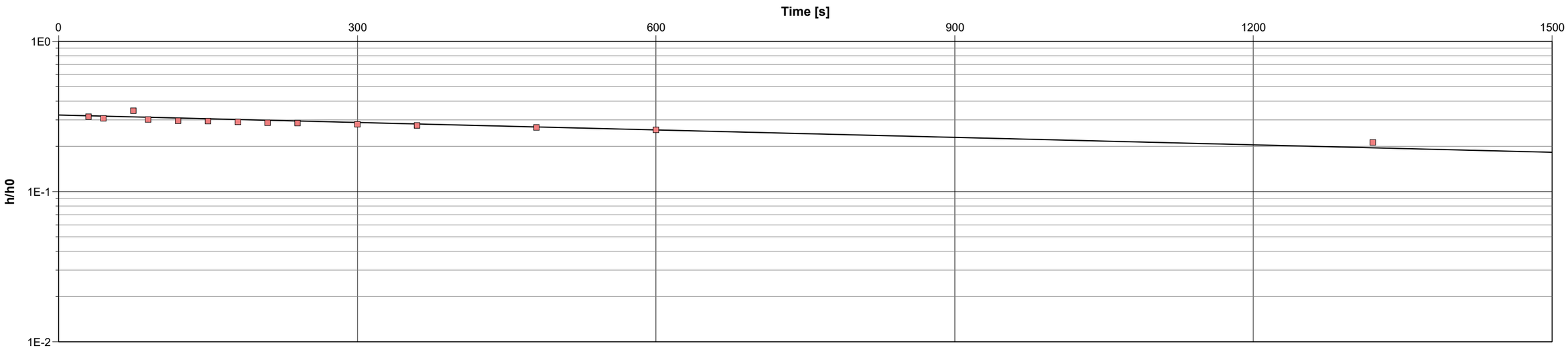
Slug Test Analysis Report

Project: Delhi Golf and Country Club

Number: 211-13079-00

Client: GolfNorth C/O Geranium

Location: Delhi, Ontario	Slug Test: BH21-3	Test Well: BH21-3 RH
Test Conducted by: V. Propp		Test Date: 1/14/2022
Analysis Performed by: L. Halwa	BH21-3 Rising Head Test	Analysis Date: 5/25/2022
Aquifer Thickness: 12.00 m		



Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH21-3 RH	2.57×10^{-7}	

Screened in Sandy Silt, some Clay

WSP Canada Group Ltd.
100 Commerce Valley Drive West
Thornhill, ON. L3T 0A1

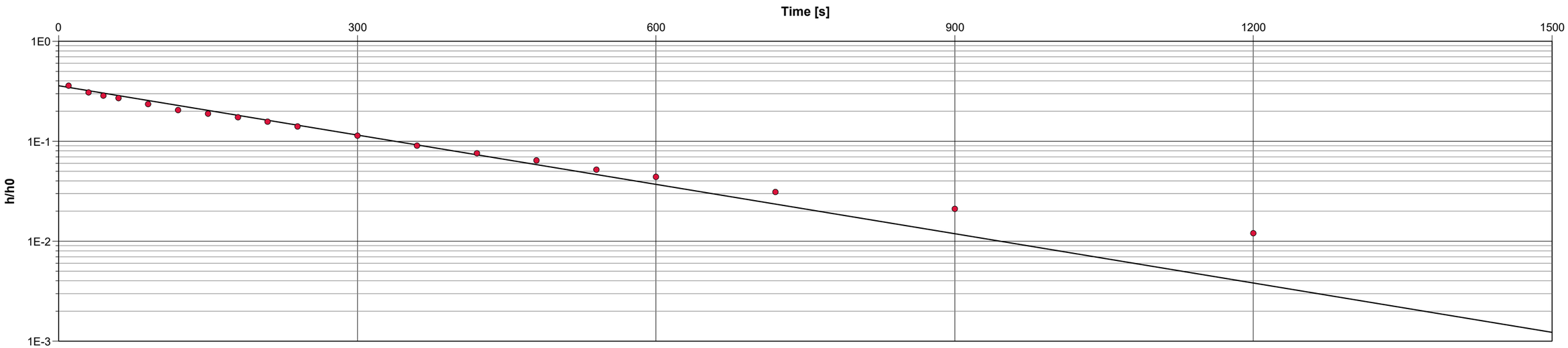
Slug Test Analysis Report

Project: Delhi Golf and Country Club

Number: 211-13079-00

Client: GolfNorth C/O Geranium

Location: Delhi, Ontario	Slug Test: BH21-7 FH	Test Well: BH21-7 FH
Test Conducted by: V.Propp		Test Date: 12/21/2021
Analysis Performed by: L.Halwa	BH21-7 Falling Head Test	Analysis Date: 5/25/2022
Aquifer Thickness: 7.00 m		



Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH21-7 FH	2.06×10^{-6}	

Screened in SAND, some gravel and silt. Grades to Silty SAND with Clayey Silt lenses. Non-Cohesive

WSP Canada Group Ltd.
100 Commerce Valley Drive West
Thornhill, ON. L3T 0A1

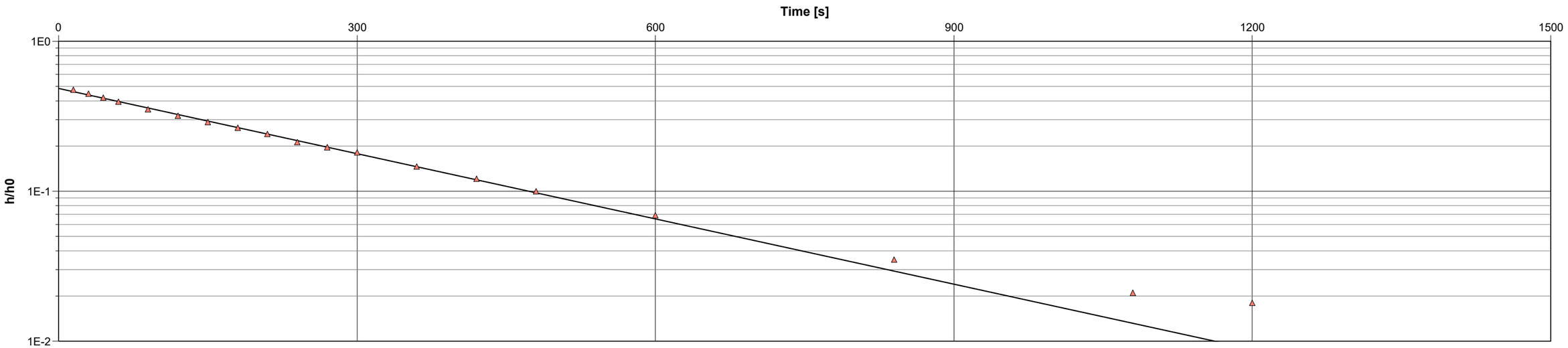
Slug Test Analysis Report

Project: Delhi Golf and Country Club

Number: 211-13079-00

Client: GolfNorth C/O Geranium

Location: Delhi, Ontario	Slug Test: BH21-7 RH	Test Well: BH21-7 RH
Test Conducted by: V.Propp		Test Date: 12/21/2021
Analysis Performed by: L.Halwa	BH21-7 Rising Head	Analysis Date: 5/25/2022
Aquifer Thickness: 7.00 m		



Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH21-7 RH	1.82×10^{-6}	

Screened in SAND, some gravel. Grades to Silty SAND, silt and clay lenses

WSP Canada Group Ltd.
100 Commerce Valley Drive West
Thornhill, ON. L3T 0A1

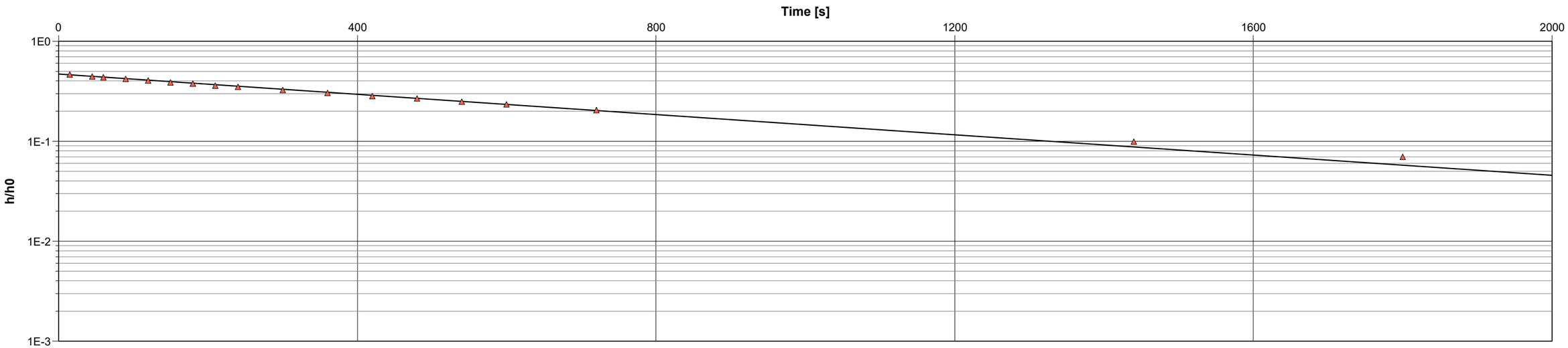
Slug Test Analysis Report

Project: Delhi Golf and Country Club

Number: 211-13079-00

Client: GolfNorth C/O Geranium

Location: Delhi, Ontario	Slug Test: BH21-8	Test Well: BH21-8 RH
Test Conducted by: V.Propp		Test Date: 12/21/2021
Analysis Performed by: L.Halwa	BH21-8 Rising Head Test	Analysis Date: 5/25/2022
Aquifer Thickness: 12.00 m		



Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH21-8 RH	7.86×10^{-7}	

Screened in SILT to Clayey SILT, some sand lenses

WSP Canada Group Ltd.
100 Commerce Valley Drive West
Thornhill, ON. L3T 0A1

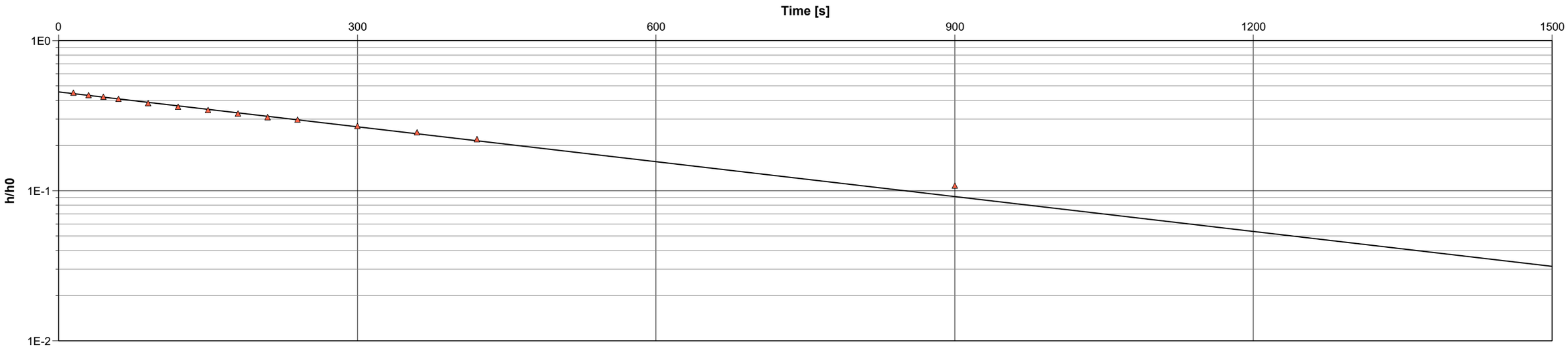
Slug Test Analysis Report

Project: Delhi Golf and Country Club

Number: 211-13079-00

Client: GolfNorth C/O Geranium

Location: Delhi, Ontario	Slug Test: BH21-11-S (B)	Test Well: BH21-11-S
Test Conducted by: V.Propp		Test Date: 12/21/2021
Analysis Performed by: L.Halwa	BH21-11-S (B) - Rising Head Test	Analysis Date: 5/25/2022
Aquifer Thickness: 5.00 m		



Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH21-11-S	1.21×10^{-6}	

Screened in SILT, cohesive

BH21-11-S (B) is the shallow well of a nested piezometer.
B=shallow
A=deep

WSP Canada Group Ltd.
100 Commerce Valley Drive West
Thornhill, ON. L3T 0A1

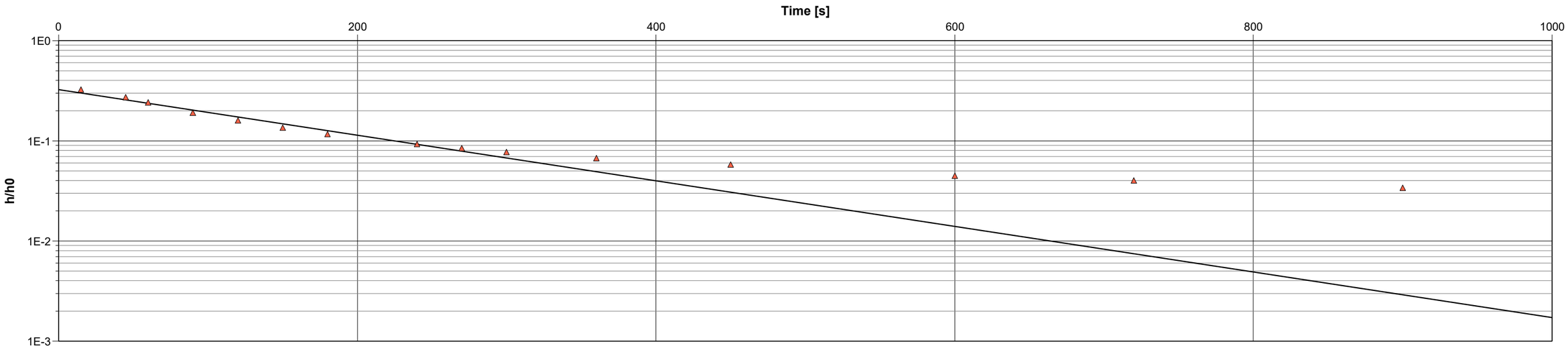
Slug Test Analysis Report

Project: Delhi Golf and Country Club

Number: 211-13079-00

Client: GolfNorth C/O Geranium

Location: Delhi, Ontario	Slug Test: BH21-12	Test Well: BH21-12 RH
Test Conducted by: V.Propp		Test Date: 1/14/2022
Analysis Performed by: L.Halwa	BH21-12 Rising Head Test	Analysis Date: 5/25/2022
Aquifer Thickness: 10.00 m		



Calculation using Bouwer & Rice

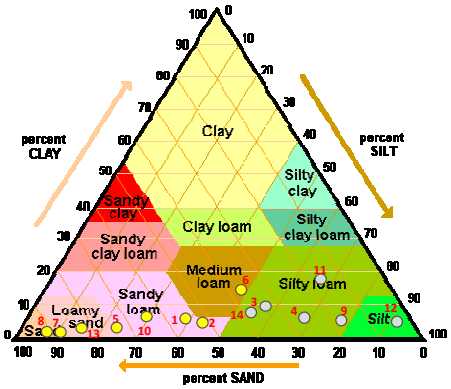
Observation Well	Hydraulic Conductivity [m/s]	
BH21-12 RH	3.55×10^{-6}	

Screened in Silty SAND, non-cohesive (233.0 masl - 231.1 masl)
Screened in Sandy SILT, some clay cohesive (231.1 masl - 230.5 masl)

APPENDIX

D SOIL CLASSIFICATION AND HAZEN ANALYSIS

Soil Classification - Geranium Delhi



Soil Guide	
Soil Type	i-soil
Fine Sand	0.40
Sandy Loam	0.30
Silty Loam	0.20
Clay Loam	0.15
Clay	0.10

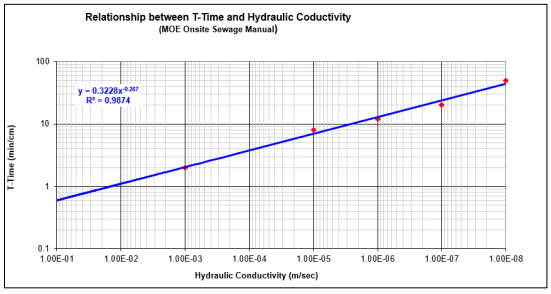
Source: http://web.ukonline.co.uk/fred.moor/soil/formed/f0107.htm

Grain Size Analysis - Distribution

				% Content (excl. gravel)			
	Borehole/SS	Depth Range	Description	Sand	Silt	clay	Soil Classification
		mbgs					
1	BH21-1 / S6	3.8 - 4.4	Silty Sand, some gravel	54.5	39.8	5.7	Sandy Loam
2	BH21-2 / S4B	2.3 - 2.9	Silty Sand, some Gravel, trace till	50.6	44.6	4.8	Sandy Loam
3	BH21-3 / S4	2.3 - 2.9	Sandy Silt, some clay	33.3	56.6	10.1	Silty Loam
4	BH21-3 / S8	6.1-6.7	Sandy Silt, some clay	26.0	69.0	5.0	Silty Loam
5	BH21-5 / S6	3.8 - 4.4	Silty Sand to Sand, trace clay	74.7	22.2	3.0	Sandy Loam
6	BH21-6 / S5	3.1 - 3.7	Sandy Silt (TILL), some sand	37.8	48.9	13.3	Medium Loam
7	BH21-7 / S6A	3.8 - 4.4	Sand, some gravel to Silty Sand	88.6	10.2	1.1	Sand
8	BH21-8 / S5A	3.1 - 3.7	Sand and Gravel, some silt	91.9	7.1	1.0	Sand
9	BH21-9 / S5	3.1 - 3.7	Silt, some sand	18.0	77.0	5.0	Silty Loam
10	BH21-10 / S3	1.5 - 2.1	Silty Sand, trace clay	65.7	29.3	5.1	Sandy Loam
11	BH21-10 / S7	4.6 - 5.2	Silty Clay to Clayey Silt	15.8	65.3	18.9	Silty Loam
12	BH21-11 / S6	3.8 - 4.4	Silt	2.0	94.0	4.0	Silty Loam
13	BH21-11 / S9A	7.6 - 8.2	Sand	84.3	13.5	2.2	Loamy Sand
14	BH21-13 / S8	6.1 - 6.78	Sandy Silt, some clay	38.1	52.6	9.3	Silty Loam

Grain Size Analysis - Hazen Approximation

BH/SA ID	depth (mbgs)	Soil Description for Borehole Logs	d10 extrapolated	Hazen k ~0.01 x d_{10}^2	
				d_{10} (mm)	est'd k (m/sec)
BH21-1 / S6	3.8 - 4.4	Silty Sand, some gravel	no	0.0070	4.9E-07
BH21-2 / S4B	2.3 - 2.9	Silty Sand, some Gravel, trace till	no	0.0100	1.0E-06
BH21-3 / S4	2.3 - 2.9	Sandy Silt, some clay	no	0.0018	3.2E-08
BH21-3 / S8	6.1-6.7	Sandy Silt, some clay	no	0.0080	6.4E-07
BH21-5 / S6	3.8 - 4.4	Silty Sand to Sand, trace clay	no	0.0390	1.5E-05
BH21-6 / S5	3.1 - 3.7	Sandy Silt (TILL), some sand	no	0.0017	2.9E-08
BH21-7 / S6A	3.8 - 4.4	Sand, some gravel to Silty Sand	no	0.0700	4.9E-05
BH21-8 / S5A	3.1 - 3.7	Sand and Gravel, some silt	no	0.0900	8.1E-05
BH21-9 / S5	3.1 - 3.7	Silt, some sand	no	0.0800	6.4E-05
BH21-10 / S3	1.5 - 2.1	Silty Sand, trace clay	no	0.0100	1.0E-06
BH21-10 / S7	4.6 - 5.2	Silty Clay to Clayey Silt	Yes	0.0009	8.1E-09
BH21-11 / S6	3.8 - 4.4	Silt	no	0.0080	6.4E-07
BH21-11 / S9A	7.6 - 8.2	Sand	no	0.0570	3.2E-05
BH21-13 / S8	6.1 - 6.78	Sandy Silt, some clay	no	0.0026	6.8E-08
			Geometric Mean in Silty Sand and Sand		9.4E-06
			Geometric Mean in Silt, Sandy Silty, Clay, and Till		7.7E-08



Percolation Rate (T-Time min/cm) = 0.3228 x $K^{-0.267}$

BH/SA ID	depth (mbgs)	Soil Description for Borehole Logs	Hazen	T-Time	Infiltration Rate	Design Infiltration Rate
			(m/sec)	min/cm	mm/hr	mm/hr
BH21-1 / S6	3.8 - 4.4	Silty Sand, some gravel	4.9E-07	15.6	38.4	15.4
BH21-2 / S4B	2.3 - 2.9	Silty Sand, some Gravel, trace till	1.0E-06	12.9	46.5	18.6
BH21-3 / S4	2.3 - 2.9	Sandy Silt, some clay	3.2E-08	32.3	18.6	7.4
BH21-3 / S8	6.1-6.7	Sandy Silt, some clay	6.4E-07	14.5	41.3	16.5
BH21-5 / S6	3.8 - 4.4	Silty Sand to Sand, trace clay	1.5E-05	6.2	96.1	38.5
BH21-6 / S5	3.1 - 3.7	Sandy Silt (TILL), some sand	2.9E-08	33.3	18.0	7.2
BH21-7 / S6A	3.8 - 4.4	Sand, some gravel to Silty Sand	4.9E-05	4.6	131.4	52.5
BH21-8 / S5A	3.1 - 3.7	Sand and Gravel, some silt	8.1E-05	4.0	150.2	60.1
BH21-9 / S5	3.1 - 3.7	Silt, some sand	6.4E-05	4.3	141.1	56.4
BH21-10 / S3	1.5 - 2.1	Silty Sand, trace clay	1.0E-06	12.9	46.5	18.6
BH21-10 / S7	4.6 - 5.2	Silty Clay to Clayey Silt	8.1E-09	46.7	12.8	5.1
BH21-11 / S6	3.8 - 4.4	Silt	6.4E-07	14.5	41.3	16.5
BH21-11 / S9A	7.6 - 8.2	Sand	3.2E-05	5.1	117.7	47.1
BH21-13 / S8	6.1 - 6.78	Sandy Silt, some clay	6.8E-08	26.5	22.6	9.1

Average Infiltration Rate---> **65.9**
Average Design Infiltration Rate---> **26.4**

APPENDIX

E WATER LEVEL MONITORING

Table 4 - Monitoring Well Static Water Levels

Monitoring Wells - Water Level Monitoring (Delhi Golf Course)

Well ID	Location[1]		Ground Elevation [2]	Top Elevation [3]	Stick-up	Screen Bottom	Screen Bottom	Screen Top	Screen Length	Installation Date	Water Level			Water Level			Water Level			Water Level			Water Level		
											14-Dec-21			22-Dec-21			14-Jan-22			2-May-22			7-Oct-22		
	Easting	Northing																							
	m	*m*	*masl*	*masl*	*mag*	*mbtop*	*mbg*	*mbg*	*m*		*mbtop*	*mbg*	*masl*	*mbtop*	*mbg*	*masl*	*mbtop*	*mbg*	*masl*	*mbtop*	*mbg*	*masl*	*mbtop*	*mbg*	*masl*
BH21-02	542139.04	4743312.99	238.78	238.68	-0.10	6.00	6.10	4.60	1.5	16-Dec-21	ND			4.82	4.92	233.86	4.78	4.88	233.90	4.71	4.81	233.97	5.60	5.70	233.08
BH21-03	542136.97	4743136.09	237.31	237.11	-0.20	5.80	6.00	4.50	1.5	15-Dec-21	ND			2.93	3.13	234.18	3.15	3.35	233.96	3.30	3.50	233.81	4.11	4.31	233.00
BH21-05	542349.29	4742921.12	239.92	239.77	-0.15	5.85	6.00	4.50	1.5	3-Dec-21	Dry			Dry			Dry			5.85	6.00	233.92	5.86	6.01	233.92
BH21-07	542338.33	4742552.19	231.55	231.41	-0.14	6.56	6.70	4.70	2.0	1-Dec-21	0.71	0.85	230.70	1.19	1.33	230.22	1.18	1.32	230.23	1.00	1.14	230.42	2.49	2.63	228.92
BH21-08	542590.19	4742578.17	232.77	232.52	-0.25	5.85	6.10	4.60	1.5	3-Dec-21	0.34	0.59	232.18	0.44	0.69	232.08	0.35	0.60	232.18	0.56	0.81	231.96	2.11	2.36	230.41
BH21-09	542539.11	4742424.81	229.82	229.66	-0.16	5.94	6.10	4.60	1.5	2-Dec-21	0.97	1.13	228.69	0.99	1.15	228.67	0.97	1.13	228.69	0.83	0.99	228.83	2.02	2.18	227.64
BH21-10	542147.79	4742381.52	227.72	227.55	-0.17	8.93	9.10	7.60	1.5	21-Dec-21	Flowing	0.17	227.55	Flowing	0.17	227.55	Flowing	0.17	227.55	Flowing	0.17	227.55	Flowing	0.17	227.55
BH21-11-D (A)	542406.70	4742390.79	228.72	228.61	-0.11	8.99	9.10	7.60	1.5	2-Dec-21	0.24	0.35	228.38	0.29	0.40	228.32	0.36	0.47	228.25	0.09	0.20	228.52	0.95	1.06	227.66
BH21-11-S (B)	542406.70	4742390.79	228.72	228.54	-0.18	4.22	4.40	2.90	1.5	2-Dec-21	0.36	0.54	228.19	0.58	0.76	227.97	0.69	0.87	227.85	0.35	0.53	228.19	1.79	1.97	226.75
BH21-12	542345.65	4743293.71	236.73	236.59	-0.14	5.96	6.10	4.60	1.5	16-Dec-21	ND			2.09	2.23	234.50	2.14	2.28	234.45	2.08	2.22	234.51	2.98	3.12	233.61

[1] - Coordinates in UTM NAD 83 surveyed at the time of installation
[2] - Ground Surface and X-Y Coordinates survey by RPE Surveying Ltd on May 2, 2022
[3] - Surveying of Top of Casing was not completed, therefore Top Elevation is determined by manual measurement of Stick-Up
All water level measurements normalized to measured stick-up taken in May 2022
mbg - metres below grade
mag - metres above grade. Ngative values represent flush-mount wells completed below grade
mbtop - metres below top of pipe
NM - No measurement taken
NA - Measurement Not Available
ND - Well is not drilled yet
Denotes that the water level is above ground surface
Denotes Water Level is within 0.3 m (1 ft) from surface

Table 5 (MP Water Levels) and Table 6 (Staff Gauge Water Levels)

Mini-Piezometer Stations - Water Level Monitoring (Delhi Golf Course)

Well ID	Location[1]		Ground Elevation [2]	Top Elevation [3]	Total length	Stick-up	Screen Bottom	Screen Top	Screen Length	Installation Date	14-Dec-21		22-Dec-21		14-Jan-22		2-May-22		7-Oct-22	
	Easting	Northing									Water Level		Water Level		Water Level		Water Level		Water Level	
	m	*m*	*masl*	*masl*	*m*	*mag*	*mbtop*	*mbtop*	*m*		*mbtop*	*masl*	*mbtop*	*masl*	*mbtop*	*masl*	*mbtop*	*masl*	*mbtop*	*masl*
Mini-Piezometers																				
MP1 (southern)	542632	4742289	227.53	228.42	1.88	0.89	1.88	1.66	0.22	14-Dec-21	1.59	226.83	0.81	227.61	Frozen		0.69	227.73	1.41	227.01
MP2 (northern)	542269	4742863	234.77	235.76	1.88	0.99	1.88	1.66	0.22	14-Dec-21	1.37	234.39	0.71	235.05	Frozen		0.70	235.06	1.09	234.66

[1] - Coordinates in UTM NAD 83 surveyed at the time of installation
[2] - Ground Surface Elevations surveyed by RPE Surveyors on May 2, 2022
[3] - Top Elevations were not surveyed and have been estimated based upon manual stick-up measurements.
mbg - metres below grade
mag - metres above grade
mbtop - metres below top of pipe
NM - no measurement taken
Denotes that the water level is above ground surface
Denotes Water Level is within 0.3 m (1 ft) from surface

Table 6 - Staff Guage Levels

Surface Water Stations - Water Level Monitoring (Delhi Golf Course)

Well ID	Location[1]		Ground Elevation [2]	Top Elevation [3]	Total length [4]	Installation Date	Staff Gauge		Staff Gauge		Staff Gauge		Staff Gauge		Staff Gauge	
	Easting	Northing					14-Dec-21		22-Dec-21		14-Jan-22		2-May-22		7-Oct-22	
	m	*m*	*masl*	*masl*	*m*		*mag*	*masl*	*mag*	*masl*	*mag*	*masl*	*mag*	*masl*	*mag*	*masl*
SW Monitoring Stations																
SW1 (southern)	542632	4742289	227.54	228.54	1.00	14-Dec-21	0.14	227.68	0.10	227.64	0.13	227.67	0.26	227.80	Dry	-
SW2 (northern)	614692	4902161	234.77	235.77	1.00	14-Dec-21	0.22	234.99	0.20	234.97	0.20	234.97	0.26	235.03	Dry	-

[1] - Coordinates in UTM NAD 83 surveyed at the time of installation
[2] - Ground Surface Elevations surveyed by RPE Surveyors on May 2, 2022
[3] - Top of the Staff Gauge was not surveyed. Top elevations are assumed to be one metre above Ground Elevation. Staff guages 1 m with the 0 cm measurement placed on the ground surface.
[4] - Total Length of Staff Guages have been assumed to be the length of the 1 m stick
Surface water elevations are calculated based on Staff Gauge measurements added to Ground Elevations
mbg - metres below grade
mag - metres above grade (Staff Guage Measurement)
mbtop - metres below top of pipe

Table 7: Vertical Gradient Calculations

Monitoring Wells

Monitoring Well ID	Ground Elevation	Stick-Up	Top of Pipe Elevation	Screen Bottom	Screen Top	Screen Length	Screen Midpoint	Screen Midpoint Elev	Water Level		V.Grad	Water Level		V.Grad	Water Level		V.Grad	Water Level		V.Grad	Water Level		V.Grad
									14-Dec-21			22-Dec-21			14-Jan-22			2-May-22			7-Oct-22		
	masl	*mag*	*masl*	*mbg*	*mbg*	*m*	*mbgs*	*mbgs*	*mbtop*	*masl*	*m/m*	*mbtop*	*masl*	*m/m*	*mbtop*	*masl*	*m/m*	*mbtop*	*masl*	*m/m*	*mbtop*	*masl*	*m/m*
WSP Monitoring Wells																							
BH21-11-S (B)	228.72	-0.18	228.54	4.40	2.90	1.50	3.65	225.07	0.36	228.19	-0.040	0.58	227.97	-0.076	0.69	227.85	-0.085	0.35	228.19	-0.070	1.79	226.75	-0.194
BH21-11-D (A)	228.72	-0.11	228.61	9.10	7.60	1.50	8.35	220.37	0.24	228.38		0.29	228.32		0.36	228.25		0.09	228.52		0.95	227.66	

Mini-Piezometer Stations

MP ID	Ground Elevation*	Stick-Up	Top of Pipe Elevation	Screen Bottom	Screen Top	Screen Length	Screen Bottom	Screen Top	14-Dec-21**			22-Dec-21			14-Jan-22			2-May-22			7-Oct-22		
									SWL inside MP	SWL in Watercourse	V.Grad	SWL inside MP	SWL in Watercourse	V.Grad	SWL inside MP	SWL in Watercourse	V.Grad	SWL inside MP	SWL in Watercourse	V.Grad	SWL inside MP	SWL in Watercourse	V.Grad
	masl	*mag*	*masl*	*mbtop*	*mbtop*	*m*	*mbg*	*mbg*	*mbtop*	*mbtop*	*m/m*	*mbtop*	*mbtop*	*m/m*	*mbtop*	*mbtop*	*m/m*	*mbtop*	*mbtop*	*m/m*	*mbtop*	*mbtop*	*m/m*
MP1 / SG1	227.5	0.9	228.4	1.9	1.7	0.2	1.0	0.8	1.59	0.87	0.41	0.81	0.90	-0.05	Frozen	-	-	0.69	0.75	-0.03	1.41	DRY	-
MP2 / SG2	234.8	1.0	235.8	1.9	1.7	0.2	0.9	0.7	1.37	0.79	0.33	0.71	0.80	-0.05	Frozen	-	-	0.70	0.75	-0.02	1.09	DRY	-

* Ground Elevation at MP stations are based on survey data by RPE collected on May 2, 2022
** SWL measurements taken in MP1 and MP2 on December 14, 2021 are not interpreted to be static. WL has not equilibrated and therefore gradients are not considered reliable
mbg - metres below grade
mag - metres above grade
masl - metres above sea level
mbtop - metres below top of pipe
Mini-Piezometer Gradients: Positive value = downward gradient (recharge), negative value = upward gradient (discharge)
Downward Gradient
Upward Gradient

APPENDIX

F WATER BALANCE

Table WB-1: Pre and Post Development Water Balance (mm Equivalents)

Weather Station Data: Delhi CDA, ON (1981-2010)

Latitude:	**42**	**degrees**	**52.0**	**minutes**	**N**
Longitude:	**80**	**degrees**	**33.0**	**minutes**	**W**

Data Provided by Environment Canada - Atmospheric Environment Services - data may exhibit round off error

PARAMETER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Wooded Areas (Pre- and Post-Development)													
Medium Loam Soils - Water Holding Capacity (WHC) 350 mm													
Average Temperature (C)	-5	-5	0	7	13	19	21	20	16	9	4	-2	**8.0**
Precipitation (P) (mm)	70	63	69	87	89	89	97	84	99	88	111	92	**1036**
Potential Evapotranspiration (PET) (mm)	0	0	0	34	76	115	130	114	78	39	12	0	**598**
Actual Evapotranspiration (AET) (mm)	0	0	0	34	76	115	127	108	78	39	12	0	**588**
Deficit (mm)	0	0	0	0	0	0	3	6	0	0	0	0	**10**
Surplus - available for infiltration/runoff (mm)	70	63	69	52	13	0	0	0	0	0	89	92	**448**
Soil Moisture (mm)	350	350	350	350	350	324	294	270	292	340	350	350	
Change in Soil Moisture Storage (mm)	0	0	0	0	0	-26	-30	-24	22	49	10	0	
Data for Use with Water Balance													
Precipitation (P) (mm)	70	63	69	87	89	89	97	84	99	88	111	92	**1,036**
Actual Evapotranspiration (AET) (mm)	0	0	0	34	76	115	127	108	78	39	12	0	**588**
Surplus - available for infiltration/runoff (mm)	70	63	69	52	13	0	0	0	0	0	89	92	**448**
Wetland and Shrubby Areas (Pre-and Post-Development)													
Medium Loam Soil - Water Holding Capacity (WHC) 200 mm													
Average Temperature (C)	-5.4	-4.7	0	6.9	13.2	18.5	21.1	20	15.5	9.4	3.5	-2.2	**8.0**
Precipitation (P) (mm)	70	63	69	87	89	89	97	83.6	99.2	88.3	110.5	91.6	**1036**
Potential Evapotranspiration (PET) (mm)	0	0	0	34	76	115	130	114	78	39	12	0	**598**
Actual Evapotranspiration (AET) (mm)	0	0	0	34	76	114	124	105	78	39	12	0	**581**
Deficit (mm)	0	0	0	0	0	1	6	9	0	0	0	0	**17**
Surplus - available for infiltration/runoff (mm)	70	63	69	52	13	0	0	0	0	0	96	92	**455**
Soil Moisture (mm)	200	200	200	200	200	175	148	127	149	197	200	200	
Change in Soil Moisture Storage (mm)	0	0	0	0	0	-25	-27	-21	22	49	3	0	
Data for Use with Water Balance													
Precipitation (P) (mm)	70	63	69	87	89	89	97	84	99	88	111	92	**1,036**
Actual Evapotranspiration (AET) (mm)	0	0	0	34	76	114	124	105	78	39	12	0	**581**
Surplus - available for infiltration/runoff (mm)	70	63	69	52	13	0	0	0	0	0	96	92	**455**
Urban Lawns (Pre- and Post-Development)													
Medium Loam Soil - Water Holding Capacity (WHC) 100 mm													
Average Temperature (C)	-5.4	-4.7	0	6.9	13.2	18.5	21.1	20	15.5	9.4	3.5	-2.2	**8.0**
Precipitation (P) (mm)	69.7	62.7	69.3	86.6	88.9	88.8	96.6	83.6	99.2	88.3	110.5	91.6	**1036**
Potential Evapotranspiration (PET) (mm)	0	0	0	34	76	115	130	114	78	39	12	0	**598**
Actual Evapotranspiration (AET) (mm)	0	0	0	34	76	112	120	98	78	39	12	0	**568**
Deficit (mm)	0	0	0	0	0	3	10	16	0	0	0	0	**30**
Surplus - available for infiltration/runoff (mm)	70	63	69	52	13	0	0	0	0	10	99	92	**468**
Soil Moisture (mm)	100	100	100	100	100	77	54	40	62	100	100	100	
Change in Soil Moisture Storage (mm)	0	0	0	0	0	-23	-23	-14	22	38	0	0	
Data for Use with Water Balance													
Precipitation (P) (mm)	70	63	69	87	89	89	97	84	99	88	111	92	**1,036**
Actual Evapotranspiration (AET) (mm)	0	0	0	34	76	112	120	98	78	39	12	0	**568**
Surplus - available for infiltration/runoff (mm)	70	63	69	52	13	0	0	0	0	10	99	92	**468**

Notes:

1. Monthly climate data, including precipitation, temperature were provided by Environment Canada for the Delhi CDA Climate Station
2. The Water Budget is adjusted for latitude and daylight savings
3. Infiltration and Runoff volumes are calculated using the methodology described in the MOE Stormwater Design Manual (2003).
4. Total Water Surplus is calculated as total precipitation minus adjusted potential evapotranspiration (Thornthwaite, 1948)
5. Total Moisture Surplus (Thornthwaite and Mather, 157) is calculated as total precipitation minus actual evapotranspiration.
6. Evaporative losses of 10% are modeled for impervious surfaces. This accounts for losses of water, such as water that collects in shallow depressions on these surfaces and does not reach the stormwater system.
7. There is minor round-off error within the Environment Canada data

Table WB-2: Pre-Development Water Balance - Geranium Delhi
Weather Station Data: Delhi, ON (1981-2010) Climate Station 6131982

Latitude:	**42**	**degrees**	**52.0**	**minutes**	**N**
Longitude:	**80**	**degrees**	**33.0**	**minutes**	**W**

Data Provided by Environment Canada - Atmospheric Environment Services - data may exhibit round off error

PARAMETER		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Wetlands - Pervious	*10.74 ha*	**WHC = 200 mm**												
Precipitation (m^3)		7,484	6,732	7,441	9,298	9,545	9,534	10,372	8,976	10,651	9,481	11,864	9,835	**111,213**
Total AET (m^3)		0	0	2	3,666	8,178	12,219	13,271	11,231	8,331	4,236	1,267	0	**62,399**
Water Surplus (m^3)		7,484	6,732	7,438	5,632	1,367	0	0	0	0	0	10,325	9,835	**48,814**
Infiltration (MOE Methodology) (m^3)	**i = 0.55**	4,106	3,694	4,081	3,090	750	0	0	0	0	0	5,665	5,396	**26,783**
Runoff (MOE Methodology) (m^3)		3,378	3,038	3,357	2,542	617	0	0	0	0	0	4,660	4,439	**22,031**
Open Water Ponds - Impervious	*0.41 ha*													
Precipitation (m^3)		288	259	287	358	368	368	400	346	411	365	457	379	**4,287**
Evaporative Losses at 10% Precipitation (m^3)		29	26	29	36	37	37	40	35	41	37	46	38	**429**
Water Surplus (m^3) - considered as standing water		260	234	258	323	331	331	360	311	369	329	412	341	**3,858**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		260	234	258	323	331	331	360	311	369	329	412	341	**3,858**
Urban Lawns and Golfing Areas - Pervious	*32.83 ha*	**WHC = 100 mm**												
Precipitation (m^3)		22,881	20,583	22,749	28,428	29,184	29,151	31,711	27,444	32,565	28,987	36,274	30,070	**340,026**
Total AET (m^3)		0	0	7	11,208	25,003	36,701	39,262	32,040	25,470	12,950	3,874	0	**186,514**
Water Surplus (m^3)		22,881	20,583	22,742	17,221	4,181	0	0	0	0	3,434	32,400	30,070	**153,512**
Infiltration (MOE Methodology) (m^3)	**i = 0.40**	9,126	8,210	9,071	6,869	1,668	0	0	0	0	1,370	12,923	11,994	**61,229**
Runoff (MOE Methodology) (m^3)		13,755	12,373	13,671	10,352	2,513	0	0	0	0	2,065	19,477	18,076	**92,283**
Forested Areas - Pervious	*10.21 ha*	**WHC = 350 mm**												
Precipitation (m^3)		7,116	6,402	7,076	8,842	9,077	9,066	9,863	8,536	10,128	9,015	11,282	9,352	**105,755**
Total AET (m^3)		0	0	2	3,486	7,776	11,721	12,926	10,986	7,922	4,028	1,205	0	**60,052**
Water Surplus (m^3)		7,116	6,402	7,073	5,356	1,300	0	0	0	0	0	9,103	9,352	**45,703**
Infiltration (MOE Methodology) (m^3)	**i = 0.55**	3,906	3,514	3,882	2,940	714	0	0	0	0	0	4,996	5,133	**25,084**
Runoff (MOE Methodology) (m^3)		3,211	2,888	3,191	2,416	587	0	0	0	0	0	4,107	4,219	**20,619**
Existing Building and Paved Areas - Impervious	*1.13 ha*													
Precipitation (m^3)		787	708	782	978	1,003	1,002	1,090	944	1,120	997	1,247	1,034	**11,692**
Evaporative Losses at 10% Precipitation (m^3)		79	71	78	98	100	100	109	94	112	100	125	103	**1,169**
Water Surplus (m^3) - considered as standing water		708	637	704	880	903	902	981	849	1,008	897	1,123	931	**10,523**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		708	637	704	880	903	902	981	849	1,008	897	1,123	931	**10,523**
Summary Total	**55.32 ha**													
Precipitation (m^3)		38,556	34,684	38,335	47,904	49,177	49,121	53,436	46,245	54,874	48,845	61,125	50,670	**572,972**
Evaporative Lossess at 10% Precipitation (m^3)		108	97	107	134	137	137	149	129	153	136	170	141	**1,598**
Total AET (m^3)		0	0	12	18,360	40,957	60,641	65,458	54,256	41,722	21,214	6,346	0	**308,965**
Water Surplus (m^3)		38,448	34,587	38,216	29,411	8,083	1,233	1,341	1,161	1,377	4,660	53,363	50,529	**262,409**
Infiltration (MOE Methodology) (m^3)		17,138	15,417	17,034	12,898	3,132	0	0	0	0	1,370	23,584	22,523	**113,096**
Runoff (MOE Methodology) (m^3)		21,310	19,170	21,182	16,513	4,951	1,233	1,341	1,161	1,377	3,290	29,778	28,006	**149,313**

Notes:

1. Monthly climate data, including precipitation, temperature were provided by Environment Canada for the Delhi Climate Station
2. The Water Budget is adjusted for latitude and daylight savings
3. Infiltration and Runoff volumes are calculated using the methodology described in the MOE Stormwater Design Manual (2003).
4. Total Water Surplus is calculated as total precipitation minus adjusted potential evapotranspiration (Thornthwaite, 1948)
5. Total Moisture Surplus (Thornthwaite and Mather) is calculated as total precipitation minus actual evapotranspiration.
6. Evaporative losses of 10% are modeled for impervious surfaces. This accounts for losses of water, such as water that collects in shallow depressions on these surfaces and does not reach the stormwater system.
7. There is minor round-off error within the Environment Canada data

Table WB-3: Post-Development Water Balance without Mitigation Measures - Geranium Delhi
Weather Station Data: Delhi, ON (1981-2010) Climate Station 6131982

Latitude:	**42**	**degrees**	**52.0**	**minutes**	**N**
Longitude:	**80**	**degrees**	**33.0**	**minutes**	**W**

Data Provided by Environment Canada - Atmospheric Environment Services - data may exhibit round off error

PARAMETER		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Wetlands - Pervious	*10.54 ha*	**WHC = 200 mm**			**0% Imperviousness**									
Precipitation (m^3)		7,344	6,607	7,302	9,125	9,367	9,357	10,179	8,809	10,453	9,304	11,643	9,652	**109,143**
Total AET (m^3)		0	0	2	3,598	8,025	11,991	13,024	11,022	8,176	4,157	1,243	0	**61,238**
Water Surplus (m^3)		7,344	6,607	7,300	5,528	1,342	0	0	0	0	0	10,133	9,652	**47,905**
Infiltration (MOE Methodology) (m^3)	**i = 0.55**	4,030	3,625	4,005	3,033	736	0	0	0	0	0	5,559	5,296	**26,284**
Runoff (MOE Methodology) (m^3)		3,315	2,982	3,295	2,495	606	0	0	0	0	0	4,573	4,356	**21,621**
Open Water Ponds - Impervious	*0.24 ha*													
Precipitation (m^3)		171	154	170	212	218	217	236	205	243	216	271	224	**2,536**
Evaporative Losses at 10% Precipitation (m^3)		17	15	17	21	22	22	24	20	24	22	27	22	**254**
Water Surplus (m^3) - considered as standing water		154	138	153	191	196	196	213	184	219	195	243	202	**2,282**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		154	138	153	191	196	196	213	184	219	195	243	202	**2,282**
Open-Spaced Parkland and Amenity Areas	*9.73 ha*	**WHC = 100 mm**			**0% Imperviousness**									
Precipitation (m^3)		6,783	6,102	6,744	8,427	8,651	8,641	9,400	8,135	9,653	8,593	10,753	8,914	**100,797**
Total AET (m^3)		0	0	2	3,322	7,412	10,880	11,639	9,498	7,550	3,839	1,148	0	**55,290**
Water Surplus (m^3)		6,783	6,102	6,742	5,105	1,239	0	0	0	0	1,018	9,605	8,914	**45,507**
Infiltration (MOE Methodology) (m^3)	**i = 0.41**	2,766	2,488	2,749	2,082	505	0	0	0	0	415	3,916	3,635	**18,556**
Runoff (MOE Methodology) (m^3)		4,017	3,614	3,993	3,023	734	0	0	0	0	603	5,688	5,279	**26,951**
Forested Areas - Pervious	*5.26 ha*	**WHC = 100 mm**			**0% Imperviousness**									
Precipitation (m^3)		3,665	3,297	3,644	4,554	4,675	4,670	5,080	4,396	5,217	4,644	5,811	4,817	**54,471**
Total AET (m^3)		0	0	1	1,795	4,005	6,037	6,658	5,659	4,080	2,075	621	0	**30,931**
Water Surplus (m^3)		3,665	3,297	3,643	2,759	670	0	0	0	0	0	4,689	4,817	**23,540**
Infiltration (MOE Methodology) (m^3)	**i = 0.55**	2,012	1,810	2,000	1,514	368	0	0	0	0	0	2,574	2,644	**12,920**
Runoff (MOE Methodology) (m^3)		1,654	1,488	1,644	1,245	302	0	0	0	0	0	2,115	2,173	**10,620**
SWMP Block					**41% Imperviousness**									
Impervious Area - Access Roads, Permanent Pool	*0.92 ha*													
Precipitation (m^3)		642	578	639	798	819	818	890	770	914	814	1,018	844	**9,545**
Evaporative Loss at 10% Precipitation (m^3)		64	58	64	80	82	82	89	77	91	81	102	84	**954**
Water Surplus (m^3)		578	520	575	718	737	736	801	693	823	732	916	760	**8,590**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		578	520	575	718	737	736	801	693	823	732	916	760	**8,590**
Pervious Area - Landscaped Areas	*1.35 ha*	**WHC = 100 mm**												
Precipitation (m^3)		942	847	936	1,170	1,201	1,200	1,305	1,129	1,340	1,193	1,493	1,237	**13,992**
Total AET (m^3)		0	0	0	461	1,029	1,510	1,616	1,318	1,048	533	159	0	**7,675**
Water Surplus (m^3)		942	847	936	709	172	0	0	0	0	141	1,333	1,237	**6,317**
Infiltration (MOE Methodology) (m^3)	**i = 0.41**	384	345	382	289	70	0	0	0	0	58	544	505	**2,576**
Runoff (MOE Methodology) (m^3)		558	502	554	420	102	0	0	0	0	84	790	733	**3,741**
Retirement Home					**49% Imperviousness**									
Impervious Area - Building, Parking, Patios	*0.60 ha*													
Precipitation (m^3)		415	374	413	516	530	529	576	498	591	526	658	546	**6,172**
Evaporative Loss at 10% Precipitation (m^3)		42	37	41	52	53	53	58	50	59	53	66	55	**617**
Water Surplus (m^3)		374	336	372	464	477	476	518	448	532	474	593	491	**5,555**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		374	336	372	464	477	476	518	448	532	474	593	491	**5,555**
Pervious Area - Landscaped Areas	*0.62 ha*	**WHC = 100 mm**												
Precipitation (m^3)		432	389	430	537	551	551	599	518	615	548	685	568	**6,424**
Total AET (m^3)		0	0	0	212	472	693	742	605	481	245	73	0	**3,524**
Water Surplus (m^3)		432	389	430	325	79	0	0	0	0	65	612	568	**2,900**
Infiltration (MOE Methodology) (m^3)	**i = 0.41**	176	159	175	133	32	0	0	0	0	26	250	232	**1,183**
Runoff (MOE Methodology) (m^3)		256	230	254	193	47	0	0	0	0	38	363	336	**1,718**
Community Commons Area					**20% Imperviousness**									
Impervious Area - Buildings, Parking, Paved Areas	*0.35 ha*													
Precipitation (m^3)		241	216	239	299	307	307	334	289	342	305	381	316	**3,576**
Evaporative Loss at 10% Precipitation (m^3)		24	22	24	30	31	31	33	29	34	30	38	32	**358**
Water Surplus (m^3)		217	195	215	269	276	276	300	260	308	274	343	285	**3,218**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		217	195	215	269	276	276	300	260	308	274	343	285	**3,218**
Pervious Area - Landscaped Areas	*1.38 ha*	**WHC = 100 mm**												
Precipitation (m^3)		963	866	957	1,196	1,228	1,226	1,334	1,155	1,370	1,219	1,526	1,265	**14,304**
Total AET (m^3)		0	0	0	471	1,052	1,544	1,652	1,348	1,071	545	163	0	**7,846**
Water Surplus (m^3)		963	866	957	724	176	0	0	0	0	144	1,363	1,265	**6,458**
Infiltration (MOE Methodology) (m^3)	**i = 0.41**	392	353	390	295	72	0	0	0	0	59	556	516	**2,633**
Runoff (MOE Methodology) (m^3)		570	513	567	429	104	0	0	0	0	86	807	749	**3,825**
Road Allowance					**80% Imperviousness**									
Impervious Area - Roads, Sidewalks	*6.13 ha*													
Precipitation (m^3)		4,269	3,840	4,245	5,304	5,445	5,439	5,917	5,121	6,076	5,408	6,768	5,611	**63,444**
Evaporative Loss at 10% Precipitation (m^3)		427	384	424	530	545	544	592	512	608	541	677	561	**6,344**
Water Surplus (m^3)		3,842	3,456	3,820	4,774	4,901	4,895	5,325	4,609	5,468	4,868	6,091	5,050	**57,099**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		3,842	3,456	3,820	4,774	4,901	4,895	5,325	4,609	5,468	4,868	6,091	5,050	**57,099**
Pervious Area - Landscaped Areas	*1.53 ha*	**WHC = 100 mm**												
Precipitation (m^3)		1,067	960	1,061	1,326	1,361	1,360	1,479	1,280	1,519	1,352	1,692	1,403	**15,861**
Total AET (m^3)		0	0	0	523	1,166	1,712	1,831	1,495	1,188	604	181	0	**8,700**
Water Surplus (m^3)		1,067	960	1,061	803	195	0	0	0	0	160	1,511	1,403	**7,161**
Infiltration (MOE Methodology) (m^3)	**i = 0.41**	435	391	433	328	80	0	0	0	0	65	616	572	**2,920**
Runoff (MOE Methodology) (m^3)		632	569	628	476	116	0	0	0	0	95	895	831	**4,241**
Residential - Townhouse Properties					**79% Imperviousness**									
Impervious Area - Buildings, Roof, Driveways, Patios	*1.16 ha*													
Precipitation (m^3)		808	727	804	1,004	1,031	1,030	1,120	970	1,150	1,024	1,282	1,062	**12,013**
Evaporative Loss at 10% Precipitation (m^3)		81	73	80	100	103	103	112	97	115	102	128	106	**1,201**
Water Surplus (m^3)		728	654	723	904	928	927	1,008	873	1,035	922	1,153	956	**10,812**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		728	654	723	904	928	927	1,008	873	1,035	922	1,153	956	**10,812**
Pervious Area - Landscaped Areas	*0.31 ha*	**WHC = 100 mm**												
Precipitation (m^3)		215	193	214	267	274	274	298	258	306	272	341	282	**3,193**
Total AET (m^3)		0	0	0	105	235	345	369	301	239	122	36	0	**1,752**
Water Surplus (m^3)		215	193	214	162	39	0	0	0	0	32	304	282	**1,442**
Infiltration (MOE Methodology) (m^3)	**i = 0.41**	88	79	87	66	16	0	0	0	0	13	124	115	**588**
Runoff (MOE Methodology) (m^3)		127	114	126	96	23	0	0	0	0	19	180	167	**854**
Residential - Single Detached Properties (25' and 36' Lots)					**57% Imperviousness**									
Impervious Area - Buildings, Roof, Driveways, Patios	*4.90 ha*													
Precipitation (m^3)		3,415	3,072	3,396	4,243	4,356	4,351	4,733	4,096	4,861	4,327	5,415	4,488	**50,755**
Evaporative Loss at 10% Precipitation (m^3)		342	307	340	424	436	435	473	410	486	433	541	449	**5,076**
Water Surplus (m^3)		3,074	2,765	3,056	3,819	3,921	3,916	4,260	3,687	4,375	3,894	4,873	4,040	**45,680**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		3,074	2,765	3,056	3,819	3,921	3,916	4,260	3,687	4,375	3,894	4,873	4,040	**45,680**
Pervious Area - Landscaped Areas	*3.70 ha*	**WHC = 100 mm**												
Precipitation (m^3)		2,577	2,318	2,562	3,201	3,286	3,283	3,571	3,090	3,667	3,264	4,085	3,386	**38,289**
Total AET (m^3)		0	0	1	1,262	2,815	4,133	4,421	3,608	2,868	1,458	436	0	**21,003**
Water Surplus (m^3)		2,577	2,318	2,561	1,939	471	0	0	0	0	387	3,648	3,386	**17,286**
Infiltration (MOE Methodology) (m^3)	**i = 0.41**	1,051	945	1,044	791	192	0	0	0	0	158	1,488	1,381	**7,049**
Runoff (MOE Methodology) (m^3)		1,526	1,373	1,517	1,148	279	0	0	0	0	229	2,161	2,005	**10,238**
Residential - Single Detached Properties (44' and 60' Lots)					**36% Imperviousness**									
Impervious Area - Buildings, Roof, Driveways, Patios	*2.26 ha*													
Precipitation (m^3)		1,577	1,418	1,567	1,959	2,011	2,009	2,185	1,891	2,244	1,997	2,499	2,072	**23,428**
Evaporative Loss at 10% Precipitation (m^3)		158	142	157	196	201	201	218	189	224	200	250	207	**2,343**
Water Surplus (m^3)		1,419	1,276	1,411	1,763	1,810	1,808	1,966	1,702	2,019	1,798	2,249	1,865	**21,086**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		1,419	1,276	1,411	1,763	1,810	1,808	1,966	1,702	2,019	1,798	2,249	1,865	**21,086**
Pervious Area - Landscaped Areas	*4.02 ha*	**WHC = 100 mm**												
Precipitation (m^3)		2,803	2,521	2,787	3,482	3,575	3,571	3,884	3,362	3,989	3,551	4,443	3,683	**41,651**
Total AET (m^3)		0	0	1	1,373	3,063	4,496	4,809	3,925	3,120	1,586	475	0	**22,847**
Water Surplus (m^3)		2,803	2,521	2,786	2,109	512	0	0	0	0	421	3,969	3,683	**18,804**
Infiltration (MOE Methodology) (m^3)	**i = 0.41**	1,143	1,028	1,136	860	209	0	0	0	0	172	1,618	1,502	**7,667**
Runoff (MOE Methodology) (m^3)		1,660	1,493	1,650	1,249	303	0	0	0	0	249	2,351	2,181	**11,137**

Table WB-3: Post-Development Water Balance without Mitigation Measures - Geranium Delhi
Weather Station Data: Delhi, ON (1981-2010) Climate Station 6131982

Latitude:	**42**	**degrees**	**52.0**	**minutes**	**N**
Longitude:	**80**	**degrees**	**33.0**	**minutes**	**W**

Data Provided by Environment Canada - Atmospheric Environment Services - data may exhibit round off error

PARAMETER		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Trails and Pathways					**100% Imperviousness**									
Impervious Area - Pavel Paths, Sidewalks around Townhouse	*0.27 ha*													
Precipitation (m^3)		187	168	186	233	239	239	259	225	266	237	297	246	**2,782**
Evaporative Loss at 10% Precipitation (m^3)		19	17	19	23	24	24	26	22	27	24	30	25	**278**
Water Surplus (m^3)		169	152	168	209	215	215	234	202	240	213	267	221	**2,504**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		169	152	168	209	215	215	234	202	240	213	267	221	**2,504**
Pumphouse Area					**100% Imperviousness**									
Considered as Impervious	*0.06 ha*													
Precipitation (m^3)		40	36	40	50	51	51	55	48	57	51	63	53	**595**
Evaporative Loss at 10% Precipitation (m^3)		4	4	4	5	5	5	6	5	6	5	6	5	**59**
Water Surplus (m^3)		36	32	36	45	46	46	50	43	51	46	57	47	**535**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		36	32	36	45	46	46	50	43	51	46	57	47	**535**
Summary Total	**55.32 ha**													
Precipitation (m^3)		38,556	34,684	38,335	47,904	49,177	49,121	53,436	46,245	54,874	48,845	61,125	50,670	**572,972**
Evaporative Lossess at 10% Precipitation (m^3)		1,177	1,058	1,170	1,462	1,501	1,499	1,631	1,411	1,675	1,491	1,865	1,546	**17,485**
Total AET (m^3)		0	0	8	13,123	29,275	43,341	46,760	38,778	29,822	15,163	4,536	0	**220,805**
Water Surplus (m^3)		37,379	33,625	37,156	33,320	18,401	13,491	14,676	12,701	15,071	15,783	53,955	49,124	**334,682**
Infiltration (MOE Methodology) (m^3)		12,476	11,223	12,400	9,390	2,280	0	0	0	0	966	17,245	16,396	**82,375**
Runoff (MOE Methodology) (m^3)		24,903	22,402	24,756	23,930	16,122	13,491	14,676	12,701	15,071	14,818	36,710	32,728	**252,307**

Notes:

1. Monthly climate data, including precipitation, temperature were provided by Environment Canada for the Delhi Climate Station
2. The Water Budget is adjusted for latitude and daylight savings
3. Infiltration and Runoff volumes are calculated using the methodology described in the MOE Stormwater Design Manual (2003).
4. Total Water Surplus is calculated as total precipitation minus adjusted potential evapotranspiration (Thornthwaite, 1948)
5. Total Moisture Surplus (Thornthwaite and Mather) is calculated as total precipitation minus actual evapotranspiration.
6. Evaporative losses of 10% are modeled for impervious surfaces. This accounts for losses of water, such as water that collects in shallow depressions on these surfaces and does not reach the stormwater system.
7. There is minor round-off error within the Environment Canada data

Table WB-4: Post-Development Water Balance with Mitigation Measures - Geranium Delhi

Weather Station Data: Delhi, ON (1981-2010) Climate Station 6131982

Latitude:	**42** degrees	**52.0** minutes	**N**
Longitude:	**80** degrees	**33.0** minutes	**W**

Data Provided by Environment Canada - Atmospheric Environment Services - data may exhibit round off error

PARAMETER		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Wetlands - Pervious	*10.54 ha*	**WHC = 200 mm**			**0% Imperviousness**									
Precipitation (m^3)		7,344	6,607	7,302	9,125	9,367	9,357	10,179	8,809	10,453	9,304	11,643	9,652	**109,143**
Total AET (m^3)		0	0	2	3,598	8,025	11,991	13,024	11,022	8,176	4,157	1,243	0	**61,238**
Water Surplus (m^3)		7,344	6,607	7,300	5,528	1,342	0	0	0	0	0	10,133	9,652	**47,905**
Infiltration (MOE Methodology) (m^3)	**i = 0.55**	4,030	3,625	4,005	3,033	736	0	0	0	0	0	5,559	5,296	**26,284**
Runoff (MOE Methodology) (m^3)		3,315	2,982	3,295	2,495	606	0	0	0	0	0	4,573	4,356	**21,621**
Open Water Ponds - Impervious	*0.24 ha*													
Precipitation (m^3)		171	154	170	212	218	217	236	205	243	216	271	224	**2,536**
Evaporative Losses at 10% Precipitation (m^3)		17	15	17	21	22	22	24	20	24	22	27	22	**254**
Water Surplus (m^3) - considered as standing water		154	138	153	191	196	196	213	184	219	195	243	202	**2,282**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		154	138	153	191	196	196	213	184	219	195	243	202	**2,282**
Open-Spaced Parkland and Amenity Areas	*9.73 ha*	**WHC = 100 mm**			**0% Imperviousness**									
Precipitation (m^3)		6,783	6,102	6,744	8,427	8,651	8,641	9,400	8,135	9,653	8,593	10,753	8,914	**100,797**
Total AET (m^3)		0	0	2	3,322	7,412	10,880	11,639	9,498	7,550	3,839	1,148	0	**55,290**
Water Surplus (m^3)		6,783	6,102	6,742	5,105	1,239	0	0	0	0	1,018	9,605	8,914	**45,507**
Infiltration (MOE Methodology) (m^3)	**i = 0.46**	3,105	2,793	3,086	2,337	567	0	0	0	0	466	4,397	4,080	**20,831**
Runoff (MOE Methodology) (m^3)		3,678	3,309	3,656	2,768	672	0	0	0	0	552	5,208	4,834	**24,676**
Forested Areas - Pervious	*5.26 ha*	**WHC = 100 mm**			**0% Imperviousness**									
Precipitation (m^3)		3,665	3,297	3,644	4,554	4,675	4,670	5,080	4,396	5,217	4,644	5,811	4,817	**54,471**
Total AET (m^3)		0	0	1	1,795	4,005	6,037	6,658	5,659	4,080	2,075	621	0	**30,931**
Water Surplus (m^3)		3,665	3,297	3,643	2,759	670	0	0	0	0	0	4,689	4,817	**23,540**
Infiltration (MOE Methodology) (m^3)	**i = 0.55**	2,012	1,810	2,000	1,514	368	0	0	0	0	0	2,574	2,644	**12,920**
Runoff (MOE Methodology) (m^3)		1,654	1,488	1,644	1,245	302	0	0	0	0	0	2,115	2,173	**10,620**
SWMP Block					**41% Imperviousness**									
Impervious Area - Access Roads, Permanent Pool	*0.92 ha*													
Precipitation (m^3)		642	578	639	798	819	818	890	770	914	814	1,018	844	**9,545**
Evaporative Loss at 10% Precipitation (m^3)		64	58	64	80	82	82	89	77	91	81	102	84	**954**
Water Surplus (m^3)		578	520	575	718	737	736	801	693	823	732	916	760	**8,590**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		578	520	575	718	737	736	801	693	823	732	916	760	**8,590**
Pervious Area - Landscaped Areas	*1.35 ha*	**WHC = 100 mm**												
Precipitation (m^3)		942	847	936	1,170	1,201	1,200	1,305	1,129	1,340	1,193	1,493	1,237	**13,992**
Total AET (m^3)		0	0	0	461	1,029	1,510	1,616	1,318	1,048	533	159	0	**7,675**
Water Surplus (m^3)		942	847	936	709	172	0	0	0	0	141	1,333	1,237	**6,317**
Infiltration (MOE Methodology) (m^3)	**i = 0.46**	431	388	428	324	79	0	0	0	0	65	610	566	**2,892**
Runoff (MOE Methodology) (m^3)		511	459	507	384	93	0	0	0	0	77	723	671	**3,425**
Retirement Home						**49% Imperviousness**								
Impervious Area - Building, Parking, Patios	*0.60 ha*													
Precipitation (m^3)		415	374	413	516	530	529	576	498	591	526	658	546	**6,172**
Evaporative Loss at 10% Precipitation (m^3)		42	37	41	52	53	53	58	50	59	53	66	55	**617**
Water Surplus (m^3)		374	336	372	464	477	476	518	448	532	474	593	491	**5,555**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		374	336	372	464	477	476	518	448	532	474	593	491	**5,555**
Pervious Area - Landscaped Areas	*0.62 ha*	**WHC = 100 mm**												
Precipitation (m^3)		432	389	430	537	551	551	599	518	615	548	685	568	**6,424**
Total AET (m^3)		0	0	0	212	472	693	742	605	481	245	73	0	**3,524**
Water Surplus (m^3)		432	389	430	325	79	0	0	0	0	65	612	568	**2,900**
Infiltration (MOE Methodology) (m^3)	**i = 0.46**	198	178	197	149	36	0	0	0	0	30	280	260	**1,328**
Runoff (MOE Methodology) (m^3)		234	211	233	176	43	0	0	0	0	35	332	308	**1,573**
Community Commons Area						**20% Imperviousness**								
Impervious Area - Buildings, Parking, Paved Areas	*0.35 ha*													
Precipitation (m^3)		241	216	239	299	307	307	334	289	342	305	381	316	**3,576**
Evaporative Loss at 10% Precipitation (m^3)		24	22	24	30	31	31	33	29	34	30	38	32	**358**
Water Surplus (m^3)		217	195	215	269	276	276	300	260	308	274	343	285	**3,218**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		217	195	215	269	276	276	300	260	308	274	343	285	**3,218**
Pervious Area - Landscaped Areas	*1.38 ha*	**WHC = 100 mm**												
Precipitation (m^3)		963	866	957	1,196	1,228	1,226	1,334	1,155	1,370	1,219	1,526	1,265	**14,304**
Total AET (m^3)		0	0	0	471	1,052	1,544	1,652	1,348	1,071	545	163	0	**7,846**
Water Surplus (m^3)		963	866	957	724	176	0	0	0	0	144	1,363	1,265	**6,458**
Infiltration (MOE Methodology) (m^3)	**i = 0.46**	441	396	438	332	81	0	0	0	0	66	624	579	**2,956**
Runoff (MOE Methodology) (m^3)		522	470	519	393	95	0	0	0	0	78	739	686	**3,502**
Road Allowance						**80% Imperviousness**								
Impervious Area - Roads, Sidewalks	*6.13 ha*													
Precipitation (m^3)		4,269	3,840	4,245	5,304	5,445	5,439	5,917	5,121	6,076	5,408	6,768	5,611	**63,444**
Evaporative Loss at 10% Precipitation (m^3)		427	384	424	530	545	544	592	512	608	541	677	561	**6,344**
Water Surplus (m^3)		3,842	3,456	3,820	4,774	4,901	4,895	5,325	4,609	5,468	4,868	6,091	5,050	**57,099**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		3,842	3,456	3,820	4,774	4,901	4,895	5,325	4,609	5,468	4,868	6,091	5,050	**57,099**
Pervious Area - Landscaped Areas	*1.53 ha*	**WHC = 100 mm**												
Precipitation (m^3)		1,067	960	1,061	1,326	1,361	1,360	1,479	1,280	1,519	1,352	1,692	1,403	**15,861**
Total AET (m^3)		0	0	0	523	1,166	1,712	1,831	1,495	1,188	604	181	0	**8,700**
Water Surplus (m^3)		1,067	960	1,061	803	195	0	0	0	0	160	1,511	1,403	**7,161**
Infiltration (MOE Methodology) (m^3)	**i = 0.46**	489	439	486	368	89	0	0	0	0	73	692	642	**3,278**
Runoff (MOE Methodology) (m^3)		579	521	575	436	106	0	0	0	0	87	820	761	**3,883**
Residential - Townhouse Properties						**79% Imperviousness**								
Impervious Area - Buildings, Roof, Driveways, Patios	*1.16 ha*													
Precipitation (m^3)		808	727	804	1,004	1,031	1,030	1,120	970	1,150	1,024	1,282	1,062	**12,013**
Evaporative Loss at 10% Precipitation (m^3)		81	73	80	100	103	103	112	97	115	102	128	106	**1,201**
Water Surplus (m^3)		728	654	723	904	928	927	1,008	873	1,035	922	1,153	956	**10,812**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)		728	654	723	904	928	927	1,008	873	1,035	922	1,153	956	**10,812**
Pervious Area - Landscaped Areas	*0.31 ha*	**WHC = 100 mm**												
Precipitation (m^3)		215	193	214	267	274	274	298	258	306	272	341	282	**3,193**
Total AET (m^3)		0	0	0	105	235	345	369	301	239	122	36	0	**1,752**
Water Surplus (m^3)		215	193	214	162	39	0	0	0	0	32	304	282	**1,442**
Infiltration (MOE Methodology) (m^3)	**i = 0.46**	98	88	98	74	18	0	0	0	0	15	139	129	**660**
Runoff (MOE Methodology) (m^3)		117	105	116	88	21	0	0	0	0	17	165	153	**782**

Table WB-4: Post-Development Water Balance with Mitigation Measures - Geranium Delhi

Weather Station Data: Delhi, ON (1981-2010) Climate Station 6131982

Latitude:	**42**	**degrees**	**52.0**	**minutes**	**N**
Longitude:	**80**	**degrees**	**33.0**	**minutes**	**W**

Data Provided by Environment Canada - Atmospheric Environment Services - data may exhibit round off error

PARAMETER			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Residential - Single Detached Properties (25' and 36' Lots)	***8.60 ha***					**57% Imperviousness**									
Impervious Area - Driveway and Patios	*1.47 ha*														
Precipitation to the driveway and patios (m^3)			1,025	922	1,019	1,273	1,307	1,305	1,420	1,229	1,458	1,298	1,624	1,347	**15,227**
Evaporative Loss at 10% Precipitation (m^3)			102	92	102	127	131	131	142	123	146	130	162	135	**1,523**
Water Surplus - Driveway and Patio (m^3)			922	830	917	1,146	1,176	1,175	1,278	1,106	1,312	1,168	1,462	1,212	**13,704**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**		0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3) - to SWMP			922	830	917	1,146	1,176	1,175	1,278	1,106	1,312	1,168	1,462	1,212	**13,704**
Impervious Area - Roof Areas	*3.43 ha*														
Precipitation to the Full Roof (m^3)			2,391	2,151	2,377	2,970	3,049	3,046	3,313	2,868	3,403	3,029	3,790	3,142	**35,529**
Evaporative Loss at 10% Precipitation (m^3)			239	215	238	297	305	305	331	287	340	303	379	314	**3,553**
Runoff Available from Full Roof (m^3)			2,152	1,936	2,139	2,673	2,744	2,741	2,982	2,581	3,062	2,726	3,411	2,828	**31,976**
Rear Roof Runoff directed to Rear Lawn (m^3)	*Roof %*	*50%*	1,076	968	1,070	1,337	1,372	1,371	1,491	1,290	1,531	1,363	1,706	1,414	**15,988**
Front Roof Runoff directed to Front Lawn (m^3)	*Roof %*	*50%*	1,076	968	1,070	1,337	1,372	1,371	1,491	1,290	1,531	1,363	1,706	1,414	**15,988**
Pervious Area - Rear Lawn	*2.77 ha*		**WHC = 100 mm**												
Precipitation to Rear Lawn (m^3)			1,932	1,738	1,921	2,401	2,465	2,462	2,678	2,318	2,750	2,448	3,064	2,540	**28,717**
AET Rear Lawn (m^3)			0	0	1	947	2,112	3,100	3,316	2,706	2,151	1,094	327	0	**15,752**
Water Surplus Rear Lawn (m^3)			1,932	1,738	1,921	1,454	353	0	0	0	0	290	2,736	2,540	**12,965**
Infiltration (MOE Methodology) (m^3)	**i = 0.46**		885	796	879	666	162	0	0	0	0	133	1,253	1,162	**5,935**
Runoff (MOE Methodology) (m^3)			1,048	943	1,041	789	191	0	0	0	0	157	1,484	1,377	**7,030**
Runoff from Rear Roof to Rear Lawn (m^3)			1,076	968	1,070	1,337	1,372	1,371	1,491	1,290	1,531	1,363	1,706	1,414	**15,988**
Additional ET provided by Rear Roof Runoff (m^3)			0	0	0	0	0	95	288	452	0	0	0	0	**834**
Water Surplus (m^3)			1,076	968	1,070	1,337	1,372	1,276	1,203	839	1,531	1,363	1,706	1,414	**15,154**
Infiltration (MOE Methodology) (m^3)	**i = 0.46**		492	443	490	612	628	584	551	384	701	624	781	647	**6,937**
Runoff (MOE Methodology) (m^3)			583	525	580	725	744	692	653	455	830	739	925	767	**8,217**
Pervious Area - Front Lawn	*0.92 ha*		**WHC = 100 mm**												
Precipitation to Front Lawn (m^3)			644	579	640	800	822	821	893	773	917	816	1,021	847	**9,572**
AET Front Lawn (m^3)			0	0	0	316	704	1,033	1,105	902	717	365	109	0	**5,251**
Water Surplus Rear Lawn (m^3)			644	579	640	485	118	0	0	0	0	97	912	847	**4,322**
Infiltration (MOE Methodology) (m^3)	**i = 0.46**		295	265	293	222	54	0	0	0	0	44	418	387	**1,978**
Runoff (MOE Methodology) (m^3)			349	314	347	263	64	0	0	0	0	52	495	459	**2,343**
Runoff from Front Roof to Front Lawn (m^3)			1,076	968	1,070	1,337	1,372	1,371	1,491	1,290	1,531	1,363	1,706	1,414	**15,988**
Additional ET provided by Rear Roof Runoff (m^3)			0	0	0	0	0	32	96	151	0	0	0	0	**278**
Water Surplus (m^3)			1,076	968	1,070	1,337	1,372	1,339	1,395	1,140	1,531	1,363	1,706	1,414	**15,710**
Infiltration (MOE Methodology) (m^3)	**i = 0.46**		492	443	490	612	628	613	639	522	701	624	781	647	**7,191**
Runoff (MOE Methodology) (m^3)			583	525	580	725	744	726	757	618	830	739	925	767	**8,519**
Residential - Single Detached Properties (44' and 60' Lots)	***6.28 ha***					**36% Imperviousness**									
Impervious Area - Drivway and Patio	*0.68 ha*														
Precipitation to Driveway and Patio (m^3)			473	425	470	588	603	603	655	567	673	599	750	622	**7,029**
Evaporative Loss at 10% Precipitation (m^3)			47	43	47	59	60	60	66	57	67	60	75	62	**703**
Water Surplus (m^3)			426	383	423	529	543	542	590	511	606	539	675	559	**6,326**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**		0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)			426	383	423	529	543	542	590	511	606	539	675	559	**6,326**
Impervious Area - Roof Areas	*1.58 ha*														
Precipitation to the Full Roof (m^3)			1,104	993	1,097	1,371	1,408	1,406	1,529	1,324	1,571	1,398	1,750	1,450	**16,400**
Evaporative Loss at 10% Precipitation (m^3)			110	99	110	137	141	141	153	132	157	140	175	145	**1,640**
Runoff Available from Full Roof (m^3)			993	893	988	1,234	1,267	1,265	1,377	1,191	1,414	1,258	1,575	1,305	**14,760**
Rear Roof Runoff directed to Rear Lawn (m^3)	*Roof %*	*50%*	497	447	494	617	633	633	688	596	707	629	787	653	**7,380**
Front Roof Runoff directed to Front Lawn (m^3)	*Roof %*	*50%*	497	447	494	617	633	633	688	596	707	629	787	653	**7,380**
Pervious Area - Rear Lawn	*3.02 ha*		**WHC = 100 mm**												
Precipitation to Rear Lawn (m^3)			2,102	1,891	2,090	2,612	2,681	2,678	2,913	2,521	2,992	2,663	3,332	2,762	**31,238**
AET Rear Lawn (m^3)			0	0	1	1,030	2,297	3,372	3,607	2,943	2,340	1,190	356	0	**17,135**
Water Surplus Rear Lawn (m^3)			2,102	1,891	2,089	1,582	384	0	0	0	0	316	2,977	2,762	**14,103**
Infiltration (MOE Methodology) (m^3)	**i = 0.41**		857	771	852	645	157	0	0	0	0	129	1,214	1,126	**5,751**
Runoff (MOE Methodology) (m^3)			1,245	1,120	1,237	937	227	0	0	0	0	187	1,763	1,636	**8,352**
Runoff from Rear Roof to Rear Lawn (m^3)			497	447	494	617	633	633	688	596	707	629	787	653	**7,380**
Additional ET provided by Rear Roof Runoff (m^3)			0	0	0	0	0	0	0	0	0	0	0	0	**0**
Water Surplus (m^3)			497	447	494	617	633	633	688	596	707	629	787	653	**7,380**
Infiltration (MOE Methodology) (m^3)	**i = 0.46**		227	204	226	282	290	290	315	273	324	288	360	299	**3,378**
Runoff (MOE Methodology) (m^3)			269	242	268	335	343	343	373	323	383	341	427	354	**4,002**
Pervious Area - Front Lawn	*1.01 ha*		**WHC = 100 mm**												
Precipitation to Front Lawn (m^3)			701	630	697	871	894	893	971	840	997	888	1,111	921	**10,413**
AET Front Lawn (m^3)			0	0	0	343	766	1,124	1,202	981	780	397	119	0	**5,712**
Water Surplus Rear Lawn (m^3)			701	630	696	527	128	0	0	0	0	105	992	921	**4,701**
Infiltration (MOE Methodology) (m^3)	**i = 0.46**		321	289	319	241	59	0	0	0	0	48	454	422	**2,152**
Runoff (MOE Methodology) (m^3)			380	342	378	286	69	0	0	0	0	57	538	499	**2,549**
Runoff from Front Roof to Front Lawn (m^3)			497	447	494	617	633	633	688	596	707	629	787	653	**7,380**
Additional ET provided by Rear Roof Runoff (m^3)			0	0	0	0	0	34	104	164	0	0	0	0	**302**
Water Surplus (m^3)			497	447	494	617	633	598	584	432	707	629	787	653	**7,077**
Infiltration (MOE Methodology) (m^3)	**i = 0.46**		227	204	226	282	290	274	267	198	324	288	360	299	**3,240**
Runoff (MOE Methodology) (m^3)			269	242	268	335	343	324	317	234	383	341	427	354	**3,838**
Trails and Pathways						**100% Imperviousness**									
Impervious Area - Pavel Paths, Sidewalks around Townhouse	*0.27 ha*														
Precipitation (m^3)			187	168	186	233	239	239	259	225	266	237	297	246	**2,782**
Evaporative Loss at 10% Precipitation (m^3)			19	17	19	23	24	24	26	22	27	24	30	25	**278**
Water Surplus (m^3)			169	152	168	209	215	215	234	202	240	213	267	221	**2,504**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**		0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)			169	152	168	209	215	215	234	202	240	213	267	221	**2,504**
Pumphouse Area						**100% Imperviousness**									
Considered as Impervious	*0.06 ha*														
Precipitation (m^3)			40	36	40	50	51	51	55	48	57	51	63	53	**595**
Evaporative Loss at 10% Precipitation (m^3)			4	4	4	5	5	5	6	5	6	5	6	5	**59**
Water Surplus (m^3)			36	32	36	45	46	46	50	43	51	46	57	47	**535**
Infiltration (MOE Methodology) (m^3)	**i = 0.00**		0	0	0	0	0	0	0	0	0	0	0	0	**0**
Runoff (MOE Methodology) (m^3)			36	32	36	45	46	46	50	43	51	46	57	47	**535**
Summary Total	**55.32 ha**														
Precipitation (m^3)			38,556	34,684	38,335	47,904	49,177	49,121	53,436	46,245	54,874	48,845	61,125	50,670	**572,972**
Evaporative Loss at 10% Precipitation (m^3)			1,177	1,058	1,170	1,462	1,501	1,499	1,631	1,411	1,675	1,491	1,865	1,546	**17,485**
Total AET (m^3)			0	0	8	13,123	29,275	43,502	47,248	39,544	29,822	15,163	4,536	0	**222,220**
Water Surplus (m^3)			37,379	33,625	37,156	33,320	18,401	13,330	14,188	11,935	15,071	15,783	53,955	49,124	**333,268**
Infiltration (MOE Methodology) (m^3)			14,600	13,133	14,512	11,693	4,241	1,760	1,772	1,376	2,049	2,892	20,495	19,187	**107,710**
Runoff (MOE Methodology) (m^3)			22,780	20,492	22,645	21,626	14,160	11,569	12,416	10,559	13,022	12,891	33,460	29,937	**225,558**

Notes:

1. Monthly climate data, including precipitation, temperature were provided by Environment Canada for the Delhi Climate Station
2. The Water Budget is adjusted for latitude and daylight savings
3. Infiltration and Runoff volumes are calculated using the methodology described in the MOE Stormwater Design Manual (2003).
4. Total Water Surplus is calculated as total precipitation minus adjusted potential evapotranspiration (Thornthwaite, 1948)
5. Total Moisture Surplus (Thornthwaite and Mather) is calculated as total precipitation minus actual evapotranspiration.
6. Evaporative losses of 10% are modeled for impervious surfaces. This accounts for losses of water, such as water that collects in shallow depressions on these surfaces and does not reach the stormwater system.
7. There is minor round-off error within the Environment Canada data

APPENDIX

G DEWATERING ASSESSMENT

Construction Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Dewatering Calculations 60 foot Detached Unit 1 (Anticipated Conditions)

Site Geranium Delhi Golf Course

Input Parameters			**User Entry**		**Calc'd**	
Initial Elevation of Water Table (m)		H	228.5	masl	4.3	m
Final Elevation of Water Table (m)		h	225.7	masl	1.5	m
Base of Aquifer/Datum			224.2	masl	0.0	m
Hydraulic Conductivity (m/s)		K	7.8E-06	m/s	7.8E-06	m/s
Hydraulic Conductivity (m/d)		K		m/d	6.7E-01	m/d
Aquifer Thickness if Confined (m)		B		m	0.0	m
Length of Excavation (m)		a	11.0	m	11.0	
Width of Excavation (m)		b	16.0	m	16.0	
Length of Dewatering - Trench Length (m)		X		m	0.0	
Linear System Zone of Influence (m)		L		m	11.8	
Sichardt Constant (well = 3, wellpoint = 1.5 or 2)		C	3.0		3.0	
Ratio a/b	Override a/b? (Y/N) N	a/b			0.7	

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m) Well radius + ZOI

$R_o = C \times (H - h) \times \sqrt{K}$ (eq. 6.14, p. 104)

$R_o + R_s$	31.2	
R_o	23.7	m

Equivalent Radius of Well (m)

R_s	7.5	m

$R_s = \sqrt{((a \times b)/ pi)}$ (eq. 6.10, p. 102)

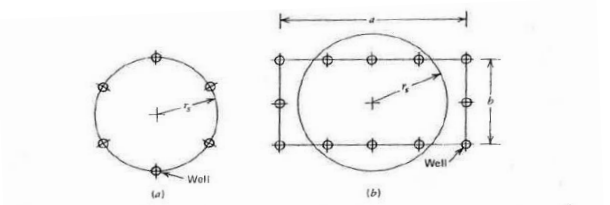


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b <= 1.5) TRUE

	Unfactored Rates		
Shaft Calculation (m^3/day)	Q	24.2	m^3/day
$Q = (\pi \times K \times (H^2 - h^2)) / \ln (R_o / R_s)$ (Eq. 6.3, p. 99)	Q	24,188	L/day

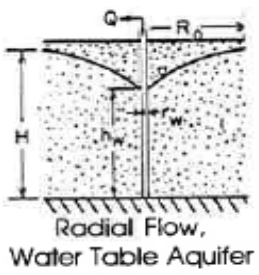
Long Narrow System - Trench (a/b > 1.5) FALSE

Trench Calculation with Radial Flow at Ends (m^3/day)	Q	N/A	m^3/day
$Q = K \times X \times (H^2 - h^2) / L + \pi \times K \times (H^2 - h^2) / \ln(R_o/R_s)$ (eq. 6.8, p. 101)	Q	N/A	L/day
Drainage Trench from a Line Source (m^3/day)	Q	N/A	m^3/day
Q = K x X x (H^2 - h^2) / L (eq. 6.9, p. 102)	Q	N/A	L/day

Number of Trench Wall Sides with Flow (1 or 2) <-- This is used only in the equation above

Calculations of Vertical Upward Flow from Underlying Sand Through Till

Difference in hydraulic head (m)	Δh	2.8	m
Difference between Base of Excavation and Aquifer (m)	ΔL	1.5	m
Hydraulic Conductivity (m/sec)	K	1.5E-07	
Vertical Flow (m^3/sec)	Q	2.7E-06	m^3/sec
Darcys Law Q=KiA	Q	236	L/day
Total Flow	Q	24,423	L/day



Radial Flow, Water Table Aquifer

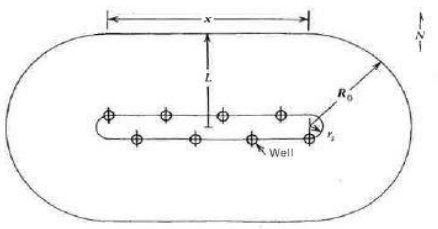
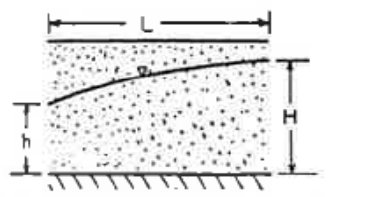


Figure 6.8 Approximate analysis of long narrow systems.



Water Table Flow From a Line Source to a Drainage Trench

Construction Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Dewatering Calculations 60 foot Detached Unit 1 (Factor of Safety - 10 x K)

Site Geranium Delhi Golf Course

Input Parameters			**User Entry**		**Calc'd**	
Initial Elevation of Water Table (m)		H	228.5	masl	4.3	m
Final Elevation of Water Table (m)		h	225.7	masl	1.5	m
Base of Aquifer/Datum			224.2	masl	0.0	m
Hydraulic Conductivity (m/s)		K	7.8E-05	m/s	7.8E-05	m/s
Hydraulic Conductivity (m/d)		K		m/d	6.7E+00	m/d
Aquifer Thickness if Confined (m)		B		m	0.0	m
Length of Excavation (m)		a	11.0	m	11.0	
Width of Excavation (m)		b	16.0	m	16.0	
Length of Dewatering - Trench Length (m)		X		m	0.0	
Linear System Zone of Influence (m)		L		m	37.5	
Sichardt Constant (well = 3, wellpoint = 1.5 or 2)		C	3.0		3.0	
Ratio a/b	Override a/b? (Y/N) N	a/b			0.7	

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m) Well radius + ZOI

$R_o = C \times (H - h) \times \sqrt{K}$ (eq. 6.14, p. 104)

$R_o + R_s$	82.4	
R_o	74.9	m

Equivalent Radius of Well (m)

R_s	7.5	m

$R_s = \sqrt{((a \times b)/ pi)}$ (eq. 6.10, p. 102)

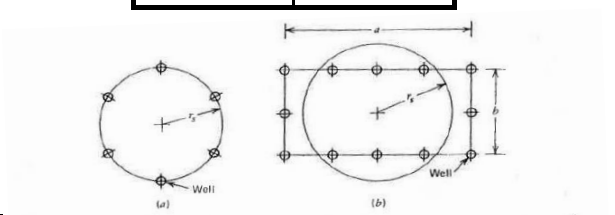


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b <= 1.5) TRUE

	Unfactored Rates		
Shaft Calculation (m^3/day)	Q	143.9	m^3/day
$Q = (\pi \times K \times (H^2 - h^2)) / \ln (R_o / R_s)$ (Eq. 6.3, p. 99)	Q	143,867	L/day

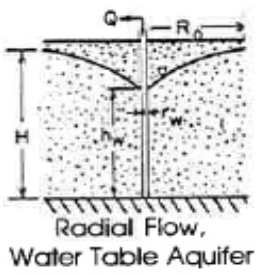
Long Narrow System - Trench (a/b > 1.5) FALSE

Trench Calculation with Radial Flow at Ends (m^3/day)	Q	N/A	m^3/day
$Q = K \times X \times (H^2 - h^2) / L + \pi \times K \times (H^2 - h^2) / \ln(R_o/R_s)$ (eq. 6.8, p. 101)	Q	N/A	L/day
Drainage Trench from a Line Source (m^3/day)	Q	N/A	m^3/day
Q = K x X x (H^2 - h^2) / L (eq. 6.9, p. 102)	Q	N/A	L/day

Number of Trench Wall Sides with Flow (1 or 2) <-- This is used only in the equation above

Calculations of Vertical Upward Flow from Underlying Sand Through Till

Difference in hydraulic head (m)	Δh	2.8	m
Difference between Base of Excavation and Aquifer (m)	ΔL	1.5	m
Hydraulic Conductivity (m/sec)	K	1.5E-06	
Vertical Flow (m^3/sec)	Q	2.7E-05	m^3/sec
Darcys Law Q=KiA	Q	2355	L/day
Total Flow	Q	146,222	L/day



Radial Flow, Water Table Aquifer

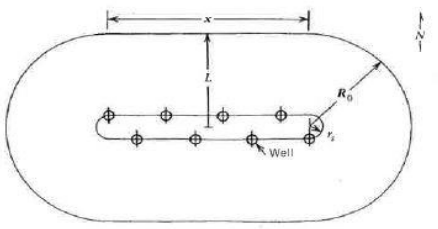
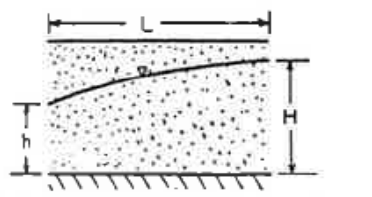


Figure 6.8 Approximate analysis of long narrow systems.



Water Table Flow From a Line Source to a Drainage Trench

Construction Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Dewatering Calculations 60 foot Detached Unit 2 (Anticipated Conditions)

Site Geranium Delhi Golf Course

Input Parameters			**User Entry**		**Calc'd**	
Initial Elevation of Water Table (m)		H	233.0	masl	4.0	m
Final Elevation of Water Table (m)		h	230.7	masl	1.7	m
Base of Aquifer/Datum			229.0	masl	0.0	m
Hydraulic Conductivity (m/s)		K	7.8E-06	m/s	7.8E-06	m/s
Hydraulic Conductivity (m/d)		K		m/d	6.7E-01	m/d
Aquifer Thickness if Confined (m)		B		m	0.0	m
Length of Excavation (m)		a	11.0	m	11.0	
Width of Excavation (m)		b	16.0	m	16.0	
Length of Dewatering - Trench Length (m)		X		m	0.0	
Linear System Zone of Influence (m)		L		m	9.5	
Sichardt Constant (well = 3, wellpoint = 1.5 or 2)		C	3.0		3.0	
Ratio a/b	Override a/b? (Y/N) N	a/b			0.7	

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m) Well radius + ZOI

$R_o = C \times (H - h) \times \sqrt{K}$ (eq. 6.14, p. 104)

$R_o + R_s$	26.4	
R_o	18.9	m

Equivalent Radius of Well (m)

R_s	7.5	m

$R_s = \sqrt{((a \times b)/ pi)}$ (eq. 6.10, p. 102)

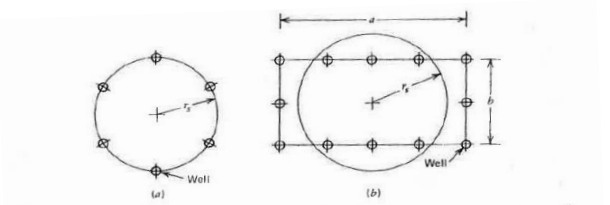


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b <= 1.5) TRUE

	Unfactored Rates		
Shaft Calculation (m^3/day)	Q	21.7	m^3/day
$Q = (\pi \times K \times (H^2 - h^2)) / \ln (R_o / R_s)$ (Eq. 6.3, p. 99)	Q	21,748	L/day

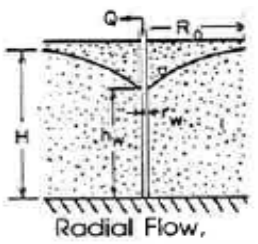
Long Narrow System - Trench (a/b > 1.5) FALSE

Trench Calculation with Radial Flow at Ends (m^3/day)	Q	N/A	m^3/day
$Q = K \times X \times (H^2 - h^2) / L + \pi \times K \times (H^2 - h^2) / \ln(R_o/R_s)$ (eq. 6.8, p. 101)	Q	N/A	L/day
Drainage Trench from a Line Source (m^3/day)	Q	N/A	m^3/day
Q = K x X x (H^2 - h^2) / L (eq. 6.9, p. 102)	Q	N/A	L/day

Number of Trench Wall Sides with Flow (1 or 2) <-- This is used only in the equation above

Calculations of Vertical Upward Flow from Underlying Sand Through Till

Difference in hydraulic head (m)	Δh	2.3	m
Difference between Base of Excavation and Aquifer (m)	ΔL	1.7	m
Hydraulic Conductivity (m/sec)	K	7.8E-06	
Vertical Flow (m^3/sec)	Q	1.4E-04	m^3/sec
Darcys Law Q=KiA	Q	11840	L/day
Total Flow	Q	33,587	L/day



Radial Flow, Water Table Aquifer

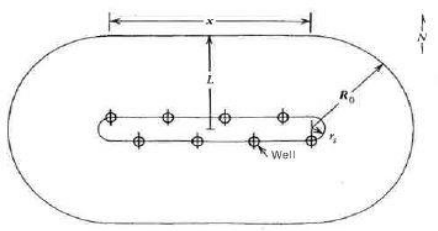
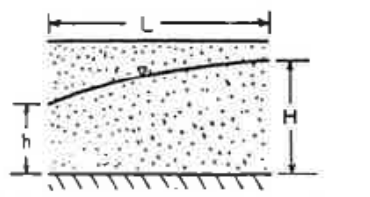


Figure 6.8 Approximate analysis of long narrow systems.



Water Table Flow From a Line Source to a Drainage Trench

Construction Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Dewatering Calculations 60 foot Detached Unit 2 (Factor of Safety - 10 x K)

Site Geranium Delhi Golf Course

Input Parameters			**User Entry**		**Calc'd**	
Initial Elevation of Water Table (m)		H	233.0	masl	4.0	m
Final Elevation of Water Table (m)		h	230.7	masl	1.7	m
Base of Aquifer/Datum			229.0	masl	0.0	m
Hydraulic Conductivity (m/s)		K	7.8E-05	m/s	7.8E-05	m/s
Hydraulic Conductivity (m/d)		K		m/d	6.7E+00	m/d
Aquifer Thickness if Confined (m)		B		m	0.0	m
Length of Excavation (m)		a	11.0	m	11.0	
Width of Excavation (m)		b	16.0	m	16.0	
Length of Dewatering - Trench Length (m)		X		m	0.0	
Linear System Zone of Influence (m)		L		m	29.9	
Sichardt Constant (well = 3, wellpoint = 1.5 or 2)		C	3.0		3.0	
Ratio a/b	Override a/b? (Y/N) N	a/b			0.7	

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m) Well radius + ZOI

$R_o = C \times (H - h) \times \sqrt{K}$ (eq. 6.14, p. 104)

$R_o + R_s$	67.3	
R_o	59.8	m

Equivalent Radius of Well (m)

R_s	7.5	m

$R_s = \sqrt{((a \times b)/ pi)}$ (eq. 6.10, p. 102)

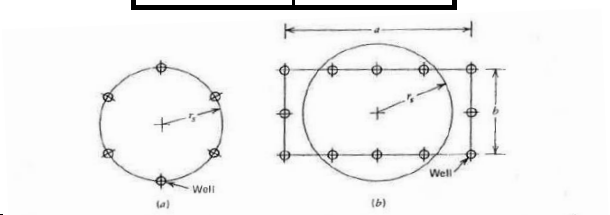


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b <= 1.5) TRUE

	Unfactored Rates		
Shaft Calculation (m^3/day)	Q	124.8	m^3/day
$Q = (\pi \times K \times (H^2 - h^2)) / \ln (R_o / R_s)$ (Eq. 6.3, p. 99)	Q	124,818	L/day

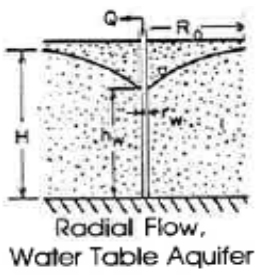
Long Narrow System - Trench (a/b > 1.5) FALSE

Trench Calculation with Radial Flow at Ends (m^3/day)	Q	N/A	m^3/day
$Q = K \times X \times (H^2 - h^2) / L + \pi \times K \times (H^2 - h^2) / \ln(R_o/R_s)$ (eq. 6.8, p. 101)	Q	N/A	L/day
Drainage Trench from a Line Source (m^3/day)	Q	N/A	m^3/day
Q = K x X x (H^2 - h^2) / L (eq. 6.9, p. 102)	Q	N/A	L/day

Number of Trench Wall Sides with Flow (1 or 2) <-- This is used only in the equation above

Calculations of Vertical Upward Flow from Underlying Sand Through Till

Difference in hydraulic head (m)	Δh	2.3	m
Difference between Base of Excavation and Aquifer (m)	ΔL	1.7	m
Hydraulic Conductivity (m/sec)	K	7.8E-05	
Vertical Flow (m^3/sec)	Q	1.4E-03	m^3/sec
Darcys Law Q=KiA	Q	118396	L/day
Total Flow	Q	243,214	L/day



Radial Flow, Water Table Aquifer

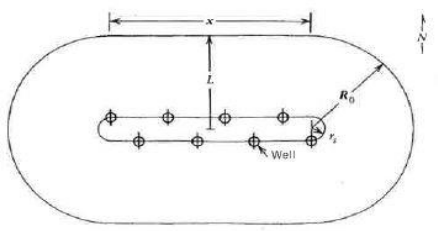
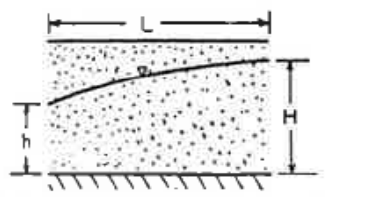


Figure 6.8 Approximate analysis of long narrow systems.



Water Table Flow From a Line Source to a Drainage Trench

Construction Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Dewatering Calculations 20 foot Townhouse Unit 1 (Anticipated Conditions)

Site Geranium Delhi Golf Course

Input Parameters			**User Entry**		**Calc'd**	
Initial Elevation of Water Table (m)	H	230.8	masl	6.6	m
Final Elevation of Water Table (m)	h	229.2	masl	5.0	m
Base of Aquifer/Datum		224.2	masl	0.0	m
Hydraulic Conductivity (m/s)	K	7.8E-06	m/s	7.8E-06	m/s
Hydraulic Conductivity (m/d)	K		m/d	6.7E-01	m/d
Aquifer Thickness if Confined (m)	B		m	0.0	m
Length of Excavation (m)	a	5.0	m	5.0	
Width of Excavation (m)	b	17.0	m	17.0	
Length of Dewatering - Trench Length (m)	X		m	0.0	
Linear System Zone of Influence (m)	L		m	6.8	
Sichardt Constant (well = 3, wellpoint = 1.5 or 2)	C	3.0		3.0	
Ratio a/b Override a/b? (Y/N) N	a/b			0.3	

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m) Well radius + ZOI

$R_o = C \times (H - h) \times \sqrt{K}$ (eq. 6.14, p. 104)

$R_o + R_s$	18.8	
R_o	13.6	m

Equivalent Radius of Well (m)

R_s	5.2	m

$R_s = \sqrt{((a \times b)/ \pi)}$ (eq. 6.10, p. 102)

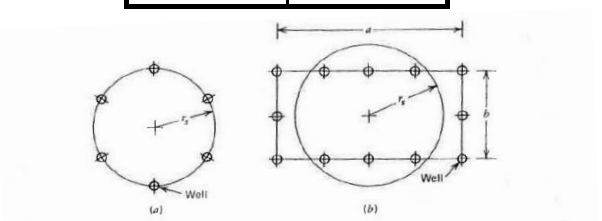


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b <= 1.5) TRUE

	Unfactored Rates		
Shaft Calculation (m^3/day)	Q	31.0	m^3/day
$Q = (\pi \times K \times (H^2 - h^2)) / \ln (R_o / R_s)$ (Eq. 6.3, p. 99)	Q	30,960	L/day

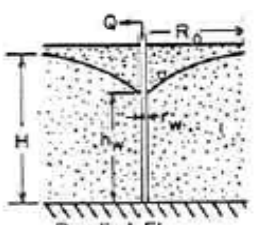
Long Narrow System - Trench (a/b > 1.5) FALSE

Trench Calculation with Radial Flow at Ends (m^3/day)	Q	N/A	m^3/day
$Q = K \times X \times (H^2 - h^2) / L + \pi \times K \times (H^2 - h^2) / \ln(R_o/R_s)$ (eq. 6.8, p. 101)	Q	N/A	L/day
Drainage Trench from a Line Source (m^3/day)	Q	N/A	m^3/day
Q = K x X x (H^2 - h^2) / L (eq. 6.9, p. 102)	Q	N/A	L/day

Number of Trench Wall Sides with Flow (1 or 2) <-- This is used only in the equation above

Calculations of Vertical Upward Flow from Underlying Sand Through Till

Difference in hydraulic head (m)	Δh	1.6	m
Difference between Base of Excavation and Aquifer (m)	ΔL	5.0	m
Hydraulic Conductivity (m/sec)	K	7.8E-06	
Vertical Flow (m^3/sec)	Q	2.2E-05	m^3/sec
Darcys Law Q=KiA	Q	1,875	L/day
Total Flow	Q	32,835	L/day



Radial Flow, Water Table Aquifer

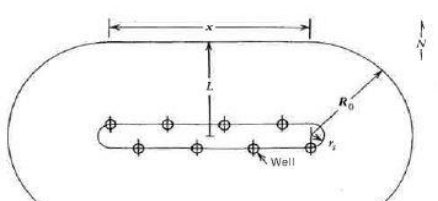
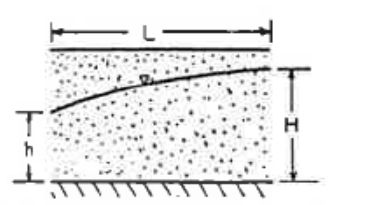


Figure 6.8 Approximate analysis of long narrow systems.



Water Table Flow From a Line Source to a Drainage Trench

Construction Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Dewatering Calculations 20 foot Townhouse Unit 1 (Factor of Safety 10 x K)

Site Geranium Delhi Golf Course

Input Parameters			**User Entry**		**Calc'd**	
Initial Elevation of Water Table (m)		H	230.8	masl	6.6	m
Final Elevation of Water Table (m)		h	229.2	masl	5.0	m
Base of Aquifer/Datum			224.2	masl	0.0	m
Hydraulic Conductivity (m/s)		K	7.8E-05	m/s	7.8E-05	m/s
Hydraulic Conductivity (m/d)		K		m/d	6.7E+00	m/d
Aquifer Thickness if Confined (m)		B		m	0.0	m
Length of Excavation (m)		a	5.0	m	5.0	
Width of Excavation (m)		b	17.0	m	17.0	
Length of Dewatering - Trench Length (m)		X		m	0.0	
Linear System Zone of Influence (m)		L		m	21.6	
Sichardt Constant (well = 3, wellpoint = 1.5 or 2)		C	3.0		3.0	
Ratio a/b	Override a/b? (Y/N) N	a/b			0.3	

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m) Well radius + ZOI

$R_o = C \times (H - h) \times \sqrt{K}$ (eq. 6.14, p. 104)

$R_o + R_s$	48.3	
R_o	43.1	m

Equivalent Radius of Well (m)

R_s	5.2	m

$R_s = \sqrt{((a \times b)/ \pi)}$ (eq. 6.10, p. 102)

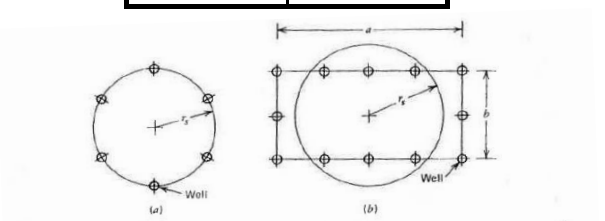


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b <= 1.5) TRUE

	Unfactored Rates		
Shaft Calculation (m^3/day)	Q	178.8	m^3/day
$Q = (\pi \times K \times (H^2 - h^2)) / \ln (R_o / R_s)$ (Eq. 6.3, p. 99)	Q	178,767	L/day

Long Narrow System - Trench (a/b > 1.5) FALSE

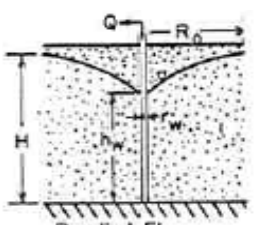
Trench Calculation with Radial Flow at Ends (m^3/day)	Q	N/A	m^3/day
$Q = K \times X \times (H^2 - h^2) / L + \pi \times K \times (H^2 - h^2) / \ln(R_o/R_s)$ (eq. 6.8, p. 101)	Q	N/A	L/day

Drainage Trench from a Line Source (m^3/day)	Q	N/A	m^3/day
Q = K x X x (H^2 - h^2) / L (eq. 6.9, p. 102)	Q	N/A	L/day

Number of Trench Wall Sides with Flow (1 or 2) <-- This is used only in the equation above

Calculations of Vertical Upward Flow from Underlying Sand Through Till

Difference in hydraulic head (m)	Δh	1.6	m
Difference between Base of Excavation and Aquifer (m)	ΔL	5.0	m
Hydraulic Conductivity (m/sec)	K	7.8E-05	
Vertical Flow (m^3/sec)	Q	2.2E-04	m^3/sec
Darcys Law Q=KiA	Q	18753	L/day
Total Flow	Q	197,520	L/day



Radial Flow, Water Table Aquifer

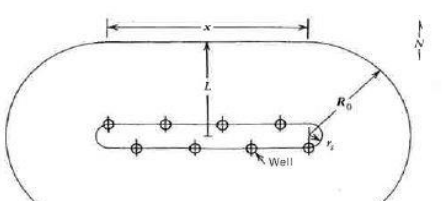
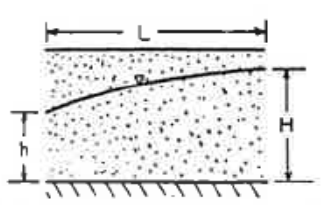


Figure 6.8 Approximate analysis of long narrow systems.



Water Table Flow From a Line Source to a Drainage Trench

Construction Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Dewatering Calculations 20 foot Townhouse Unit 2 (Anticipated Conditions)

Site Geranium Delhi Golf Course

Input Parameters			**User Entry**		**Calc'd**	
Initial Elevation of Water Table (m)	H	228.7	masl	4.5	m
Final Elevation of Water Table (m)	h	228.7	masl	4.5	m
Base of Aquifer/Datum		224.2	masl	0.0	m
Hydraulic Conductivity (m/s)	K	7.8E-06	m/s	7.8E-06	m/s
Hydraulic Conductivity (m/d)	K		m/d	6.7E-01	m/d
Aquifer Thickness if Confined (m)	B		m	0.0	m
Length of Excavation (m)	a	5.0	m	5.0	
Width of Excavation (m)	b	17.0	m	17.0	
Length of Dewatering - Trench Length (m)	X		m	0.0	
Linear System Zone of Influence (m)	L		m	0.0	
Sichardt Constant (well = 3, wellpoint = 1.5 or 2)	C	3.0		3.0	
Ratio a/b Override a/b? (Y/N) N	a/b			0.3	

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m) Well radius + ZOI

$R_o = C \times (H - h) \times \sqrt{K}$ (eq. 6.14, p. 104)

$R_o + R_s$	5.2	
R_o	0.0	m

Equivalent Radius of Well (m)

R_s	5.2	m

$R_s = \sqrt{((a \times b)/ \pi)}$ (eq. 6.10, p. 102)

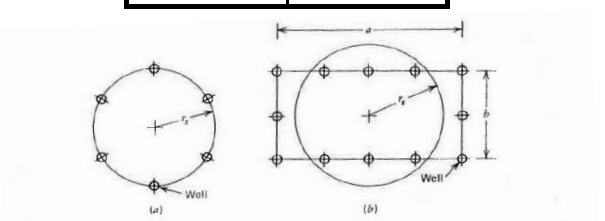


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b <= 1.5) TRUE

	Unfactored Rates		
Shaft Calculation (m^3/day) Q	11.8	m^3/day	
$Q = (\pi \times K \times (H^2 - h^2)) / \ln (R_o / R_s)$ (Eq. 6.3, p. 99) Q	11,818	L/day	

Long Narrow System - Trench (a/b > 1.5) FALSE

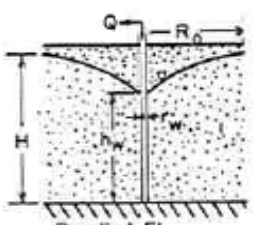
Trench Calculation with Radial Flow at Ends (m^3/day) Q	N/A	m^3/day
$Q = K \times X \times (H^2 - h^2) / L + \pi \times K \times (H^2 - h^2) / \ln(R_o/R_s)$ (eq. 6.8, p. 101) Q	N/A	L/day

Drainage Trench from a Line Source (m^3/day) Q	N/A	m^3/day
$Q = K \times X \times (H^2 - h^2) / L$ (eq. 6.9, p. 102) Q	N/A	L/day

Number of Trench Wall Sides with Flow (1 or 2) <-- This is used only in the equation above

Calculations of Vertical Upward Flow from Underlying Sand Through Till

Difference in hydraulic head (m)	Δh	0.0	m
Difference between Base of Excavation and Aquifer (m)	ΔL	4.5	m
Hydraulic Conductivity (m/sec)	K	7.8E-06	
Vertical Flow (m^3/sec)	Q	0.0E+00	m^3/sec
Darcys Law Q=KiA	Q	0	L/day
Total Flow	Q	11,818	L/day



Radial Flow, Water Table Aquifer

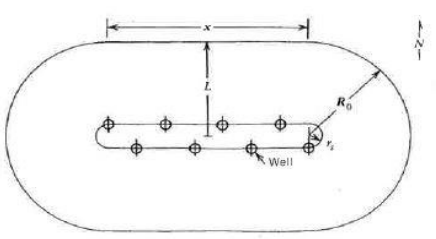
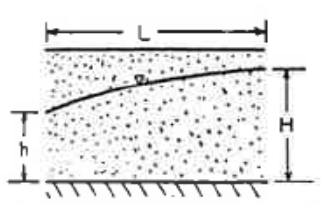


Figure 6.8 Approximate analysis of long narrow systems.



Water Table Flow From a Line Source to a Drainage Trench

Construction Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Dewatering Calculations SWMP (Anticipated Conditions)

Site Geranium Delhi Golf Course

Input Parameters			**User Entry**		**Calc'd**	
Initial Elevation of Water Table (m)		H	228.0	masl	3.8	m
Final Elevation of Water Table (m)		h	225.5	masl	1.3	m
Base of Aquifer/Datum			224.2	masl	0.0	m
Hydraulic Conductivity (m/s)		K	7.8E-06	m/s	7.8E-06	m/s
Hydraulic Conductivity (m/d)		K		m/d	6.7E-01	m/d
Aquifer Thickness if Confined (m)		B		m	0.0	m
Length of Excavation (m)		a	140.8	m	140.8	
Width of Excavation (m)		b	111.4	m	111.4	
Length of Dewatering - Trench Length (m)		X		m	0.0	
Linear System Zone of Influence (m)		L		m	10.5	
Sichardt Constant (well = 3, wellpoint = 1.5 or 2)		C	3.0		3.0	
Ratio a/b	Override a/b? (Y/N) N	a/b			1.3	

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m) Well radius + ZOI

$R_o = C \times (H - h) \times \sqrt{K}$ (eq. 6.14, p. 104)

$R_o + R_s$	91.6	
R_o	20.9	m

Equivalent Radius of Well (m)

R_s	70.7	m

$R_s = \sqrt{((a \times b)/ pi)}$ (eq. 6.10, p. 102)

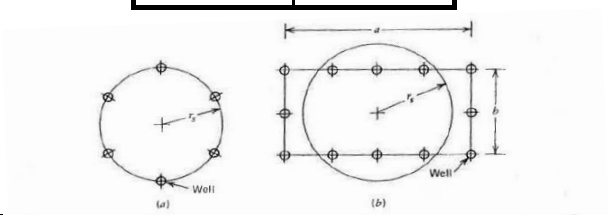


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b <= 1.5) TRUE

	Unfactored Rates		
Shaft Calculation (m^3/day)	Q	103.9	m^3/day
$Q = (\pi \times K \times (H^2 - h^2)) / \ln (R_o / R_s)$ (Eq. 6.3, p. 99)	Q	103,869	L/day

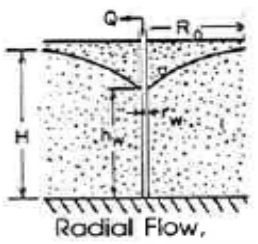
Long Narrow System - Trench (a/b > 1.5) FALSE

Trench Calculation with Radial Flow at Ends (m^3/day)	Q	N/A	m^3/day
$Q = K \times X \times (H^2 - h^2) / L + \pi \times K \times (H^2 - h^2) / \ln(R_o/R_s)$ (eq. 6.8, p. 101)	Q	N/A	L/day
Drainage Trench from a Line Source (m^3/day)	Q	N/A	m^3/day
Q = K x X x (H^2 - h^2) / L (eq. 6.9, p. 102)	Q	N/A	L/day

Number of Trench Wall Sides with Flow (1 or 2) <-- This is used only in the equation above

Calculations of Vertical Upward Flow from Underlying Sand Through Till

Difference in hydraulic head (m)	Δh	2.5	m
Difference between Base of Excavation and Aquifer (m)	ΔL	1.3	m
Hydraulic Conductivity (m/sec)	K	1.5E-07	
Vertical Flow (m^3/sec)	Q	2.4E-04	m^3/sec
Darcys Law Q=KiA	Q	20,991	L/day
Total Flow	Q	124,860	L/day



Radial Flow, Water Table Aquifer

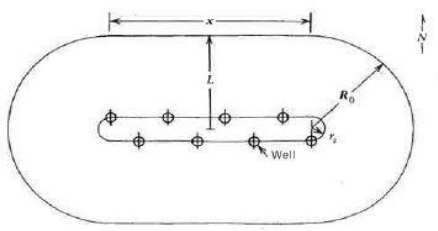
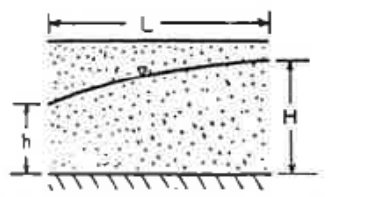


Figure 6.8 Approximate analysis of long narrow systems.



Water Table Flow From a Line Source to a Drainage Trench

Construction Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Dewatering Calculations SWMP (Factor of Safety - 10 X Hydraulic Conductivity)

Site Geranium Delhi Golf Course

Input Parameters		**User Entry**		**Calc'd**	
Initial Elevation of Water Table (m)	H	228.0	masl	3.8	m
Final Elevation of Water Table (m)	h	225.5	masl	1.3	m
Base of Aquifer/Datum		224.2	masl	0.0	m
Hydraulic Conductivity (m/s)	K	7.8E-05	m/s	7.8E-05	m/s
Hydraulic Conductivity (m/d)	K		m/d	6.7E+00	m/d
Aquifer Thickness if Confined (m)	B		m	0.0	m
Length of Excavation (m)	a	140.8	m	140.8	
Width of Excavation (m)	b	111.4	m	111.4	
Length of Dewatering - Trench Length (m)	X		m	0.0	
Linear System Zone of Influence (m)	L		m	33.1	
Sichardt Constant (well = 3, wellpoint = 1.5 or 2)	C	3.0		3.0	
Ratio a/b Override a/b? (Y/N) N	a/b			1.3	

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m) Well radius + ZOI

$R_o = C \times (H - h) \times \sqrt{K}$ (eq. 6.14, p. 104)

$R_o + R_s$	136.8	
R_o	66.2	m

Equivalent Radius of Well (m)

R_s	70.7	m

$R_s = \sqrt{((a \times b)/ pi)}$ (eq. 6.10, p. 102)

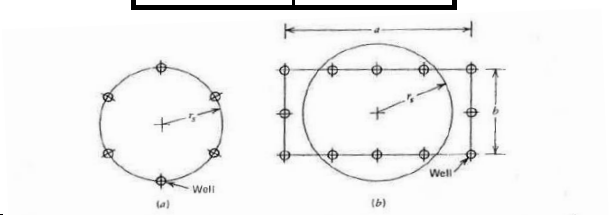


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b <= 1.5) TRUE

	Unfactored Rates		
Shaft Calculation (m^3/day)	Q	407.7	m^3/day
$Q = (\pi \times K \times (H^2 - h^2)) / \ln (R_o / R_s)$ (Eq. 6.3, p. 99)	Q	407,691	L/day

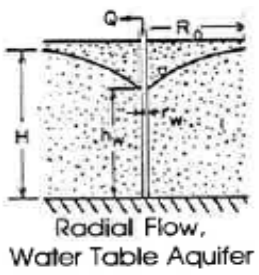
Long Narrow System - Trench (a/b > 1.5) FALSE

Trench Calculation with Radial Flow at Ends (m^3/day)	Q	N/A	m^3/day
$Q = K \times X \times (H^2 - h^2) / L + \pi \times K \times (H^2 - h^2) / \ln(R_o/R_s)$ (eq. 6.8, p. 101)	Q	N/A	L/day
Drainage Trench from a Line Source (m^3/day)	Q	N/A	m^3/day
Q = K x X x (H^2 - h^2) / L (eq. 6.9, p. 102)	Q	N/A	L/day

Number of Trench Wall Sides with Flow (1 or 2) <-- This is used only in the equation above

Calculations of Vertical Upward Flow from Underlying Sand Through Till

Difference in hydraulic head (m)	Δh	2.5	m
Difference between Base of Excavation and Aquifer (m)	ΔL	1.3	m
Hydraulic Conductivity (m/sec)	K	1.5E-06	
Vertical Flow (m^3/sec)	Q	2.4E-03	m^3/sec
Darcys Law Q=KiA	Q	209915	L/day
Total Flow	Q	617,606	L/day



Radial Flow, Water Table Aquifer

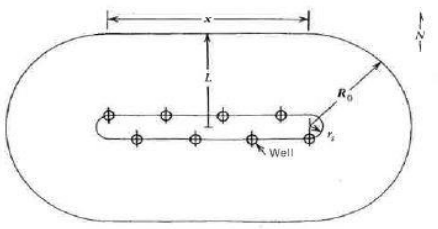
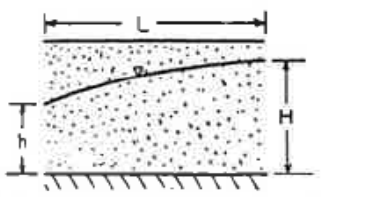


Figure 6.8 Approximate analysis of long narrow systems.



Water Table Flow From a Line Source to a Drainage Trench

Construction Dewatering Worksheet - Confined Conditions

from Powers, 1992

Dewatering Calculations Trench Section 1 (Anticipated Conditions)

Input Parameters		User Entry		Calc'd	
Initial Elevation of Water Table (m)	H	235.0	masl	1.8	m
Final Elevation of Water Table (m)	h	234.4	masl	1.2	m
Base of Aquifer/Datum		233.2	masl	0.0	m
Hydraulic Conductivity (m/s)	K	7.8E-06	m/s	7.8E-06	m/s
Hydraulic Conductivity (m/d)	K		m/d	6.7E-01	m/d
Aquifer Thickness if Confined (m)	B	1.5	m	1.5	m
Length of Excavation (m)	a	50.0	m	50.0	m
Width of Excavation (m)	b	3.0	m	3.0	m
Length of Dewatering - Trench Length (m)	X	50.0	m	50.0	m
Linear System Zone of Influence (m)	L		m	2.5	m
Sichardt Constant (well = 3, wellpoint = 1.5 or 2)	C	3.0		3.0	
Ratio a/b Override a/b? (Y/N) N	a/b			16.7	

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m) Well radius + ZOI

R_o = C x (H - h) x sqrt (K) (eq. 6.14, p. 104)

$R_o + R_s$	11.9	m
R_o	5.0	m

Equivalent Radius of Well (m)

R_s = sqrt ((a x b)/ pi) (eq. 6.10, p. 102)

R_s	6.9	m

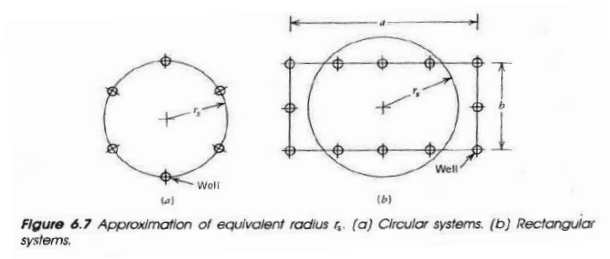


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b <= 1.5) FALSE

Shaft Calculation (m^3/day)

Q = (2 x π x K x B x (H - h)) / ln (R_o / R_s) (Eq. 6.1, p. 98)

Q	N/A	m^3/day
Q	N/A	L/day

Long Narrow System - Trench (a/b > 1.5) TRUE

Trench Calculation with Radial Flow at Ends (m^3/day)

Q = (2 x K x B x X x (H - h)) / L + (2 x π x K x B x (H - h)) / ln (R_o / R_s)

Q	30.9	m^3/day
Q	30,864	L/day

Drainage Trench from a Line Source (m^3/day)

Q = 2 x X x K x B x (H - h) / L (eq. 6.8, p. 101) - for flow at both walls

Q	23.9	m^3/day
Q	23,948	L/day

Number of Trench Wall Sides with Flow (1 or 2) 2 <-- This is used only in the equation above

Specify 2 walls if an actual trench, specify 1 wall if modelling a wall of a building - equations shown above based on 2 walls

Calculations of Vertical Upward Flow from Underlying Sand Through Till

Difference in hydraulic head (m)	Δh	0.6	m
Difference between Base of Excavation and Aquifer (m)	ΔL	1.2	m
Hydraulic Conductivity (m/sec)	K	7.8E-06	
Vertical Flow (m^3/sec)	Q	5.8E-05	m^3/sec
Darcys Law Q=KiA	Q	5045	L/day
Total Flow	Q	28,993	L/day

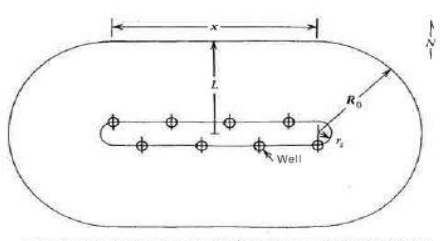
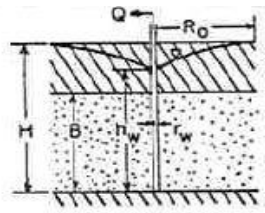
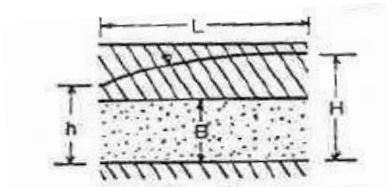


Figure 6.8 Approximate analysis of long narrow systems.



Radial Flow, Confined Aquifer



Confined Flow From a Line Source to a Drainage Trench

Construction Dewatering Worksheet - Confined Conditions

from Powers, 1992

Dewatering Calculations Trench Section 1 (Factor of Safety - 10 X Hydraulic Conductivity)

Input Parameters		User Entry		Calc'd	
Initial Elevation of Water Table (m)	H	235.0	masl	1.8	m
Final Elevation of Water Table (m)	h	234.4	masl	1.2	m
Base of Aquifer/Datum		233.2	masl	0.0	m
Hydraulic Conductivity (m/s)	K	7.8E-05	m/s	7.8E-05	m/s
Hydraulic Conductivity (m/d)	K		m/d	6.7E+00	m/d
Aquifer Thickness if Confined (m)	B	1.5	m	1.5	m
Length of Excavation (m)	a	50.0	m	50.0	m
Width of Excavation (m)	b	3.0	m	3.0	m
Length of Dewatering - Trench Length (m)	X	50.0	m	50.0	m
Linear System Zone of Influence (m)	L		m	7.9	m
Sichardt Constant (well = 3, wellpoint = 1.5 or 2)	C	3.0		3.0	
Ratio a/b Override a/b? (Y/N) N	a/b			16.7	

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m) Well radius + ZOI

$R_o = C \times (H - h) \times \sqrt{K}$ (eq. 6.14, p. 104)

$R_o + R_s$	22.8	m
R_o	15.9	m

Equivalent Radius of Well (m)

$R_s = \sqrt{((a \times b)/ \pi)}$ (eq. 6.10, p. 102)

R_s	6.9	m

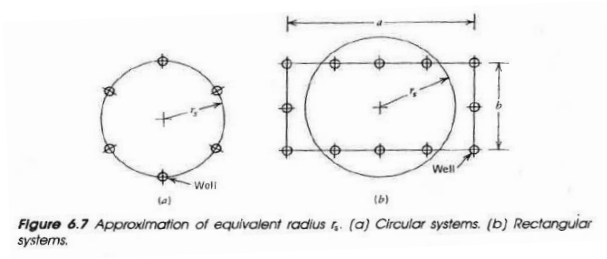


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b <= 1.5) FALSE

Shaft Calculation (m^3/day)

$Q = (2 \times \pi \times K \times B \times (H - h)) / \ln (R_o / R_s)$ (Eq. 6.1, p. 98)

Q	N/A	m^3/day
Q	N/A	L/day

Long Narrow System - Trench (a/b > 1.5) TRUE

Trench Calculation with Radial Flow at Ends (m^3/day)

$Q = (2 \times K \times B \times X \times (H - h)) / L + (2 \times \pi \times K \times B \times (H - h)) / \ln (R_o / R_s)$

Q	107.4	m^3/day
Q	107,390	L/day

Drainage Trench from a Line Source (m^3/day)

$Q = 2 \times X \times K \times B \times (H - h) / L$ (eq. 6.8, p. 101) - for flow at both walls

Q	75.7	m^3/day
Q	75,729	L/day

Number of Trench Wall Sides with Flow (1 or 2) 2 <-- This is used only in the equation above

Specify 2 walls if an actual trench, specify 1 wall if modelling a wall of a building - equations shown above based on 2 walls

Calculations of Vertical Upward Flow from Underlying Sand Through Till

Difference in hydraulic head (m)	Δh	0.6	m
Difference between Base of Excavation and Aquifer (m)	ΔL	1.2	m
Hydraulic Conductivity (m/sec)	K	7.8E-05	
Vertical Flow (m^3/sec)	Q	5.8E-04	m^3/sec
Darcys Law Q=KiA	Q	50,453	L/day
Total Flow	Q	126,182	L/day

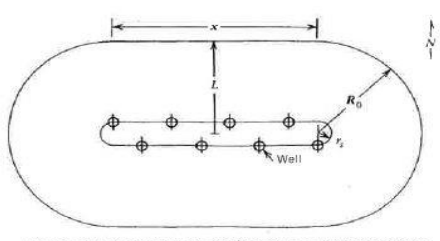
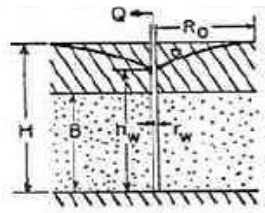
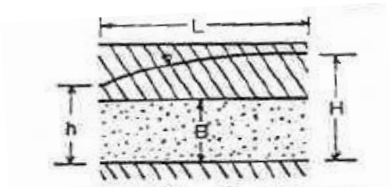


Figure 6.8 Approximate analysis of long narrow systems.



Radial Flow, Confined Aquifer



Confined Flow From a Line Source to a Drainage Trench

Construction Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Dewatering Calculations Trench Section 2 (Anticipated Conditions)

Site Geranium Delhi Golf Course

Input Parameters			**User Entry**		**Calc'd**	
Initial Elevation of Water Table (m)	H	232.0	masl	2.1	m
Final Elevation of Water Table (m)	h	230.3	masl	0.4	m
Base of Aquifer/Datum		229.9	masl	0.0	m
Hydraulic Conductivity (m/s)	K	7.8E-06	m/s	7.8E-06	m/s
Hydraulic Conductivity (m/d)	K		m/d	6.7E-01	m/d
Aquifer Thickness if Confined (m)	B		m	0.0	m
Length of Excavation (m)	a	50.0	m	50.0	
Width of Excavation (m)	b	3.0	m	3.0	
Length of Dewatering - Trench Length (m)	X	50.0	m	50.0	
Linear System Zone of Influence (m)	L		m	7.1	
Sichardt Constant (well = 3, wellpoint = 1.5 or 2)	C	3.0		3.0	
Ratio a/b Override a/b? (Y/N) N	a/b			16.7	

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m) Well radius + ZOI

$R_o = C \times (H - h) \times \sqrt{K}$ (eq. 6.14, p. 104)

$R_o + R_s$	21.1	
R_o	14.2	m

Equivalent Radius of Well (m)

R_s	6.9	m

$R_s = \sqrt{((a \times b)/ pi)}$ (eq. 6.10, p. 102)

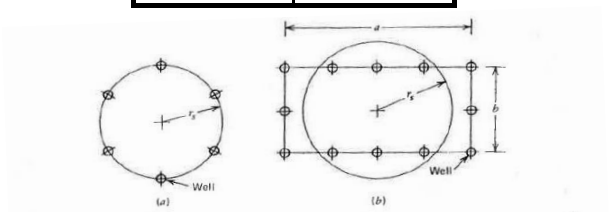


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b <= 1.5) FALSE

Shaft Calculation (m^3/day)

$Q = (\pi \times K \times (H^2 - h^2)) / \ln (R_o / R_s)$ (Eq. 6.3, p. 99)

Q	N/A	m^3/day
Q	N/A	L/day

Long Narrow System - Trench (a/b > 1.5) TRUE

Trench Calculation with Radial Flow at Ends (m^3/day)

$Q = K \times X \times (H^2 - h^2) / L + \pi \times K \times (H^2 - h^2) / \ln(R_o/R_s)$ (eq. 6.8, p. 101)

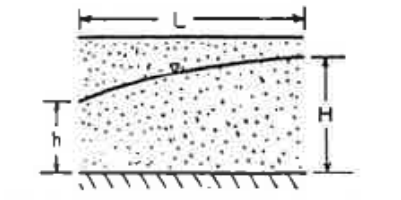
Q	28.1	m^3/day
Q	28,122	L/day

	Unfactored Rates		
Drainage Trench from a Line Source (m^3/day)	Q	20.1	m^3/day
Q = K x X x (H^2 - h^2) / L (eq. 6.9, p. 102)	Q	20,090	L/day

Number of Trench Wall Sides with Flow (1 or 2) 2 <-- This is used only in the equation above

Calculations of Vertical Upward Flow from Underlying Sand Through Till

Difference in hydraulic head (m)	Δh	1.7	m
Difference between Base of Excavation and Aquifer (m)	ΔL	0.4	m
Hydraulic Conductivity (m/sec)	K	7.8E-06	
Vertical Flow (m^3/sec)	Q	1.2E-04	m^3/sec
Darcys Law Q=KiA	Q	10091	L/day
Total Flow	Q	30,181	L/day



Water Table Flow From a Line Source to a Drainage Trench

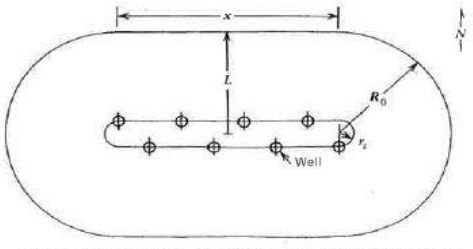
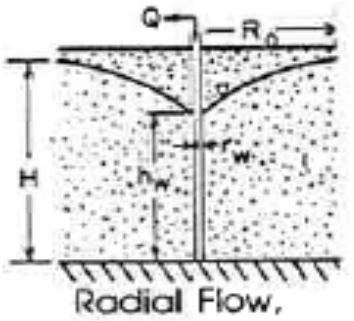


Figure 6.8 Approximate analysis of long narrow systems.



Radial Flow, Water Table Aquifer

Construction Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Dewatering Calculations Trench Section 2 (Factor of Safety - 10 X Hydraulic Conductivity)

Site Geranium Delhi Golf Course

Input Parameters			**User Entry**		**Calc'd**	
Initial Elevation of Water Table (m)		H	232.0	masl	2.1	m
Final Elevation of Water Table (m)		h	230.3	masl	0.4	m
Base of Aquifer/Datum			229.9	masl	0.0	m
Hydraulic Conductivity (m/s)		K	7.8E-05	m/s	7.8E-05	m/s
Hydraulic Conductivity (m/d)		K		m/d	6.7E+00	m/d
Aquifer Thickness if Confined (m)		B		m	0.0	m
Length of Excavation (m)		a	50.0	m	50.0	
Width of Excavation (m)		b	3.0	m	3.0	
Length of Dewatering - Trench Length (m)		X	50.0	m	50.0	
Linear System Zone of Influence (m)		L		m	22.5	
Sichardt Constant (well = 3, wellpoint = 1.5 or 2)		C	3.0		3.0	
Ratio a/b	Override a/b? (Y/N) N	a/b			16.7	

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m) Well radius + ZOI

$R_o = C \times (H - h) \times \sqrt{K}$ (eq. 6.14, p. 104)

$R_o + R_s$	51.9	
R_o	45.0	m

Equivalent Radius of Well (m)

R_s	6.9	m

$R_s = \sqrt{((a \times b)/ pi)}$ (eq. 6.10, p. 102)

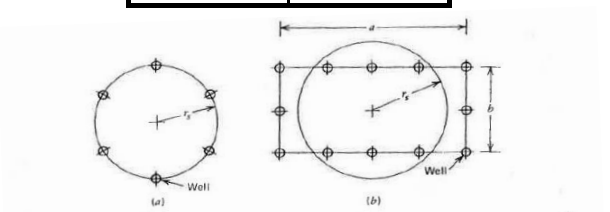


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b <= 1.5) FALSE

Shaft Calculation (m^3/day)	Q	N/A m^3/day
$Q = (\pi \times K \times (H^2 - h^2)) / \ln (R_o / R_s)$ (Eq. 6.3, p. 99)	Q	N/A L/day

Long Narrow System - Trench (a/b > 1.5) TRUE

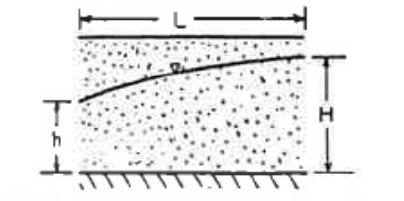
Trench Calculation with Radial Flow at Ends (m^3/day)	Q	108.1 m^3/day
$Q = K \times X \times (H^2 - h^2) / L + \pi \times K \times (H^2 - h^2) / \ln(R_o/R_s)$ (eq. 6.8, p. 101)	Q	108,071 L/day

	Unfactored Rates		
Drainage Trench from a Line Source (m^3/day)	Q	63.5	m^3/day
Q = K x X x (H^2 - h^2) / L (eq. 6.9, p. 102)	Q	63,531	L/day

Number of Trench Wall Sides with Flow (1 or 2): 2 <-- This is used only in the equation above

Calculations of Vertical Upward Flow from Underlying Sand Through Till

Difference in hydraulic head (m)	Δh	1.7	m
Difference between Base of Excavation and Aquifer (m)	ΔL	0.4	m
Hydraulic Conductivity (m/sec)	K	7.8E-05	
Vertical Flow (m^3/sec)	Q	1.2E-03	m^3/sec
Darcys Law Q=KiA	Q	100906	L/day
Total Flow	Q	164,437	L/day



Water Table Flow From a Line Source to a Drainage Trench

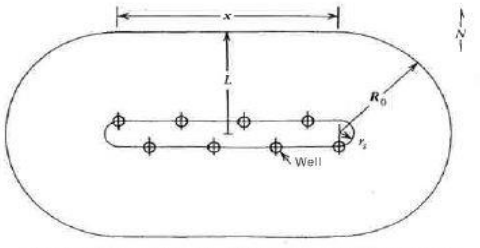
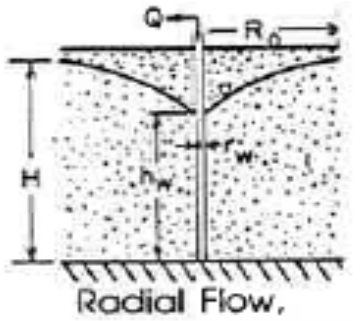


Figure 6.8 Approximate analysis of long narrow systems.



Radial Flow, Water Table Aquifer

Construction Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Dewatering Calculations Trench Section 3 (Anticipated Conditions)

Site Geranium Delhi Golf Course

Input Parameters		**User Entry**		**Calc'd**	
Initial Elevation of Water Table (m)	H	229.0	masl	5.0	m
Final Elevation of Water Table (m)	h	225.3	masl	1.3	m
Base of Aquifer/Datum		224.0	masl	0.0	m
Hydraulic Conductivity (m/s)	K	7.8E-06	m/s	7.8E-06	m/s
Hydraulic Conductivity (m/d)	K		m/d	6.7E-01	m/d
Aquifer Thickness if Confined (m)	B		m	0.0	m
Length of Excavation (m)	a	50.0	m	50.0	
Width of Excavation (m)	b	3.0	m	3.0	
Length of Dewatering - Trench Length (m)	X	50.0	m	50.0	
Linear System Zone of Influence (m)	L		m	15.4	
Sichardt Constant (well = 3, wellpoint = 1.5 or 2)	C	3.0		3.0	
Ratio a/b Override a/b? (Y/N) N	a/b			16.7	

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m) Well radius + ZOI

$R_o = C \times (H - h) \times \sqrt{K}$ (eq. 6.14, p. 104)

$R_o + R_s$	37.7	
R_o	30.8	m

Equivalent Radius of Well (m)

R_s	6.9	m

$R_s = \sqrt{((a \times b)/ \pi)}$ (eq. 6.10, p. 102)

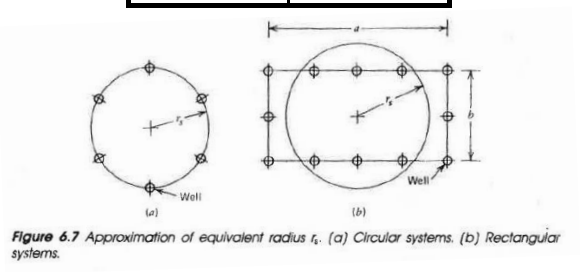


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b <= 1.5) FALSE

Shaft Calculation (m^3/day)	Q	N/A	m^3/day
$Q = (\pi \times K \times (H^2 - h^2)) / \ln (R_o / R_s)$ (Eq. 6.3, p. 99)	Q	N/A	L/day

Long Narrow System - Trench (a/b > 1.5) TRUE

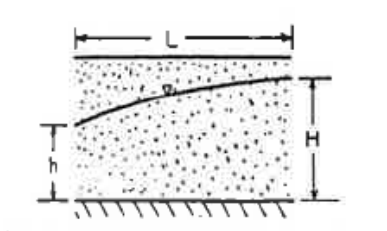
Trench Calculation with Radial Flow at Ends (m^3/day)	Q	79.8	m^3/day
$Q = K \times X \times (H^2 - h^2) / L + \pi \times K \times (H^2 - h^2) / \ln(R_o/R_s)$ (eq. 6.8, p. 101)	Q	79,750	L/day

		Unfactored Rates	
Drainage Trench from a Line Source (m^3/day)	Q	50.8	m^3/day
Q = K x X x (H^2 - h^2) / L (eq. 6.9, p. 102)	Q	50,788	L/day

Number of Trench Wall Sides with Flow (1 or 2) 2 <-- This is used only in the equation above

Calculations of Vertical Upward Flow from Underlying Sand Through Till

Difference in hydraulic head (m)	Δh	3.7	m
Difference between Base of Excavation and Aquifer (m)	ΔL	1.3	m
Hydraulic Conductivity (m/sec)	K	7.8E-06	
Vertical Flow (m^3/sec)	Q	1.2E-04	m^3/sec
Darcys Law Q=KiA	Q	10091	L/day
Total Flow	Q	60,879	L/day



Water Table Flow From a Line Source to a Drainage Trench

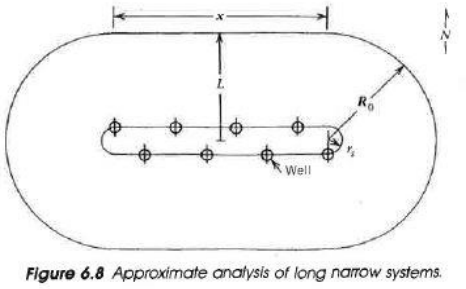
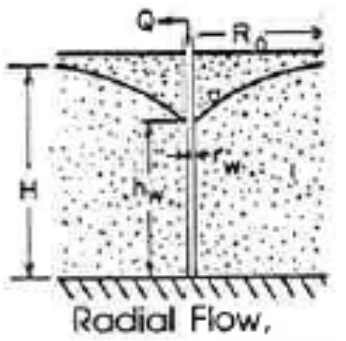


Figure 6.8 Approximate analysis of long narrow systems.



Radial Flow, Water Table Aquifer

Construction Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Dewatering Calculations Trench Section 3 (Factor of Safety - 10 X Hydraulic Conductivity)

Site Geranium Delhi Golf Course

Input Parameters			**User Entry**		**Calc'd**	
Initial Elevation of Water Table (m)		H	229.0	masl	5.0	m
Final Elevation of Water Table (m)		h	225.3	masl	1.3	m
Base of Aquifer/Datum			224.0	masl	0.0	m
Hydraulic Conductivity (m/s)		K	7.8E-05	m/s	7.8E-05	m/s
Hydraulic Conductivity (m/d)		K		m/d	6.7E+00	m/d
Aquifer Thickness if Confined (m)		B		m	0.0	m
Length of Excavation (m)		a	50.0	m	50.0	
Width of Excavation (m)		b	3.0	m	3.0	
Length of Dewatering - Trench Length (m)		X	50.0	m	50.0	
Linear System Zone of Influence (m)		L		m	48.7	
Sichardt Constant (well = 3, wellpoint = 1.5 or 2)		C	3.0		3.0	
Ratio a/b	Override a/b? (Y/N) N	a/b			16.7	

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m) Well radius + ZOI

$R_o = C \times (H - h) \times \sqrt{K}$ (eq. 6.14, p. 104)

$R_o + R_s$	104.3	
R_o	97.4	m

Equivalent Radius of Well (m)

R_s	6.9	m

$R_s = \sqrt{((a \times b)/ \pi)}$ (eq. 6.10, p. 102)

Flow Calculations - Q

Radial Flow to a Shaft (a/b <= 1.5) FALSE

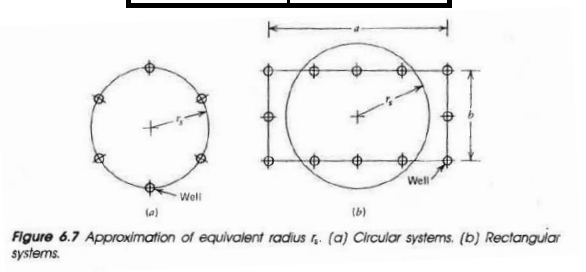


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Shaft Calculation (m^3/day)

$Q = (\pi \times K \times (H^2 - h^2)) / \ln (R_o / R_s)$ (Eq. 6.3, p. 99)

Q	N/A	m^3/day
Q	N/A	L/day

Long Narrow System - Trench (a/b > 1.5) TRUE

Trench Calculation with Radial Flow at Ends (m^3/day)

$Q = K \times X \times (H^2 - h^2) / L + \pi \times K \times (H^2 - h^2) / \ln(R_o/R_s)$ (eq. 6.8, p. 101)

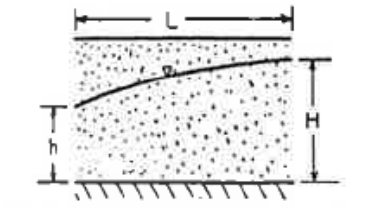
Q	341.7	m^3/day
Q	341,675	L/day

	Unfactored Rates		
Drainage Trench from a Line Source (m^3/day)	Q	160.6	m^3/day
Q = K x X x (H^2 - h^2) / L (eq. 6.9, p. 102)	Q	160,607	L/day

Number of Trench Wall Sides with Flow (1 or 2) 2 <-- This is used only in the equation above

Calculations of Vertical Upward Flow from Underlying Sand Through Till

Difference in hydraulic head (m)	Δh	3.7	m
Difference between Base of Excavation and Aquifer (m)	ΔL	1.3	m
Hydraulic Conductivity (m/sec)	K	7.8E-05	
Vertical Flow (m^3/sec)	Q	1.2E-03	m^3/sec
Darcys Law Q=KiA	Q	100906	L/day
Total Flow	Q	261,513	L/day



Water Table Flow From a Line Source to a Drainage Trench

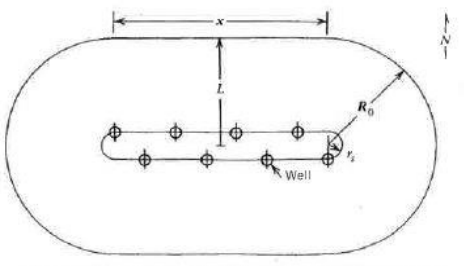
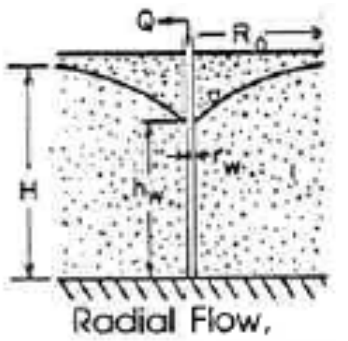


Figure 6.8 Approximate analysis of long narrow systems.



Radial Flow, Water Table Aquifer

Construction Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Dewatering Calculations Trench Section 4 (Anticipated Conditions)

Site Geranium Delhi Golf Course

Input Parameters		**User Entry**		**Calc'd**	
Initial Elevation of Water Table (m)	H	228.5	masl	2.0	m
Final Elevation of Water Table (m)	h	227.6	masl	1.1	m
Base of Aquifer/Datum		226.5	masl	0.0	m
Hydraulic Conductivity (m/s)	K	7.8E-06	m/s	7.8E-06	m/s
Hydraulic Conductivity (m/d)	K		m/d	6.7E-01	m/d
Aquifer Thickness if Confined (m)	B		m	0.0	m
Length of Excavation (m)	a	50.0	m	50.0	
Width of Excavation (m)	b	3.0	m	3.0	
Length of Dewatering - Trench Length (m)	X	50.0	m	50.0	
Linear System Zone of Influence (m)	L		m	3.8	
Sichardt Constant (well = 3, wellpoint = 1.5 or 2)	C	3.0		3.0	
Ratio a/b Override a/b? (Y/N) N	a/b			16.7	

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m) Well radius + ZOI

$R_o = C \times (H - h) \times \sqrt{K}$ (eq. 6.14, p. 104)

$R_o + R_s$	14.5	
R_o	7.6	m

Equivalent Radius of Well (m)

R_s	6.9	m

$R_s = \sqrt{((a \times b)/ \pi)}$ (eq. 6.10, p. 102)

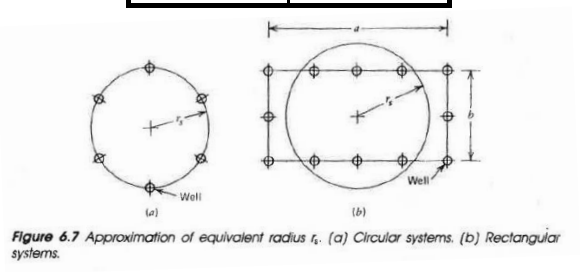


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b <= 1.5) FALSE

Shaft Calculation (m^3/day)

$Q = (\pi \times K \times (H^2 - h^2)) / \ln (R_o / R_s)$ (Eq. 6.3, p. 99)

Q	N/A	m^3/day
Q	N/A	L/day

Long Narrow System - Trench (a/b > 1.5) TRUE

Trench Calculation with Radial Flow at Ends (m^3/day)

$Q = K \times X \times (H^2 - h^2) / L + \pi \times K \times (H^2 - h^2) / \ln(R_o/R_s)$ (eq. 6.8, p. 101)

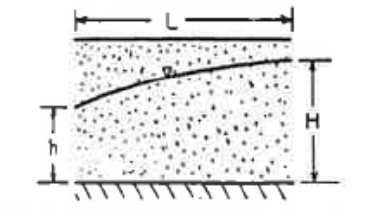
Q	32.8	m^3/day
Q	32,829	L/day

	Unfactored Rates		
Drainage Trench from a Line Source (m^3/day)	Q	24.8	m^3/day
Q = K x X x (H^2 - h^2) / L (eq. 6.9, p. 102)	Q	24,832	L/day

Number of Trench Wall Sides with Flow (1 or 2) 2 <-- This is used only in the equation above

Calculations of Vertical Upward Flow from Underlying Sand Through Till

Difference in hydraulic head (m)	Δh	0.9	m
Difference between Base of Excavation and Aquifer (m)	ΔL	1.1	m
Hydraulic Conductivity (m/sec)	K	7.8E-06	
Vertical Flow (m^3/sec)	Q	9.8E-05	m^3/sec
Darcys Law Q=KiA	Q	8424	L/day
Total Flow	Q	33,256	L/day



Water Table Flow From a Line Source to a Drainage Trench

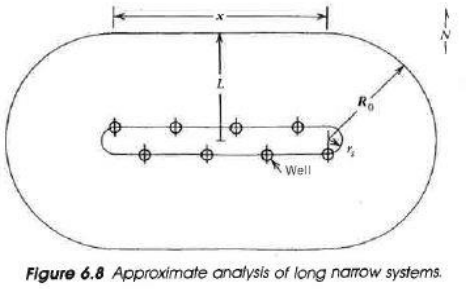
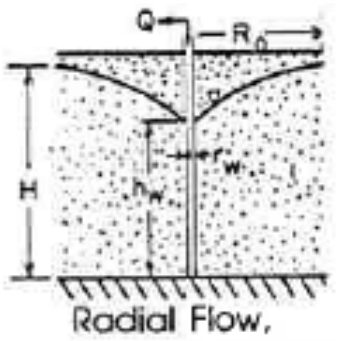


Figure 6.8 Approximate analysis of long narrow systems.



Radial Flow, Water Table Aquifer

Construction Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Dewatering Calculations Trench Section 4 (Factor of Safety - 10 X Hydraulic Conductivity)

Site Geranium Delhi Golf Course

Input Parameters		**User Entry**		**Calc'd**	
Initial Elevation of Water Table (m)	H	228.5	masl	2.0	m
Final Elevation of Water Table (m)	h	227.6	masl	1.1	m
Base of Aquifer/Datum		226.5	masl	0.0	m
Hydraulic Conductivity (m/s)	K	7.8E-05	m/s	7.8E-05	m/s
Hydraulic Conductivity (m/d)	K		m/d	6.7E+00	m/d
Aquifer Thickness if Confined (m)	B		m	0.0	m
Length of Excavation (m)	a	50.0	m	50.0	
Width of Excavation (m)	b	3.0	m	3.0	
Length of Dewatering - Trench Length (m)	X	50.0	m	50.0	
Linear System Zone of Influence (m)	L		m	12.0	
Sichardt Constant (well = 3, wellpoint = 1.5 or 2)	C	3.0		3.0	
Ratio a/b Override a/b? (Y/N) N	a/b			16.7	

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m) Well radius + ZOI

$R_o = C \times (H - h) \times \sqrt{K}$ (eq. 6.14, p. 104)

$R_o + R_s$	31.0	
R_o	24.1	m

Equivalent Radius of Well (m)

R_s	6.9	m

$R_s = \sqrt{((a \times b)/ \pi)}$ (eq. 6.10, p. 102)

Flow Calculations - Q

Radial Flow to a Shaft (a/b <= 1.5) FALSE

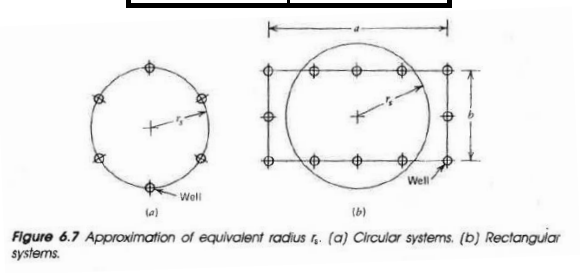


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Shaft Calculation (m^3/day)

$Q = (\pi \times K \times (H^2 - h^2)) / \ln (R_o / R_s)$ (Eq. 6.3, p. 99)

Q	N/A	m^3/day
Q	N/A	L/day

Long Narrow System - Trench (a/b > 1.5) TRUE

Trench Calculation with Radial Flow at Ends (m^3/day)

$Q = K \times X \times (H^2 - h^2) / L + \pi \times K \times (H^2 - h^2) / \ln(R_o/R_s)$ (eq. 6.8, p. 101)

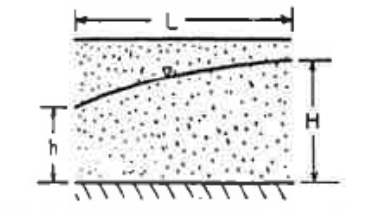
Q	118.1	m^3/day
Q	118,115	L/day

	Unfactored Rates		
Drainage Trench from a Line Source (m^3/day)	Q	78.5	m^3/day
Q = K x X x (H^2 - h^2) / L (eq. 6.9, p. 102)	Q	78,525	L/day

Number of Trench Wall Sides with Flow (1 or 2) 2 <-- This is used only in the equation above

Calculations of Vertical Upward Flow from Underlying Sand Through Till

Difference in hydraulic head (m)	Δh	0.9	m
Difference between Base of Excavation and Aquifer (m)	ΔL	1.1	m
Hydraulic Conductivity (m/sec)	K	7.8E-05	
Vertical Flow (m^3/sec)	Q	9.8E-04	m^3/sec
Darcys Law Q=KiA	Q	84242	L/day
Total Flow	Q	162,767	L/day



Water Table Flow From a Line Source to a Drainage Trench

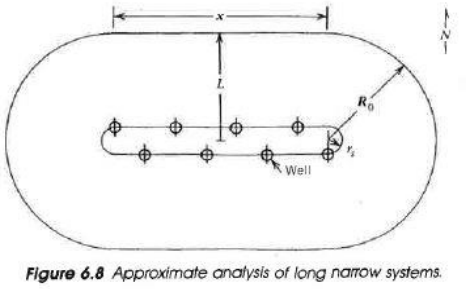
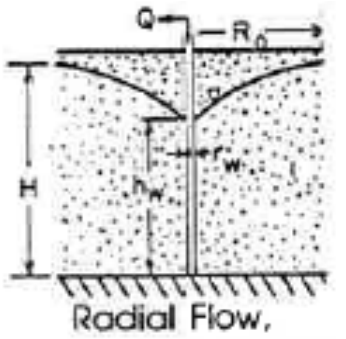


Figure 6.8 Approximate analysis of long narrow systems.



Radial Flow, Water Table Aquifer

BURNSIDE

Functional Servicing Report - Delhi Golf & Country Club Redevelopment

Delhi Development Inc.
c/o Geranium
3190 Steeles Avenue East
Suite 300
Markham, ON L3R 1G9

Functional Servicing Report - Delhi Golf & Country Club Redevelopment

Delhi Development Inc.
c/o Geranium
3190 Steeles Avenue East
Suite 300
Markham, ON L3R 1G9

R.J. Burnside & Associates Limited
35 Perry Street
Woodstock ON N4S 3C4 CANADA

March 2023
3000053741.0000

Distribution List

No. of Hard Copies	PDF	Email	Organization Name
	Yes	Yes	Geranium
0	Yes	Yes	Norfolk County

Record of Revisions

Revision	Date	Description
0	December 22, 2022	Initial Submission to Norfolk County
1	February 1, 2023	Submission to Norfolk County
2	March 15, 2023	Updated Submission to Norfolk County

R.J. Burnside & Associates Limited

Report Prepared By:

Frank Goulding, P.Eng.,
Civil Engineer
FG:cvh/lam/tp

Report Reviewed By:

Steven Roorda, P.Eng.,
Vice President of Land Development

Table of Contents

1.0 Introduction and Background 1
1.1 Site Description and Context 1
1.2 Scope of Work 3
1.3 Background Studies and Documentations 4
1.4 Existing Site Conditions 4
1.4.1 Soil Conditions 6
1.4.2 Groundwater Conditions 6
1.4.3 Environmental Features 6
1.5 Proposed Development Limit 6
1.6 Proposed Site Concept 7
2.0 Grading and Storm Drainage 9
2.1 Site Grading 9
2.2 Existing Storm Drainage 9
2.3 Proposed Storm Drainage 11
2.4 Foundation Drain Collection 13
2.5 Minor System Conveyance 13
2.6 Major System Conveyance 13
2.7 External Drainage Conveyance 13
3.0 Water Distribution 14
3.1 Water Design Criteria 14
3.2 Existing Water Infrastructure 15
3.3 Proposed Water Distribution Layout 15
4.0 Wastewater Servicing 16
4.1 Wastewater Design Criteria 16
4.2 Existing Wastewater Infrastructure 16
4.3 Proposed Wastewater Servicing 17
4.4 Downstream Wastewater Improvements 19
5.0 Utilities 19
6.0 Roadways 19
6.1 Municipal Right of Ways 19
7.0 Erosion and Sediment Control 22
8.0 Conclusions and Recommendations 22

Drawing List

G1 – Grading Plan
G2 – Grading Plan
CUSP – Conceptual Underground Servicing Plan
STM1 – Preliminary Storm Servicing Plan
SAN1 – Preliminary Sanitary Servicing Plan
WAT1 – Preliminary Water Servicing Plan

Figures

Figure 1: Site Location Plan 2
Figure 2: Existing Soil Conditions 5
Figure 3: Proposed Concept Plan 8
Figure 4: Pre-Development (Existing) Drainage Area Plan 10
Figure 5: Post-Development Drainage Area Plan 12
Figure 6: Sanitary Drainage Area Plan 18
Figure 7: ROW Typical 20.0m 20
Figure 8: ROW Modified 20.0m Cross Section 21

Appendices

Drawings
Appendix A Calculations and Hydrant Flow Test Results
Appendix B Sanitary Design Calculations
Appendix C Floodplain Modelling Figures

Disclaimer

Other than by the addressee, copying or distribution of this document, in whole or in part, is not permitted without the express written consent of R.J. Burnside & Associates Limited.

1.0 Introduction and Background

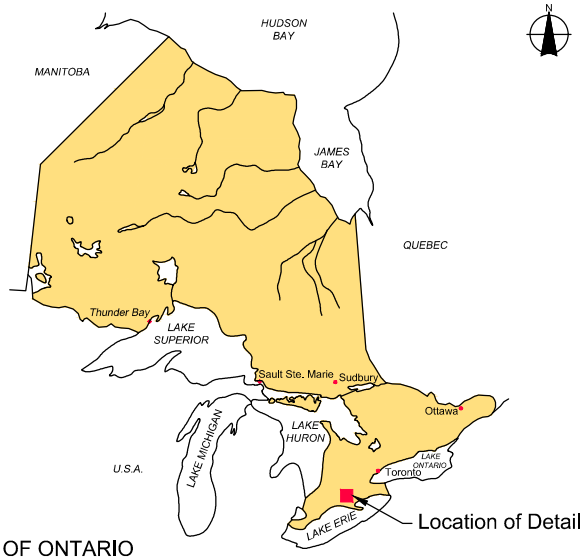
R.J. Burnside & Associates Limited (Burnside) has been retained by Delhi Development Inc. c/o Geranium, to prepare a Functional Servicing Report (FSR) for the proposed redevelopment of the Delhi Golf and Country Club. This FSR has been prepared to accompany the application for an Official Plan Amendment (for an urban boundary expansion and redesignation of the lands), Zoning By-law Amendment, Plan of Subdivision and Plan of Condominium applications and demonstrates that the subject lands can be provided with public servicing in accordance with applicable regulatory requirements and criteria. A Stormwater Management (SWM) Report has been prepared in March 2023 by Burnside, under a separate cover, and should be reviewed in conjunction with this report.

1.1 Site Description and Context

The Delhi Golf and Country Club redevelopment (the “Site”) is located along Highway 3 (James Street), south of Dalton Road, in the County of Norfolk, Ontario.

The existing Site consists of two developable areas, separated by a Provincially Significant Wetland (PSW) and is 55.32ha in size. For the purposes of this report, the developable area will be referenced as the North and South Sites. The north developable area (the “North Site”) has frontage on Wilson Ave and St. Michael’s Street and consists of a proposed residential condominium and freehold residential block. The south developable area (the “South Site”) fronts onto Highway 3 (James Street) and Tisdale Drive and consists of the remaining proposed freehold residential blocks, wastewater services, SWM facilities, a retirement block and community spaces. Please refer to Figure 1 for the location of the Site.

The existing South Site includes two PSWs, connected via the Delhi Golf Estates Municipal Drain which flows from the north side of the property downstream towards Stoney Creek, located on the southern boundary of the Site.



KEY MAP OF ONTARIO

BURNSIDE

Client

DELHI DEVELOPMENT INC.

Figure Title

DELHI GOLF COURSE

SITE LOCATION PLAN

Drawn	Checked	Date	Figure No.
BF	FG	23/03/15	1
Scale		Project No.	
1:20,000		053741.05	

File: \\SHERLOCK\Shared Work Areas\053741 Delhi GC\053741.05 FSR\07_Figures\SHARED FIGURES\053741.05 FIG1_SITE LOCATION.dwg Date Plotted: March 14, 2023 - 2:15 PM

1.2 Scope of Work

The proposed scope of work for the Delhi Golf and Country Club redevelopment FSR will include the following:

a) Overview of Existing Conditions

   1) Confirm storm drainage areas from detailed mapping; and

   2) Review flooding limits established after coordination with the Long Point Region Conservation Authority (LPRCA).

b) Servicing, Grading and Limits of Development

   1) Identify the water and sanitary servicing requirements for the redevelopment area;

   2) Prepare a functional servicing system to provide water services as well as sanitary services outletting into a proposed extension of municipal services; and

   3) Prepare preliminary grading of roads, lots and / or blocks, and ponds with consideration for adjacent environmental features.

1.3 Background Studies and Documentations

The servicing concepts presented within this report have been developed to comply with the information contained in the reports below, which were established for the subject property. The following documents, studies, and reports have been incorporated unless otherwise noted.

Document Title	Prepared By	Date
Delhi Golf and Country Club – Stormwater Management Report	R.J. Burnside & Associates Limited	March 2023
Delhi Golf and Country Club – External Servicing Study	T.Y. Lin International Company	November 2022
Environmental Impact Study	Beacon Environmental	December 2022
Preliminary Geotechnical Investigation Report, Proposed Residential Development – Delhi Golf and Country Club	Golder Associates Limited	December 2022
Hydrogeological Assessment, Proposed Residential Development – Delhi Golf and Country Club	Golder Associates Limited	December 2022
Inter-Urban Water Supply	WSP Global	January 2021
Integrated Sustainable Master Plan	MMM Group	September 2016
Norfolk Design Standards	Norfolk County	August 2017

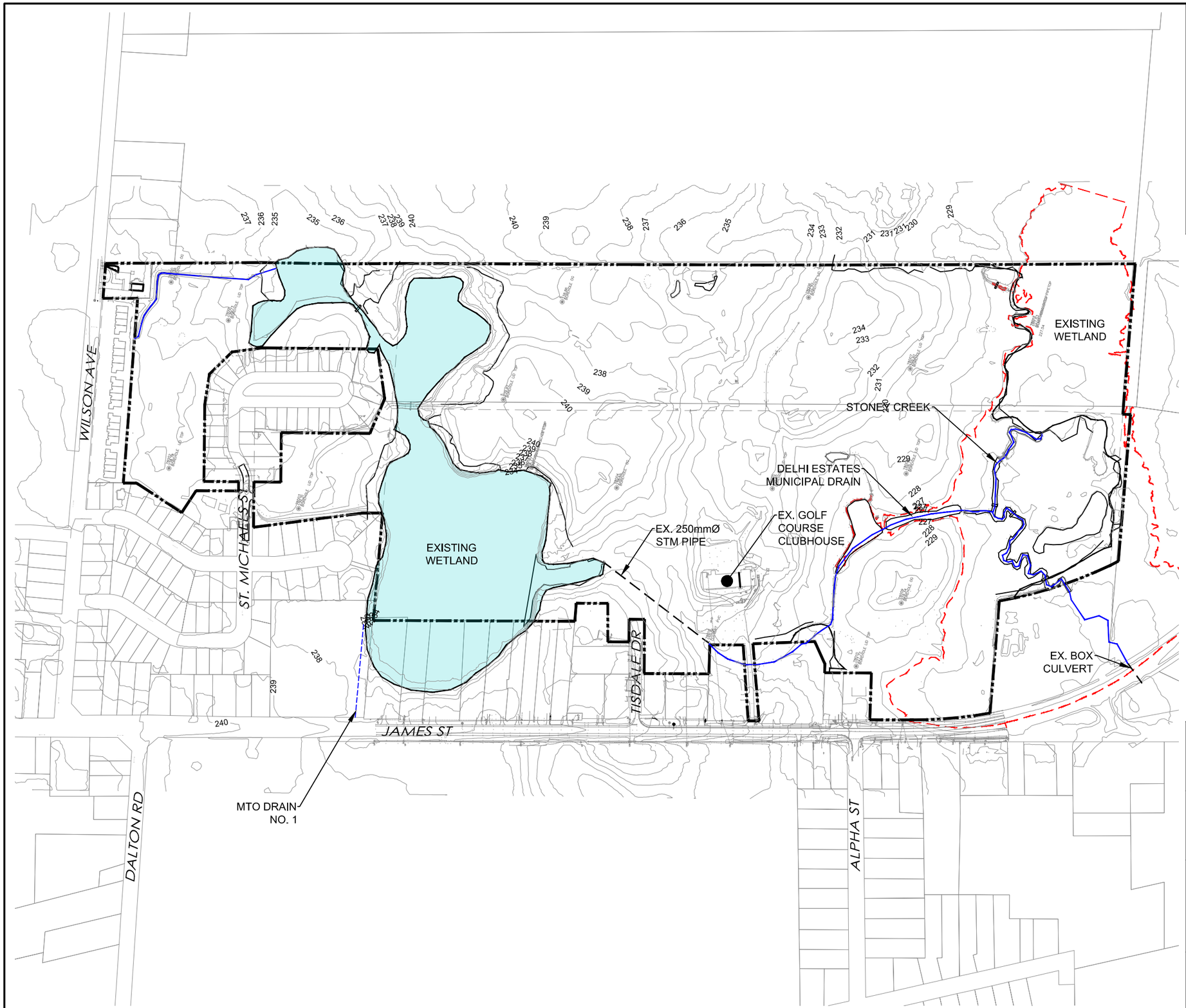
1.4 Existing Site Conditions

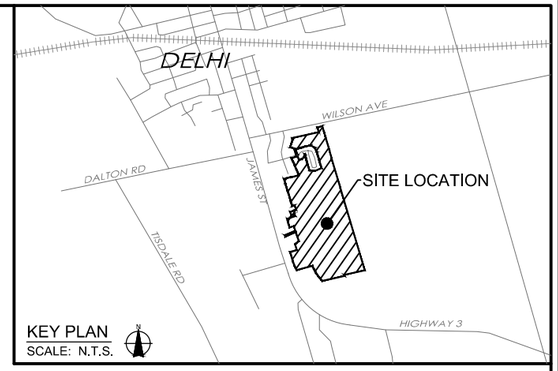
Currently the Subject Site consists of mainly the Delhi Golf and Country Club. The North Site also includes an existing residential property that has frontage on Wilson Ave.

The Delhi Golf and Country Club is currently serviced by two existing water supply wells on the South Site. The wells service the existing club house and golf course irrigation system. The clubhouse is serviced via an onsite sewage treatment and dispersal bed system. The Site is not currently serviced via municipal owned services.

A municipal drain (Delhi Golf Estates Drain) runs through the South Site, connecting the PSW to the watercourse to the south. There are multiple wetlands, online ponds, and watercourses within the redevelopment area, portions of which are proposed to be retained as part of the redevelopment plan per the Environmental Impact Study completed by Beacon Environmental.

Please refer to Figure 2 for Existing Soil Conditions.





LEGEND

- PROPERTY BOUNDARY
- EXISTING 100-YR FLOODLINE
- 320.5 EXISTING CONTOUR
- EXISTING WATERCOURSE

N

0 50 100 200 300 400

Metres

BURNSIDE

Client

DELHI DEVELOPMENT INC.

Figure Title

DELHI GOLF COURSE

EXISTING CONDITIONS

Drawn	Checked	Date	Figure No.
BF	FG	23/03/15	**2**
Scale		Project No.	
1:5000		053741.05	

File: \\SHERLOCK\Shared Work Areas\053741 Delhi GC\053741.05 FSR\07_ Figures\SHARED FIGURES\053741.05 FIG2_ EXISTING CONDITIONS.dwg Date Plotted: March 14, 2023 - 2:16 PM

1.4.1 Soil Conditions

A preliminary geotechnical investigation for the study area was completed by Golder Associates Limited. Based upon the findings, the Site is covered by topsoil underlain by clayey sand to silt to clayey silt to silty clay. The topsoil thickness generally ranges from 150 mm to 900 mm. In addition, cobbles and boulders in the till deposit were detected within the Site. For additional information, please refer to the Preliminary Geotechnical Investigation by Golder Associates Limited (2022) submitted under separate cover.

1.4.2 Groundwater Conditions

Groundwater conditions were monitored, and it was found that water tables varied from 0.0 m to 6.1 m below ground level. The shallower water table depths were generally located in the southern portion of the Site, adjacent to existing wetlands, the Municipal Drain, and Stoney Creek floodplain. The servicing design and approach was completed based on the recommendations made by Golder's Hydrogeological report, December 2022, submitted as part of the Site's application. Based on the recommendations from the Hydrogeological report, foundation drain collection systems will be explored during detailed design.

1.4.3 Environmental Features

A detailed description of the natural features and functions of the Site is presented in the Environmental Impact Study by Beacon Environmental (December 2022). The features include multiple Provincially Significant Wetlands, the Stoney Creek watercourse, open ditch channels, on-line ponds, and other features as described in the Beacon report.

1.5 Proposed Development Limit

The development limit was determined using a combination of information provided in Beacon Environmental's Report, correspondence with the LPRCA, the Stoney Creek floodplain, regulation limits and hazards, and additional floodplain modelling completed with the Topographic information gathered as part of this application. For more information on the modelling of the Stoney Creek floodplain, please refer to the SWM Report completed by Burnside, dated March 15, 2023.

The floodplain is proposed to be modified in two areas to optimize the design and development limit of the Site. The cut/fill balance approach to modifying the floodplain is an acceptable practice and was done after discussions with the LPRCA. The first proposed modification to the floodplain is an on-line pond, located along the Delhi Golf Estates Municipal Drain. In Beacon Environmental's report, it was determined that this pond is man made and was deemed appropriate for removal, modifying the floodplain. The other minor proposed adjustment to the floodplain is along James Street at the southern limit of the property; the floodplain is proposed to be adjusted to allow an extra lot fronting onto James Street. The proposed adjustments to the floodplain were

achieved by the widening and naturalization of the open ditch channel, the larger channel resulted in a volume of cut material that offset the fill volumes for the floodplain adjustments. For more details on the cut/fill analysis of the floodplain, please refer to Appendix C. The development limit has been defined as the greatest environmental constraint; either 100-Year Flood Line, the regulated limit per LPRCA, the 30 m regulated area for the naturalized channel, or as the 30 m buffer from the Provincially Significant Wetland within the Site boundary. Please refer to Appendix C for details.

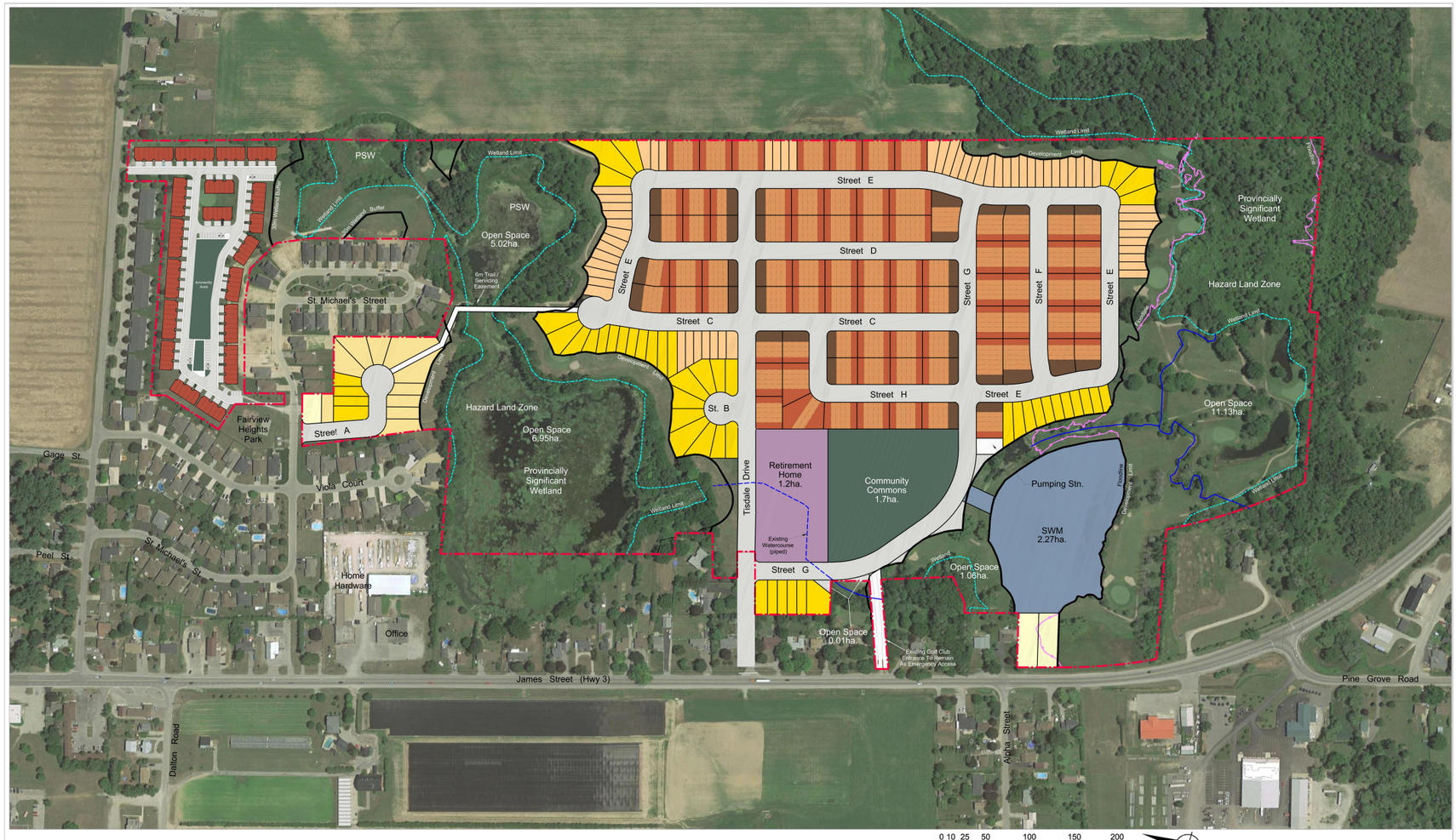
1.6 Proposed Site Concept

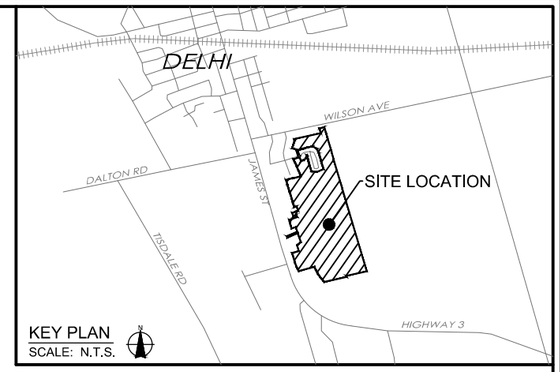
The proposed redevelopment will be on the 29.73 ha of developable land within the boundaries of the property and will include 120 single family dwelling lots, 475 street townhouses, a townhouse block (with 129 townhouses), a retirement home, a 1.7 ha Community Commons Block, a proposed sanitary pumping station (0.06 ha), and an SWM pond (2.27 ha) for quality and quantity control.

There are two accesses proposed for the South Site, the first is an extension of Tisdale Drive, which is an existing municipal road off James Street and will serve as the main access to the proposed subdivision. The second access will utilize the existing Delhi Golf and Country Club driveway off James Street as an emergency access. There are two accesses proposed for the North Site, one for the townhome block off Wilson Avenue and the other for Street ‘A’ connecting to St. Michaels Street.

The proposed redevelopment will be serviced by an extension of existing municipal water and sanitary services. The water will be an extension of the existing 300 mm watermain on Wilson Avenue and looped to connect to the existing 200 m watermain at the intersection of Dalton Road and James Street. The sanitary will be a forcemain and a pumping station to connect to the Main Street pumping station as well as an extension of gravity sanitary services to connect to the St. Michael’s Street pumping station. The external servicing required for the proposed redevelopment is examined further in the Servicing Study completed by the T.Y. Lin International Company.

Please refer to Figure 3 for the proposed concept plan.





Delhi Development Inc.

DEVELOPMENT CONCEPT

Delhi Golf & Country Club

Site Area: 55.32ha. (136.7ac.)
Developable Area: 29.73ha. (73.4ac)
No. of Lots / Units: 874

- 18' Townhouses (129)
- 18' Street Townhouses (313)
- 20' Street Townhouses (130)
- 22' Street Townhouses (32)
- 30' Lots (57)
- 36' Lots (50)
- 44' Lots (10)
- 60' Lots (3)
- Retirement Home (150)

0 10 25 50 100 150 200
Metres

NOTE: This concept should be considered as a preliminary demonstration model that illustrates an 'order of magnitude' development scenario for the site and is subject to municipal planning approvals.

Scale 1:4,000 | February 23, 2023 | Project No.: 21208 | Drawn By: SL

BURNSIDE

Client

DELHI DEVELOPMENT INC.

Figure Title

DELHI GOLF COURSE

PROPOSED DRAFT PLAN

Drawn	Checked	Date	Figure No.
BF	FG	23/03/15	3
Scale		Project No.	
N.T.S.		053741.05	

File: \\SHERLOCK\Shared Work Areas\053741 Delhi GC\053741.05 FSR\07_Figures\SHARED FIGURES\053741.05 FIG3_PROPOSED DRAFT PLAN.dwg Date Plotted: March 14, 2023 - 2:16 PM

2.0 Grading and Storm Drainage

2.1 Site Grading

The conceptual grading design for the North and South Site is provided in drawing G1 has been developed with consideration of the following requirements and constraints:

a) Conformance with Norfolk County (the “County”) grading and design criteria;

b) Incorporating existing grades at road access points to Tisdale Drive, James Street, St. Michaels Street, as well as Wilson Avenue;

c) Matching of existing boundary grades at the property limits as well as existing wetland, floodplain and wooded areas identified for protection;

d) Optimization of earthworks (i.e., minimizing fill);

e) Provision for adequate cover on proposed services;

f) Provision for overland flow conveyance on the roadways and easements to the proposed SWM pond (i.e., major system storm drainage and emergency overland flow);

g) Conveyance of stormwater within the Site and minimizing external runoff; and

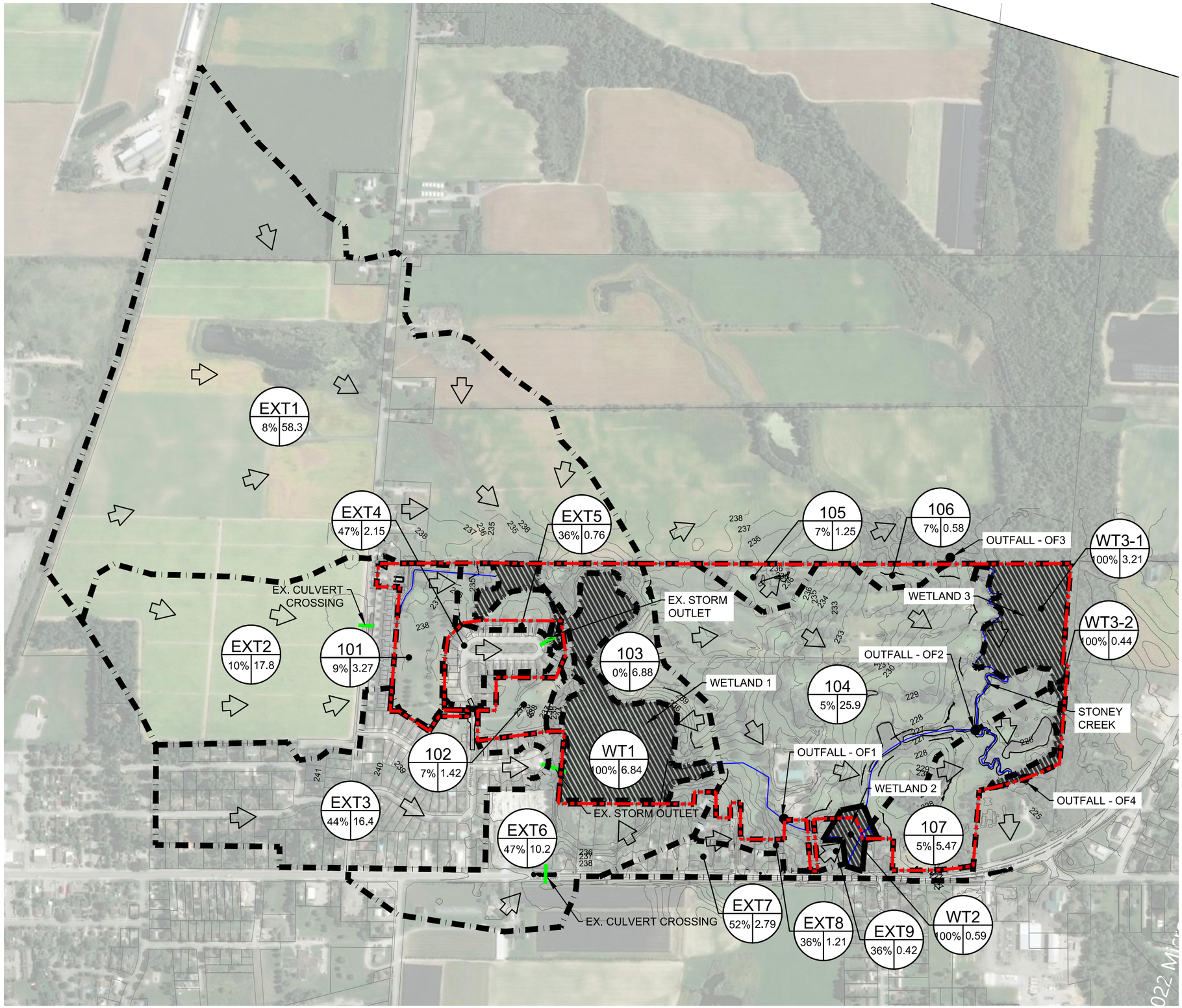
h) Incorporating recommendations from the accompanying Hydrogeological, Environmental, and Traffic reports.

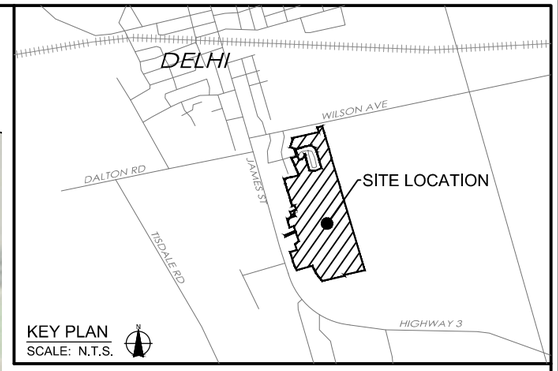
The proposed road grades allow for overland flow conveyance within the future Right-Of-Way (ROW) to direct major storm drainage from the redevelopment to the proposed SWM pond located in the southwest corner of the South Site.

2.2 Existing Storm Drainage

The existing Site topography generally drains from north to south to the PSW and Delhi Golf Estates Drain. The Delhi Golf Estates Drain is a municipal drain composed of a control structure in the middle PSW, a section of piped sewer, and an open channel ditch that outlets into Stoney Creek. Stoney Creek is located within the southern PSW and generally flows in a southwesterly direction connecting to Big Creek in Norfolk County. For more details regarding the existing Storm Drainage, please refer to the SWM report prepared by Burnside dated March 15, 2023.

Please refer to Figure 4, which shows the Pre-Development (Existing) Stormwater Drainage Area Plan.





LEGEND

- PROPERTY BOUNDARY
- EXISTING DRAINAGE BOUNDARY
- 230.9
- EXISTING OVERLAND FLOW DIRECTION
- 101 / 0.50 | 1.21 — CATCHMENT No. / CATCHMENT AREA / IMPERVIOUS FRACTION
- EXISTING WETLAND

N

0 100 200 400 600
Metres

BURNSIDE

Client

DELHI DEVELOPMENT INC.

Figure Title

DELHI GOLF COURSE

PRE-DEVELOPMENT DRAINAGE PLAN

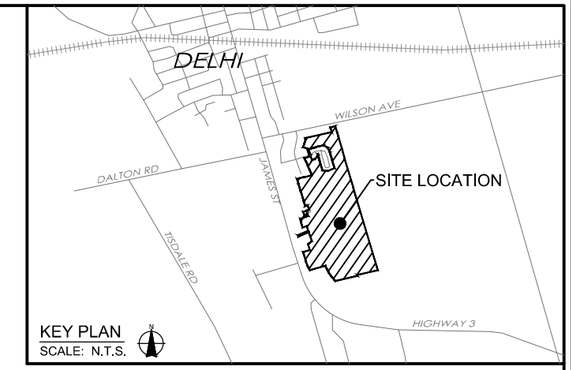
Drawn	Checked	Date	Figure No.
BF	LG	23/01/31	4
Scale		Project No.	
1:7500		053741.05	

File: \\SHERLOCK\Shared Work Areas\053741 Delhi GC\053741.05 FSR\07_Figures\SHARED FIGURES\053741.05 FIG4_PRE-DEVELOPMENT DRAINAGE PLAN.dwg Date Plotted: March 14, 2023 - 2:17 PM

2.3 Proposed Storm Drainage

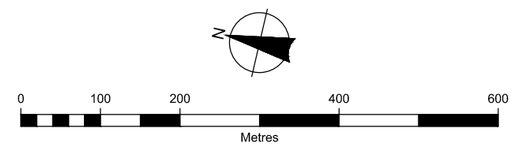
One SWM pond is proposed, which is to be located along the southwestern border of the developable area. This pond is designed to meet or exceed the SWM criteria with respect to quantity, quality, erosion control, water balance, and conveyance of storm drainage for the Site. For more details regarding the proposed drainage area, please refer to the SWM Report prepared by Burnside dated March 15, 2023.

The post-development drainage areas are shown on Figure 5.



LEGEND

- PROPERTY BOUNDARY
- PROPOSED DRAINAGE BOUNDARY
- PROPOSED OVERLAND FLOW DIRECTION
- 201 / 55% / 1.21 — CATCHMENT No., CATCHMENT AREA, % IMPERVIOUS
- EXISTING WETLAND



BURNSIDE

Client

DELHI DEVELOPMENT INC.

Figure Title

DELHI GOLF COURSE

POST-DEVELOPMENT DRAINAGE PLAN

Drawn	Checked	Date	Figure No.
BF	LG	23/03/15	5
Scale		Project No.	
1:7500		053741.05	

File: \\SHERLOCK\Shared Work Areas\053741 Delhi GC\053741.05 FSR\07_ Figures\SHARED FIGURES\053741.05 FIG5_ POST-DEVELOPMENT DRAINAGE PLAN.dwg Date Plotted: March 14, 2023 - 2:18 PM

2.4 Foundation Drain Collection

All proposed foundation drains will be connected to the storm sewer system, where required, as per Norfolk County Design Standards. The preliminary grading design was coordinated with the results of Golder's Hydrogeological Study, December 2022 to assess the potential impact of the observed groundwater level on the proposed building foundations. An initial review suggests foundation drains will be required for 40% of the proposed lots.

2.5 Minor System Conveyance

As per Norfolk County Design standards, the minor system flow will be conveyed through a series of storm sewers sized in combination with catchbasins (CBs) located within the ROW and rear yards to convey the 5-year return period storm. One SWM Pond is proposed to collect the storm discharge, located in the southwestern portion of the developable land.

The middle PSW discharges through the Site via the municipal drain. The minor flows from this system will continue to be conveyed via a separate sewer to an outlet into the existing open ditch in the rear of existing properties fronting James Street to maintain the natural features of the channel. The open ditch, downstream of that location, will continue along its current alignment, outletting into Stoney Creek.

Drawing STM1 shows the overall layout for the preliminary storm sewer network for the proposed drainage areas.

2.6 Major System Conveyance

The major system will convey the 100-year storm within the proposed ROW and direct the flow into the proposed SWM pond as overland flow. The middle PSW's 100-year storm will be conveyed via over-sized storm sewers through the proposed easement, outletting into the existing open ditch, bypassing the proposed SWM pond. For more details regarding the Major System Conveyance, please refer to the SWM Report prepared by Burnside, dated March 15, 2023.

2.7 External Drainage Conveyance

There are nine external drainage areas that flow through the Subject Lands ultimately reaching the Stoney Creek watercourse, as shown on Figure 5.

The first external drainage area (EXT1) is located north-west of the Site and drains overland to the Site. The area is mainly comprised of rural lawns.

The second external drainage area (EXT2) is located north of the Site and drains overland and via a culvert into the Site. The area is mainly comprised of rural lawns.

The third external drainage area (EXT3) is located north-west of the Site and drains to the Site via a sixth external area (EXT6) that is located farther south, and north-west of the Site. EXT3 is comprised of single-family residential buildings along St. Michael's Street and Viola Court.

The fourth and fifth external drainage areas (EXT4 and EXT5, respectively), are located adjacent to the existing Site and are comprised of single-family residential buildings along St. Michael's Street.

The sixth external drainage area noted above (EXT6) is comprised of farmland, one commercial lot and single-family residential buildings. The farmland is separated from the Site by James Street (Highway 3) and drains through a combination of overland flow conveyance through a culvert crossing that passes under the road into the Site, and through the MTO Drain No. 1.

The final three external drainage areas (EXT7, EXT8 and EXT9) are located south of EXT6 on the west side of the Site and are bound by James Street (Highway 3) to the west. EXT8 and EXT9 comprise of the existing golf course and lawns which drain into Catchment 104. EXT7 is comprised of single-family residential buildings and drains south into the Site via Catchment 107 and outlets to Stoney Creek downstream of the proposed outlet for the Site in post-development.

The surface flows from each of these external areas will be appropriately conveyed through the Site. For more details regarding the External Drainage Conveyance, please refer to the SWM Report prepared by Burnside, dated March 2023.

3.0 Water Distribution

3.1 Water Design Criteria

The proposed water distribution within the property will be designed and constructed to current County and Ministry of the Environment, Conservation and Parks (MECP) criteria and specifications, which are as follows:

a) Peak hourly demand plus fire flow;

b) Pressure in transmission watermains to be a minimum 40psi (275kPa) during peak hour demands at hydrant elevation;

c) Pressure in a transmission main under condition of simultaneous peak hour flow and fire demands is to be no less than 20psi (140kPa) at the point in the system where the fire flow is drawn. Fire Flow shall be minimum 275kPa (40psi); and

d) Preferred pressure ranges are;

    1) Average Day and Maximum Day: 50psi (350kPa) to 80psi (550kPa).

2) Minimum Hour and Peak Hour: 40psi (375kPa) to 100psi (700kPa).

3.2 Existing Water Infrastructure

The existing Delhi Golf and Country Club is currently supplied with water by the existing well on the South Site. No other water services are provided to the subject property.

There is an existing 300 mm watermain along the frontage of Wilson Avenue, and a 150 mm watermain along the frontage of St. Michaels Street. In the September 20, 2022, Information Memo from Norfolk's Environmental and Infrastructure Department, the Delhi Drinking Water System was described to have 2,768 m^3/day of capacity after existing, committed, and pending demands were removed.

3.3 Proposed Water Distribution Layout

The proposed water supply for the proposed subdivision will be delivered by the existing municipal watermain that services the community of Delhi. The water supply requirement is estimated to be 596 m^3/day for the Average Day Flow and 1267 m^3/day for the Maximum Day Flow (MAF). Please refer to the External Servicing Study prepared by T.Y. Lin for more information regarding the existing system and required upgrades.

The preliminary Water Distribution Plan (Drawing WAT1) is a plan indicating connection points, as well as layout and routing for the proposed 300 mm watermain within the proposed subdivision. A minimum ground cover of 1.7 m will be ensured for the entire length of water services within the Site. The watermain will be looped through the Site, connecting to the future James Street watermain and the existing Watermain on Wilson Avenue. A watermain model will be completed during detailed design to confirm the proposed watermain sizing.

The supply source along Watson Avenue, James Street, and Dalton Road will provide the minimum required pressure of 275kPa (40psi) for fire flow supply as demonstrated in the attached calculations and hydrant flow test results (Appendix A).

For any additional detailed information regarding the required external water infrastructure and upgrades, please reference the External Servicing Study by T.Y. Lin.

4.0 Wastewater Servicing

4.1 Wastewater Design Criteria

The proposed wastewater sewers will be designed and constructed to current County and MECP criteria and specifications. The following summary of applicable County criteria will be applied in generating the average and peak flows:

a) Residential flow rate: 266 L/capita/day

b) Infiltration: Max. 0.26 L/s/ha

c) Peaking Factor: Harmon peaking factor formula

d) Population Densities:

   1) Single Dwelling Units: 2.75 ppu

   2) Retirement Facility: 1.7 ppu

e) Design Minimum and Maximum:

   1) Pipe Diameter: Minimum size for local sanitary sewer is 200 mm

   2) Flow Velocity: Max. 4.6 m/s for full pipe, Min. 0.75 m/s at dry weather flow.

   3) Slopes: Min. Slope of 0.40% unless fewer than 13 dwelling units are connected.

Sanitary Design Sheets will be prepared during the detailed design stage to confirm that the above parameters are within the acceptable limits per County standards and to confirm sizing of sanitary sewers within the Site.

4.2 Existing Wastewater Infrastructure

For the North Site, there is an existing 200 mm sanitary sewer within the St. Michaels Street ROW servicing the existing residential and condominium units in the area. The sewer flows towards the St. Michaels Street pumping station, adjacent to the Site and existing Open Space. For the South Site, there are currently no sanitary sewers located on either James Street or Tisdale Drive in the vicinity of the site. The Sanitary Average Daily Flow for the North Site is 95m^3/day and Peak Wet Weather Flow of 6 L/s. The Average Daily Flow for the South Site is 494m^3/day with a Peak Wet Weather Flow of 27 L/s. Please see Appendix B for sanitary design calculations.

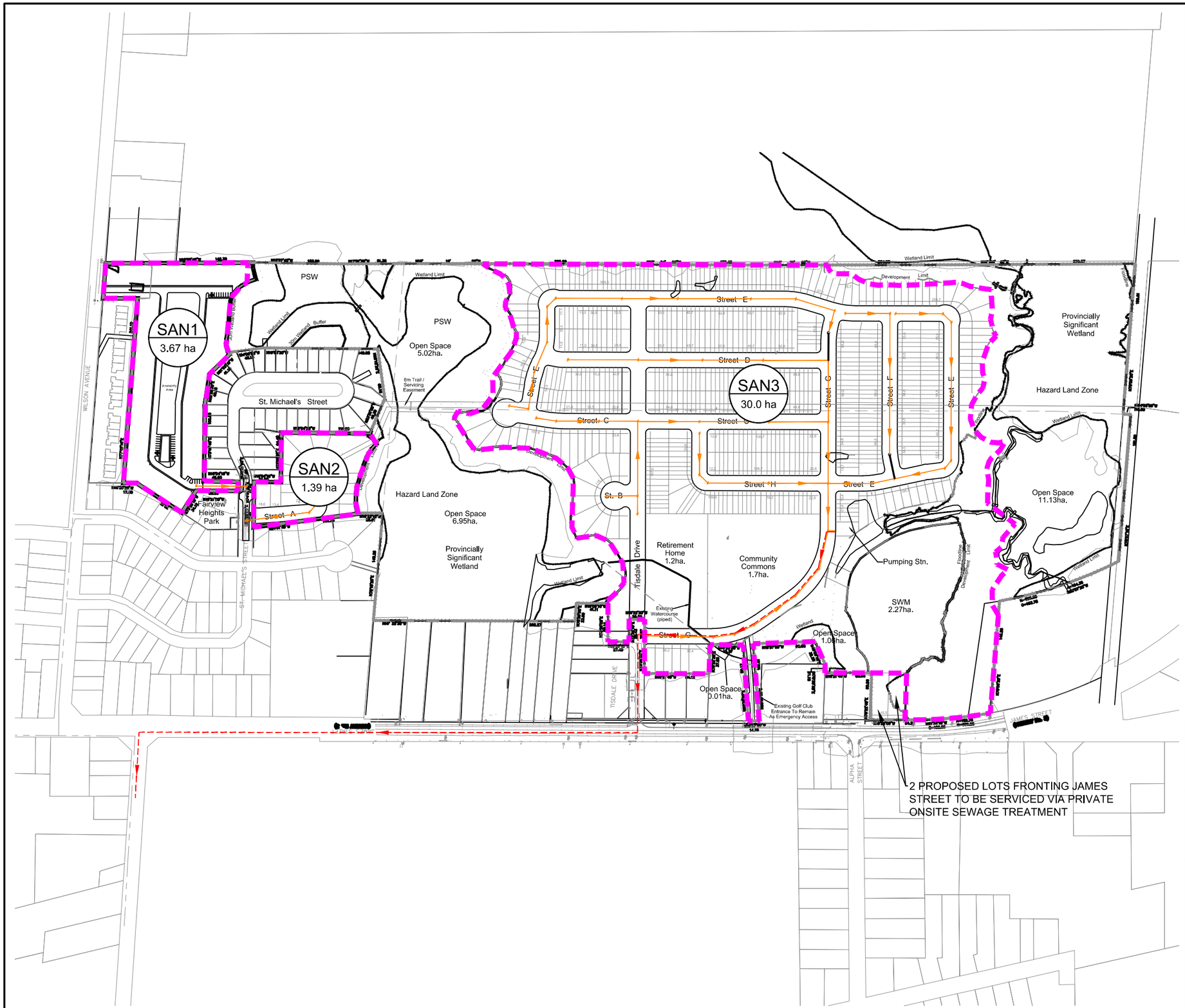
All the sanitary flows within the settlement of Delhi are treated at the Delhi Wastewater Treatment Plant (WWTP). In the September 20, 2022, Information Memo from Norfolk's Environmental and Infrastructure Department, the Delhi WWTP was described to have 1,636 m^3/day of capacity after existing, committed, and pending demands were removed.

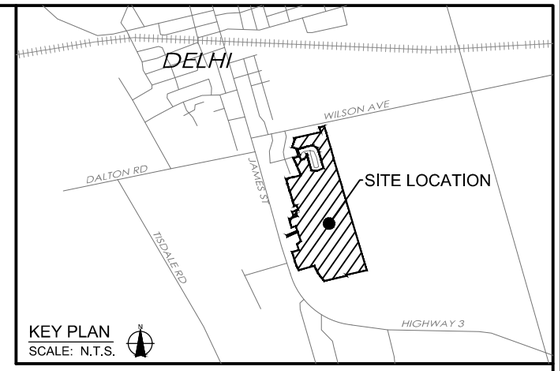
4.3 Proposed Wastewater Servicing

The North Site will connect and discharge into the existing 200 mm sanitary sewer system within the St Michaels Street ROW. From there the sewer flows by gravity into the nearby pumping station where it is pumped to the existing Main Street pumping station and onto the Delhi WWTP.

A new sanitary pumping station and forcemain is proposed to service the South Site. A collection of 200 mm to 250 mm gravity sewers within the South Site will collect flows and direct them to the proposed pumping station which will discharge to the forcemain. The forcemain will connect to Delhi's existing sanitary sewer network. The connection point is examined in further detail in the External Servicing Study by T.Y. Lin. The proposed pumping station and associated linear infrastructure would be assumed by the County after construction.

Please refer to Drawing SAN1 for the Preliminary Wastewater Distribution Plan, as well as Figure 6 for the Sanitary Drainage Plan.





LEGEND

- PROPERTY BOUNDARY
- SANITARY DRAINAGE BOUNDARY
- PROPOSED SANITARY SEWER
- PROPOSED SANITARY FORCEMAIN

SAN1 / 20.0 ha — CATCHMENT No. / CATCHMENT AREA

N

0 50 100 200 300 400

Metres

BURNSIDE

Client

DELHI DEVELOPMENT INC.

Figure Title

DELHI GOLF COURSE

SANITARY DRAINAGE AREA

Drawn	Checked	Date	Figure No.
FR	FG	23/03/15	6
Scale		Project No.	
1:5000		053741.05	

File: \\SHERLOCK\Shared Work Areas\053741 Delhi GC\053741.05 FSR\07_Figures\FSR FIGURES\053741.05 FIG6_SANITARY DRAINAGE.dwg Date Plotted: March 14, 2023 - 2:34 PM

4.4 Downstream Wastewater Improvements

With current demands, there is capacity within the Delhi WWTP (3,182 m^3/day). Based on the future growth statistics stated in the 2016 Integrated Sustainable Master Plan (ISMP) as well as the demands that were included in the Servicing Memo prepared by the County's Environment and Infrastructure Group on September 20, 2022, it is forecasted that the capacity will not be reached by 2041.The Servicing Memo indicates that there is sufficient residual capacity in the system to accommodate the flows from the proposed subdivision. The capacity of the two existing pumping stations proposed for tie-in to the proposed subdivision will be examined further during the detailed design stage. The External Servicing Study by T.Y. Lin explores the connection points to the existing external system to accommodate the proposed subdivision in greater detail.

5.0 Utilities

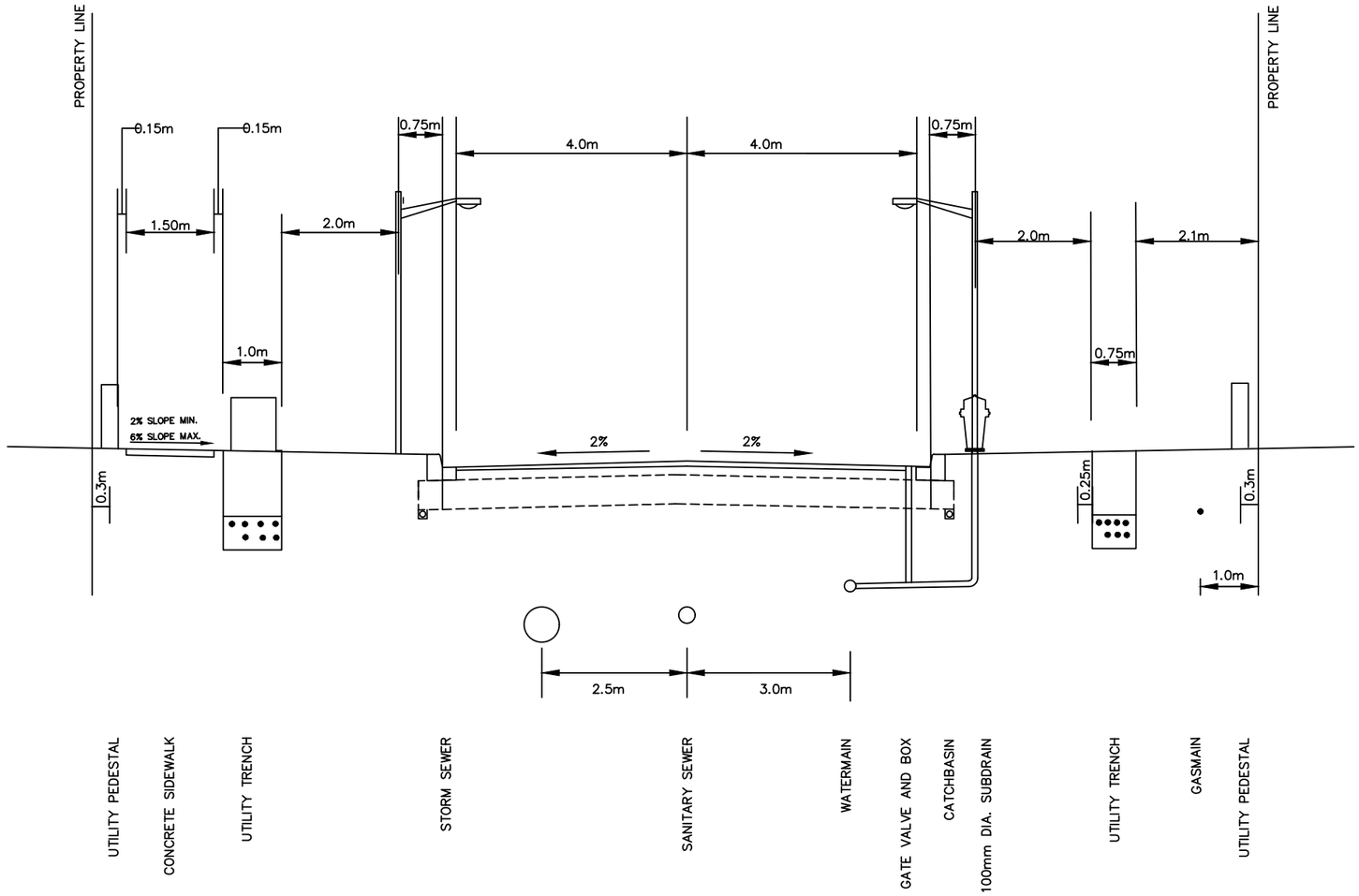
Utilities will be installed in a joint utility trench. Design will be provided by the utility companies. It appears that there are connections for natural gas, and electrical supply adjacent to the Site. A detailed design consultation with Enbridge (natural gas) and Hydro One will be conducted to confirm an adequate external utility supply.

6.0 Roadways

6.1 Municipal Right of Ways

All roadway ROWs are proposed to be 20.0 m ROWs as per Figure 7. The proposed ROW will provide a 4.00 m traffic lane in each direction, 0.50 m wide curbs on both sides as well as 5.50 m strip for planting and utilities on both sides. One side will have a 1.50 m wide sidewalk. The 20.0 m ROW will provide enough space for underground sanitary, forcemain, water services as well as storm sewers and the Delhi Golf Estates Drain Bypass.

Access to the proposed redevelopment off Tisdale Drive will be examined further by BA Group who will provide details on the entrance to the site and the impact of the subdivision on the existing intersection of James Street and Tisdale Drive. The BA Group report recommends improvements to the existing Highway 3 and James Street intersection. The other connection points are recommended via unsignalized intersections. Please refer to the Traffic Impact Study by BA Group for more details.



20.0m ROW

BURNSIDE

Client

GERANIUM HOMES

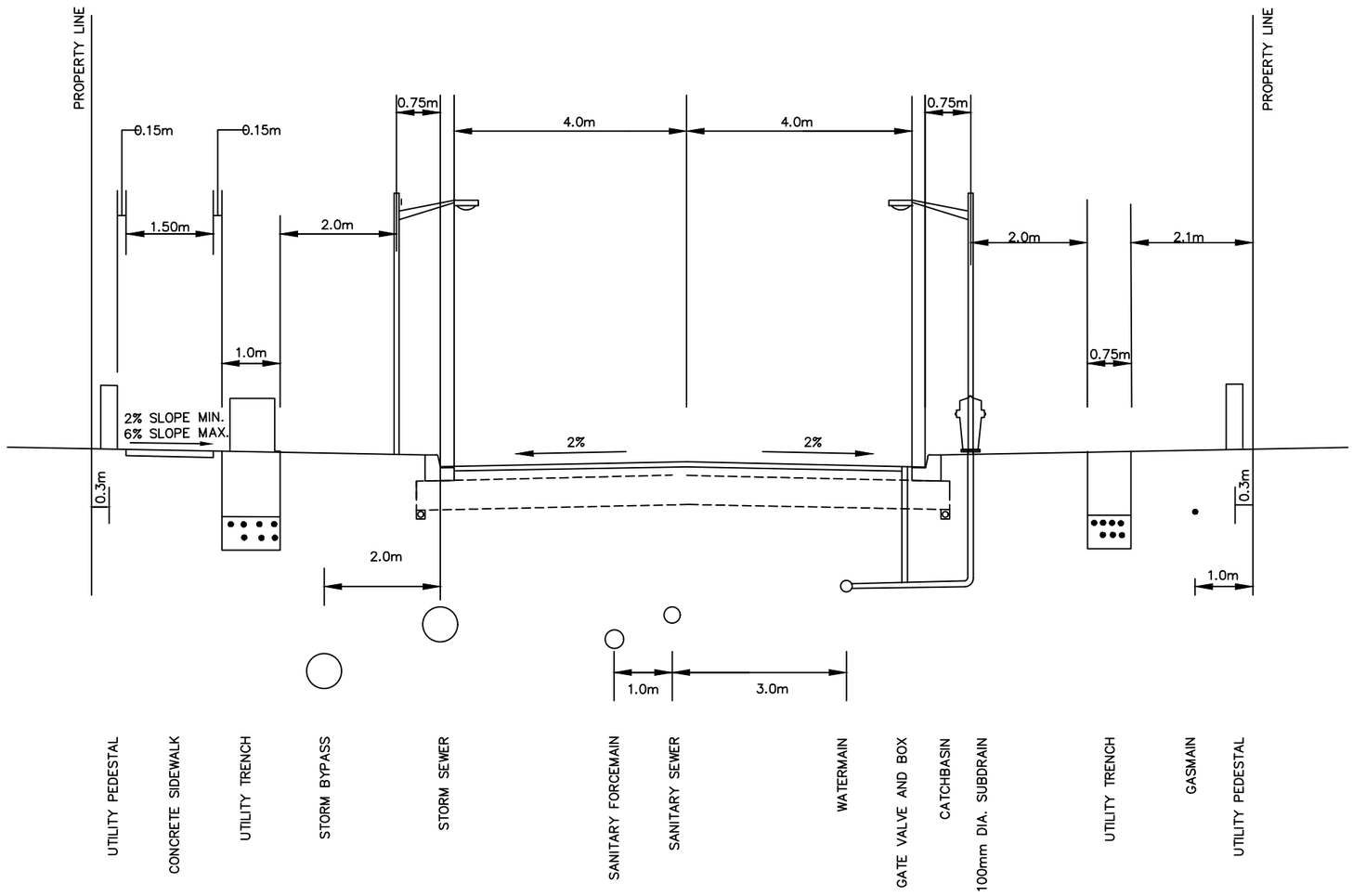
Figure Title

DELHI GOLF COURSE

TYPICAL ROW 20.0m CROSS SECTION

Drawn	Checked	Date	Figure No.
BF	FG	23/01/31	7
Scale		Project No.	
H 1:___ V 1:__		053741.05	

File: \\SHERLOCK\Shared Work Areas\053741 Delhi GC\053741.05 FSR\07_Figures\FSR FIGURES\053741.05 20m ROW typical section_MP_221711.dwg Date Plotted: March 14, 2023 - 2:34 PM



20.0m ROW

BURNSIDE

Client

GERANIUM HOMES

Figure Title

DELHI GOLF COURSE

MODIFIED ROW 20.0m CROSS SECTION

Drawn	Checked	Date	Figure No.
BF	FG	23/01/31	8
Scale		Project No.	
NTS		053741.05	

File: \\SHERLOCK\Shared Work Areas\053741 Delhi GC\053741.05 FSR\07_Figures\FSR FIGURES\053741.05 20m ROW section_MP_220911.dwg Date Plotted: March 14, 2023 - 2:34 PM

7.0 Erosion and Sediment Control

The erosion and sediment control plan for the Site will be developed in accordance with the County and LPRCA guidelines. The plan will be completed at the detail design stage prior to the undertaking of any grading activity on the Site.

Erosion and sediment control will be implemented for all construction activities including topsoil stripping, foundation excavation, and stockpiling of material. The following erosion and sediment control measures will be implemented:

a) Temporary sediment control fence will be placed around the perimeter of all areas to be disturbed prior to grading. Double row fencing may be appropriate adjacent to natural areas;

b) Appropriately designed sediment control ponds will be provided;

c) CB sediment traps will be provided on existing CBs being affected by construction as well as newly installed CBs within the new development Site;

d) Check dams, etc., for erosion / velocity control will be provided; and

e) Gravel mud mats will be provided at all construction access points to minimize off-site tracking of sediment.

All temporary erosion and sediment control measures will be routinely inspected and repaired if required during construction. Temporary controls will not be removed until the serviced areas they have served have been restored and stabilized.

Connection to Low Impact Development (LID) measures will not be completed until the Site is stabilized with vegetation to minimize sediment accumulation and maintenance issues.

All reasonable measures will be taken to ensure that sediment loading is minimized both during and following construction. Additional details will be provided as part of the detailed design.

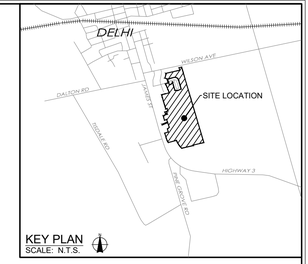
8.0 Conclusions and Recommendations

This report addresses the requirements for submission of an FSR to accompany the Official Plan Amendment (for an urban boundary expansion and redesignation of the lands), Zoning By-Law Amendment, Plan of Subdivision, and Plan of Condominium applications for the Delhi Golf and Country Club Redevelopment. This FSR demonstrates that the proposed redevelopment can be developed on full municipal services as seen in the Conceptual Underground Servicing Plan drawing (CUSP).

BURNSIDE
[THE DIFFERENCE IS OUR PEOPLE]

Drawings

G1 – Grading Plan
G2 – Grading Plan
CUSP – Conceptual Underground Servicing Plan
STM1 – Preliminary Storm Servicing Plan
SAN1 – Preliminary Sanitary Servicing Plan
WAT1 – Preliminary Water Servicing Plan



LEGEND

- PROPERTY BOUNDARY
- EASEMENT
- 320.5 EXISTING CONTOUR
- ×319.36 EX EXISTING ELEVATION
- ×326.26 PROPOSED ELEVATION
- 2.00% PROPOSED SLOPE
- PROPOSED OVERLAND FLOW DIRECTION
- MAX. 3:1 SIDE SLOPES
- PROPOSED SWALE

N

0 25 50 75 100
Metres

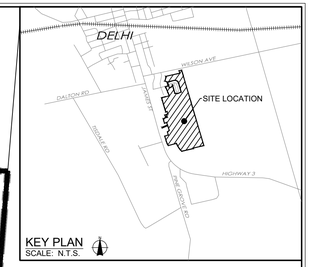
BURNSIDE

Client
DELHI DEVELOPMENT INC.

Figure Title
DELHI GOLF COURSE
GRADING PLAN

Drawn	Checked	Date	Figure No.
BF	FG	23/03/15	G1
Scale		Project No.	
1:1250		053741.05	

M:\2015\05\053741.05\Civil\Drawings\053741.05-GRADING.dwg, Date Printed: March 14, 2023 - 11:15 PM



Wetland Limit

Development Limit

Floodline

PSW

Open Space
5.02ha.

Provincially Significant Wetland

Hazard Land Zone

PROPOSED RETAINING WALL

Open Space
11.13ha.

Open Space
6.95ha.

Provincially Significant Wetland

REFER TO DWG G1

Retirement Home
1.2ha.

Community Commons
1.7ha.

Existing Watercourse (piped)

Wetland

Open Space
1.06ha.

Open Space
0.01ha.

Existing Golf Club Entrance To Remain As Emergency Access

Street E

Street D

Street F

Street C

Street G

Street H

Street B

LEGEND

- PROPERTY BOUNDARY
- EASEMENT
- 330.5 EXISTING CONTOUR
- ×319.36 EX EXISTING ELEVATION
- ×326.26 PROPOSED ELEVATION
- 2.00% PROPOSED SLOPE
- PROPOSED OVERLAND FLOW DIRECTION
- MAX. 3:1 SIDE SLOPES
- PROPOSED SWALE

0 25 50 75 100
Metres

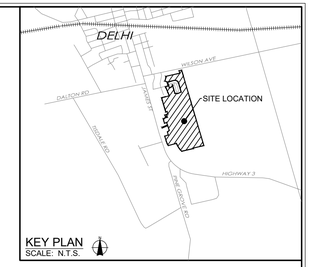
BURNSIDE

Client: DELHI DEVELOPMENT INC.

Figure Title: DELHI GOLF COURSE

GRADING PLAN

Drawn	Checked	Date	Figure No.
BF	FG	23/03/15	G2
Scale: 1:1250		Project No.: 053741.05	



PSW
Wetland Limit
30m Wetland Buffer
PSW
Open Space 5.02ha.
6m Trail / Servicing Easement
St. Michael's Street
Ammenity Area
Fairview Heights Park
Hazard Land Zone
Open Space 6.95ha.
Provincially Significant Wetland
Development Limit
Street A
Street B
Street C
Street D
Street E
Street F
Street G
Street H
Street I
Street J
St. B
Isdale Drive
Retirement Home 1.2ha.
Existing Watercourse (piped)
Open Space 0.01ha.
Open Space 1.06ha.
Existing Golf Club Entrance To Remain As Emergency Access
Provincially Significant Wetland
Hazard Land Zone
Open Space 11.13ha.
Floodline

	OBV.	COVER
R.G.	238.63	
BYPASS	237.15	1.5

	OBV.	COVER
R.G.	237.72	
SAN	233.35	4.4

	OBV.	COVER
R.G.	236.91	
SAN	234.34	2.6
STM	235.98	0.9

	OBV.	COVER
R.G.	237.08	
SAN	233.05	4.0

	OBV.	COVER
R.G.	238.58	
SAN	234.92	3.7
STM	236.46	2.1

	OBV.	COVER
R.G.	239.17	
SAN	235.54	3.6
STM	236.92	2.2

	OBV.	COVER
R.G.	238.55	
SAN	236.01	2.5
STM	237.05	1.5

	OBV.	COVER
R.G.	237.07	
SAN	235.26	1.8
SAN FM	235.46	1.6
STM	235.70	1.7
BYPASS	232.89	4.1

	OBV.	COVER
R.G.	237.21	
SAN	233.85	3.4
STM	234.54	2.6

	OBV.	COVER
R.G.	235.16	
SAN	232.01	3.2
STM	233.36	1.8

	OBV.	COVER
R.G.	233.62	
SAN	230.78	2.8
STM	232.03	1.4

	OBV.	COVER
R.G.	235.60	
SAN	232.67	2.9
STM	233.91	1.7

	OBV.	COVER
R.G.	236.12	
BYPASS	233.95	2.2

	OBV.	COVER
R.G.	232.10	
SAN	229.50	2.6
STM	230.27	1.8

	OBV.	COVER
R.G.	231.65	
SAN	228.83	2.8
STM	229.91	2.0

	OBV.	COVER
R.G.	231.14	
SAN	228.25	2.9
STM	229.49	1.7

	OBV.	COVER
R.G.	230.86	
SAN	227.67	3.2
STM	229.12	1.6

	OBV.	COVER
R.G.	230.49	
SAN FM	225.72	4.8
SAN	225.25	5.3
STM	228.74	1.7

	OBV.	COVER
R.G.	230.37	
SAN FM	225.92	4.5
SAN	225.82	4.9
STM	228.35	1.9
BYPASS	226.84	3.7

	OBV.	COVER
R.G.	232.46	
SAN	229.17	3.3
STM	230.29	2.1

	OBV.	COVER
R.G.	232.45	
SAN	229.42	3.0
STM	230.49	2.0

	OBV.	COVER
R.G.	231.57	
SAN	228.52	3.1
STM	229.78	1.8

	OBV.	COVER
R.G.	231.09	
SAN	228.09	3.0
STM	229.44	1.6

LEGEND

- PROPERTY BOUNDARY
- EASEMENT
- EXISTING SANITARY SEWER
- PROPOSED SANITARY FORCEMAIN
- PROPOSED SANITARY SEWER
- EXISTING STORM SEWER
- PROPOSED STORM SEWER
- EXISTING WATERMAIN
- PROPOSED WATERMAIN
- PROPOSED OVERLAND FLOW DIRECTION

PIPE OBVERT
ROAD GRADE
PIPE COVER

	OBV.	COVER
R.G.	182.29	
SAN	424.30	3.0
STM	427.48	1.8

0 40 80 120 160
Metres

BURNSIDE

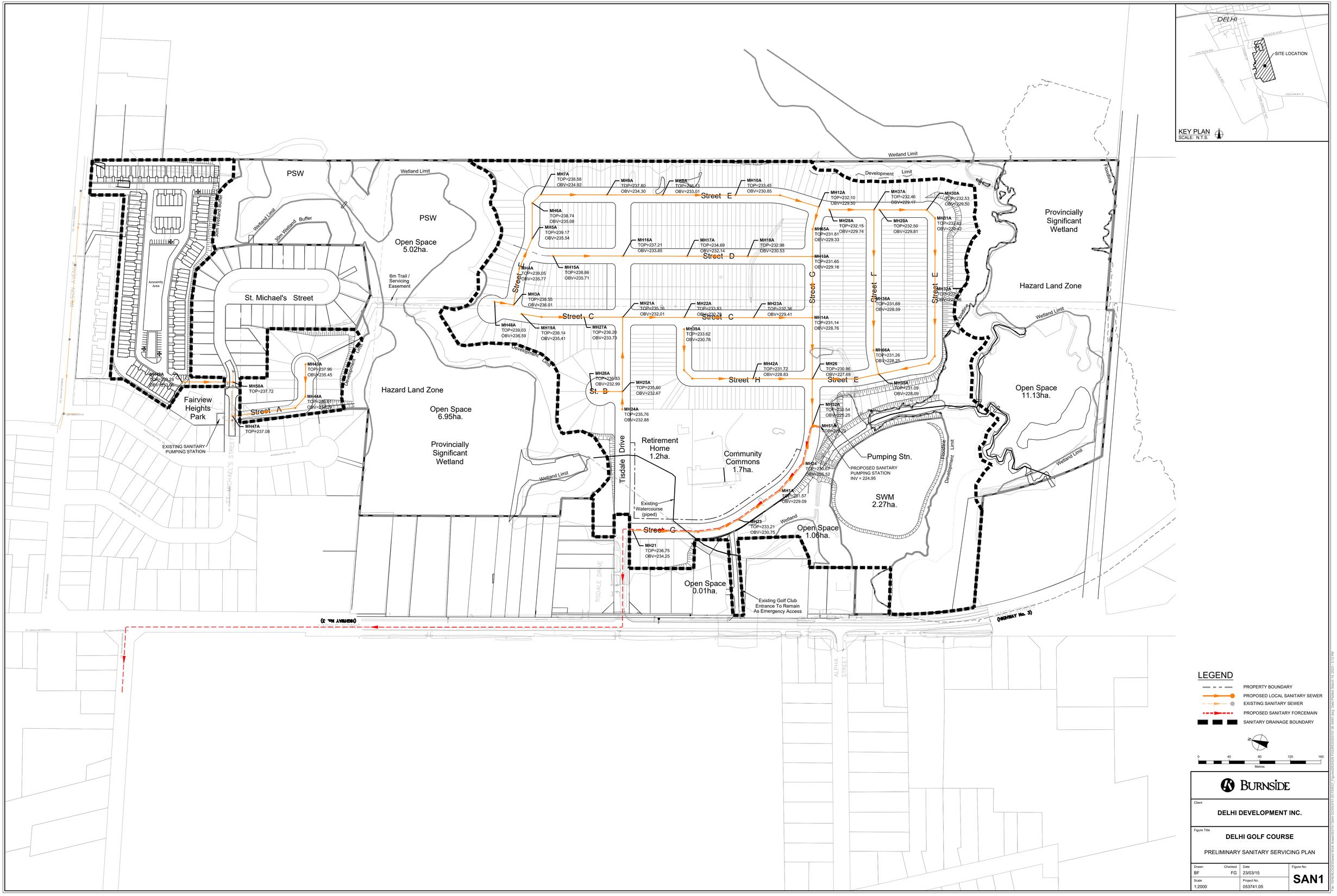
Client
DELHI DEVELOPMENT INC.

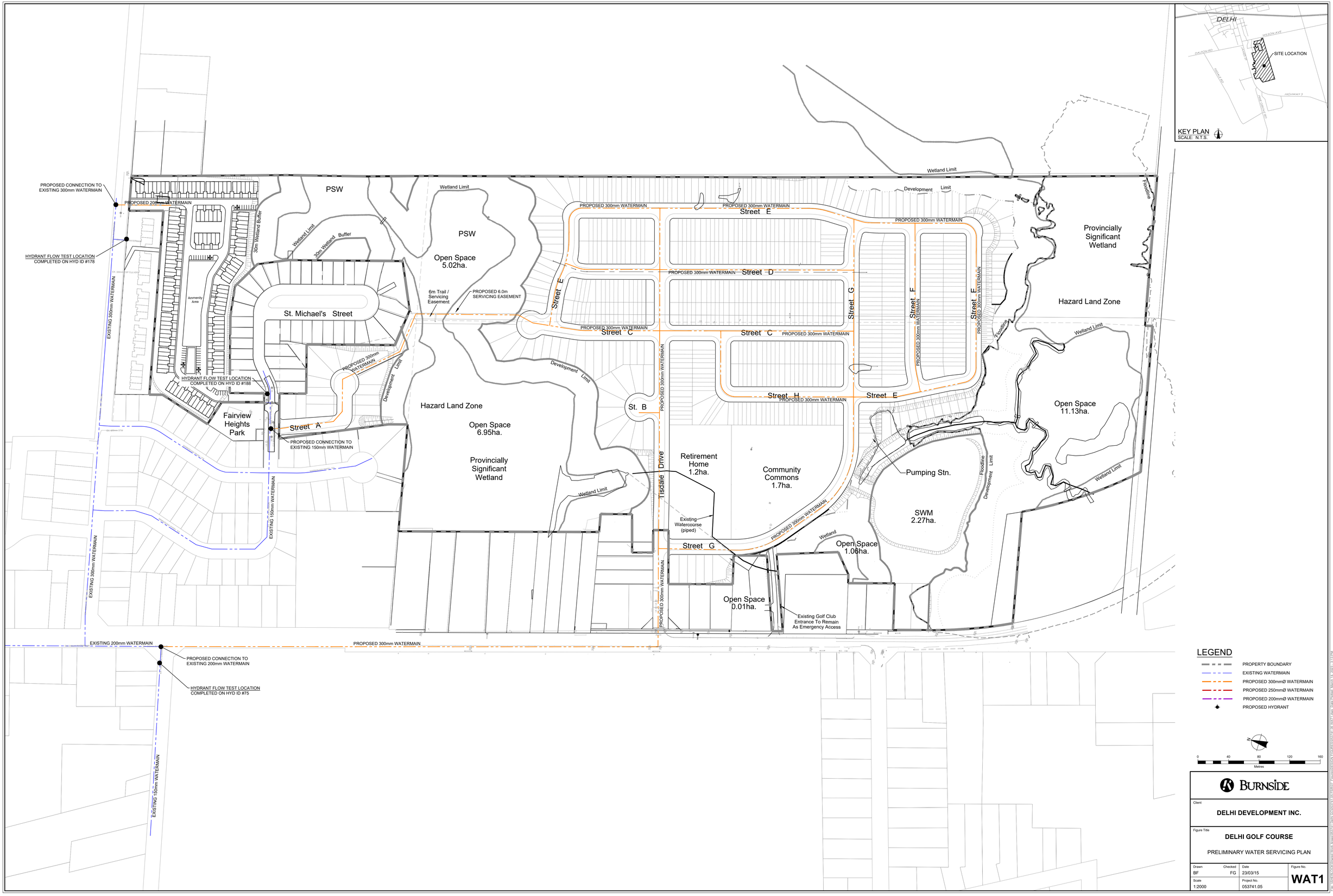
Figure Title
DELHI GOLF COURSE
CONCEPTUAL UNDERGROUND SERVICING PLAN

Drawn	Checked	Date	Figure No.
BF	FG	23/03/15	CUSP
Scale		Project No.	
1:2000		053741.05	

File: C:\Projects\053741.05\Civil\Drawings\Figures\053741.05 CUSP Plan Profile Sheet 1 to 4.dwg, 2015-03-23 9:15:54 AM

KEY PLAN
SCALE: N.T.S.
DELHI
SITE LOCATION
DALSON RD
HIGHWAY 3
WILSON AVE
Wetland Limit
Development Limit
Floodline
PSW
Open Space 5.02ha.
Provincially Significant Wetland
Hazard Land Zone
Open Space 11.13ha.
Open Space 6.95ha.
Provincially Significant Wetland
Retirement Home 1.2ha.
Community Commons 1.7ha.
Open Space 1.06ha.
Open Space 0.01ha.
Fairview Heights Park
Amenity Area
30m Wetland Buffer
6m Trail / Servicing Easement
St. Michael's Street
Street A
Street B
Street C
Street D
Street E
Street F
Street G
Street H
Tisdale Drive
WILSON AVENUE
ST. MICHAEL'S STREET
TISDALE DRIVE
JAMES STREET
ALPHA STREET
(HIGHWAY No. 3)
MH108 TOP=238.62 OBV=237.50
MH109 TOP=237.90 OBV=236.08
MH110 NW INV=235.30
MH77 TOP=237.90 OBV=236.65
MH78 TOP=236.88 OBV=235.98
MH79 N INV=235.42
MH95 TOP=236.66 OBV=236.06
MH50 TOP=238.57 OBV=238.26
MH51 TOP=237.78 OBV=235.92
MH53 TOP=238.19 OBV=234.11
MH52 TOP=234.09 OBV=232.27
MH45 TOP=237.43 OBV=235.48
MH48 TOP=239.12 OBV=237.22
MH42 TOP=237.10 OBV=234.84
MH47 TOP=239.06 OBV=237.45
MH41 TOP=238.90 OBV=236.81
MH43 TOP=234.75 OBV=233.29
MH44 TOP=232.91 OBV=231.27
MH94 TOP=238.57 OBV=237.05
MH35 TOP=236.32 OBV=234.49
MH39 TOP=234.00 OBV=232.38
MH40 TOP=232.38 OBV=230.85
MH36 TOP=238.97 OBV=237.00
MH37 TOP=237.46 OBV=235.47
MH66 TOP=236.08 OBV=234.13
MH20 TOP=235.12 OBV=233.36
MH32 TOP=233.42 OBV=232.10
MH01 TOP=235.58 OBV=233.91
MH38 TOP=231.77 OBV=233.33
MH09 TOP=232.85 OBV=230.57
MH126 TOP=231.76 OBV=230.40
MH10 TOP=231.89 OBV=230.21
MH11 TOP=231.19 OBV=229.94
MH12 TOP=230.76 OBV=229.57
MH112 TOP=230.43 OBV=229.34
MH92 N INV=228.43
MH65 TOP=232.39 OBV=230.59
MH64 TOP=231.65 OBV=230.14
MH127 TOP=231.21 OBV=229.86
MH62 TOP=231.07 OBV=229.74
MH57 TOP=232.54 OBV=230.84
MH59 TOP=231.95 OBV=230.41
HW03 W INV=226.85
HW02 NE INV=227.56
HW01 NE INV=227.56
MH02 TOP=230.08 OBV=228.56
MH68 TOP=236.12 OBV=234.30
MH91 S INV=233.95
MH15 S INV=233.42
MH75 TOP=230.54 OBV=227.49
MH05 TOP=230.22 OBV=226.80
PROPOSED BYPASS SEWER FOR EXISTING FLOWS 900mm x 1800mm BOX
REALIGNED 250mmØ STORM SEWER
MH72 TOP=233.76 OBV=230.27
MH18 TOP=235.33 OBV=230.96
MH28 TOP=231.50 OBV=229.81
MH70 Existing Watercourse (piped) TOP=236.99 OBV=232.45
MH17 TOP=236.98 OBV=232.59
MH19 TOP=230.54
MH02 TOP=237.39 OBV=235.48
MH113 TOP=233.87 OBV=232.41
PROPOSED BOX CULVERT 17.4m @ 0.30%
Existing Golf Club Entrance To Remain As Emergency Access
LEGEND
PROPERTY BOUNDARY
PROPOSED DRAINAGE BOUNDARY
PROPOSED STORM BYPASS SEWER
PROPOSED STORM SEWER
EXISTING STORM SEWER
PROPOSED OVERLAND FLOW ROUTE
0 40 80 120 160
Metres
BURNSIDE
Client
DELHI DEVELOPMENT INC.
Figure Title
DELHI GOLF COURSE
PRELIMINARY STORM SERVICING PLAN
Drawn BF
Checked FG
Date 23/03/15
Scale 1:2000
Project No. 053741.05
Figure No. STM1


KEY PLAN
SCALE: N.T.S.
DELHI
SITE LOCATION
DALSON AVE
DALSON RD
HIGHWAY 3
PSW
Wetland Limit
30m Wetland Buffer
Development Limit
Floodline
St. Michael's Street
Amenity Area
6m Trail / Servicing Easement
Fairview Heights Park
EXISTING SANITARY PUMPING STATION
Hazard Land Zone
Open Space 5.02ha.
Open Space 6.95ha.
Provincially Significant Wetland
Open Space 11.13ha.
Open Space 1.06ha.
Open Space 0.01ha.
Retirement Home 1.2ha.
Community Commons 1.7ha.
SWM 2.27ha.
Pumping Stn.
PROPOSED SANITARY PUMPING STATION INV = 224.95
Tisdale Drive
Existing Watercourse (piped)
Existing Golf Club Entrance To Remain As Emergency Access
Street A
Street B
Street C
Street D
Street E
Street F
Street G
Street H
MH7A TOP=238.58 OBV=234.92
MH9A TOP=237.80 OBV=234.30
MH8A TOP=236.43 OBV=233.01
MH10A TOP=233.45 OBV=230.85
MH6A TOP=238.74 OBV=235.08
MH5A TOP=239.17 OBV=235.54
MH16A TOP=237.21 OBV=233.85
MH17A TOP=234.69 OBV=232.14
MH18A TOP=232.98 OBV=230.53
MH4A TOP=239.05 OBV=235.77
MH15A TOP=238.86 OBV=235.71
MH3A TOP=238.55 OBV=236.01
MH21A TOP=235.16 OBV=232.01
MH22A TOP=233.83 OBV=230.78
MH23A TOP=232.96 OBV=229.41
MH48A TOP=239.03 OBV=236.59
MH19A TOP=238.14 OBV=235.41
MH27A TOP=236.20 OBV=233.73
MH39A TOP=233.62 OBV=230.78
MH42A TOP=231.72 OBV=228.83
MH26A TOP=239.83 OBV=232.99
MH25A TOP=235.60 OBV=232.67
MH24A TOP=235.76 OBV=232.88
MH12A TOP=232.10 OBV=229.50
MH28A TOP=232.15 OBV=229.74
MH65A TOP=231.81 OBV=229.33
MH13A TOP=231.65 OBV=229.16
MH14A TOP=231.14 OBV=228.76
MH26 TOP=230.88 OBV=227.69
MH24 TOP=230.67 OBV=226.52
MH1A TOP=231.57 OBV=229.09
MH23 TOP=233.21 OBV=230.75
MH21 TOP=236.75 OBV=234.25
MH37A TOP=232.46 OBV=229.17
MH29A TOP=232.50 OBV=229.81
MH30A TOP=232.53 OBV=229.50
MH31A TOP=232.43 OBV=229.42
MH32A TOP=232.46 OBV=229.46
MH38A TOP=231.69 OBV=228.59
MH66A TOP=231.26 OBV=228.25
MH35A TOP=231.09 OBV=228.09
MH52A TOP=230.54 OBV=225.25
MH51A TOP=230.73
MH43A TOP=237.96 OBV=235.45
MH49A TOP=239.35 OBV=235.75
MH50A TOP=237.72
MH44A TOP=240.91 OBV=237.25
MH47A TOP=237.08
ST. MICHAEL'S STREET
HIGHWAY No. 3
ALPHA STREET
TISDALE DRIVE
LEGEND
PROPERTY BOUNDARY
PROPOSED LOCAL SANITARY SEWER
EXISTING SANITARY SEWER
PROPOSED SANITARY FORCEMAIN
SANITARY DRAINAGE BOUNDARY
0 40 80 120 160
Metres
BURNSIDE
Client
DELHI DEVELOPMENT INC.
Figure Title
DELHI GOLF COURSE
PRELIMINARY SANITARY SERVICING PLAN
Drawn BF
Checked FG
Date 23/03/15
Scale 1:2000
Project No. 053741.05
Figure No. SAN1



BURNSIDE

Client
DELHI DEVELOPMENT INC.

Figure Title
DELHI GOLF COURSE

PRELIMINARY WATER SERVICING PLAN

Drawn	Checked	Date	Figure No.
BF	FG	23/03/15	**WAT1**
Scale		Project No.	
1:2000		053741.05	

File: 53741-05\CAD\Drawing Work Sheets\053741-05 WAT1.dwg Date Plotted: March 24, 2023 - 3:51PM

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix A

Calculations and Hydrant Flow Test Results

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Water Demand Calculations - Private Condo Block		Date:	23/03/15

I. Fire Flow Calculation

**Based on Fire Underwriters Survey*

Table 8: Simplified Method for One and Two Family Dwellings Exceeding 450 sq.m, and Row Housing Exposure distances

Exposure Distances	Suggested Fire Flow (L/min)	
	Wood Frame	Masonry
< 3m	12000	9000
3 to 10m	8000	8000
10.1 to 30m	6000	6000
> 30m	4000	4000

F = 12,000 L/min
200.00 L/s
F = 3,170 US GPM

Fire Flow Required = 200.00 L/s
Fire Flow Required = 12,000 L/min 3,170 US GPM

II. Domestic Flow Calculations

Type	Quantity	P/Unit	Population
Townhouse	129	2.75	355
Single/Semi Detached	0	2.75	0
Total	129		355

Average Day Demand = 266 L/cap/day
= 1.1 L/s
= 17 US GPM

Max. Daily Demand Peaking Factor = 2.12
Max. Daily Demand = 2.32 L/s
= 37 US GPM

or

Max. Hourly Demand Peaking Factor = 3.00
Max. Hourly Demand = 3.28 L/s
= 52 US GPM

Domestic Flow = 3.28 L/s 52 US GPM

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Water Demand Calculations - Private Condo Block		Date:	23/03/15

Peak Domestic Flow =	**3.28**	**L/s**
Fire Flow =	**200.00**	**L/s**
Max Day Domestic + Fire Demand =	**202.32**	**L/s**
	12138.92	**L/min**

Pressure Loss Calculations

$$h_f = \frac{10.7L}{C^{1.852}D^{4.87}}Q^{1.852}$$

Scenario 1: Peak Domestic Demand (Min. 275 kPa)

Watermain (Section 1)

Length, L =	360	m
C =	150	
Diameter, D =	250	mm
Flow, Q =	3.28	L/s
Velocity, V =	0.07	m/s
Pressure Loss, h_f =	0.01	m
=	0.01	psi
=	0.08	kPa

Pressure at Connection =	420.55	kPa	*from hydrant test results
Total Pressure Loss =	0.08	kPa	
Service Pressure =	**420.48**	**kPa**	> 275 kPa

Scenario 2: Fire Flow + Max Day (Min. 140 kPa)

Watermain (Section 1)

Length, L =	360	m
C =	150	
Diameter, D =	300	mm
Flow, Q =	202.32	L/s
Velocity, V =	2.86	m/s
Pressure Loss, h_f =	6.56	m
=	9.33	psi
=	64.33	kPa

Pressure at Connection =	331.80	kPa	*Calculated Residual Pressure at Wilson Ave Hydrant
Total Pressure Loss =	64.33	kPa	
Service Pressure =	**267.47**	**kPa**	> 140 kPa

BURNSIDE

CALCULATION SHEET

Project:			
Delhi GC Development		Prepared by:	BF
Delhi, ON		Checked by:	FG
Water Demand Calculations - Private Condo Block		Project No:	300053741
		Date:	23/03/15

IV. Flow Test Results - Test 1

** As per fire flow test completed on fire hydrant ID #178 located on Wilson Ave*

Static Pressure = 61 psi
= 42.90 m head

Pressure (psi)	*Pressure (m)*	*Flow (GPM)*	*Flow (L/s)*
59	41.49	1186	74.82
55	38.68	2069	130.53

Pump Head Equation

$Head(m) = A - B(Q^C)$

A =	42.90
B =	0.0004907
C =	1.85

Theoretical Flow @ 20.3 psi = 377 L/s
= 22611 L/min
= 5973 US GPM

Anticipated Residual Pressures

Scenario	Flow (L/s)	Pressure (psi)		
		Estimated	Required	
Peak Domestic	3.3	***61.0***	39.9	** Minimum pressure of 275 kpa (39.9 psi)*
Fire + Max Day	202.3	***48.1***	20.3	** Minimum pressure of 140 kpa (20.3 psi)*

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Water Demand Calculations - South Site		Date:	23/03/15

I. Fire Flow Calculation

**Based on Fire Underwriters Survey*

Row Townhouses

Table 8: Simplified Method for One and Two Family Dwellings Exceeding 450 sq.m, and Row Housing Exposure distances

Exposure Distances	Suggested Fire Flow (L/min) Wood Frame	Masonry
< 3m	12000	9000
3 to 10m	8000	8000
10.1 to 30m	6000	6000
> 30m	4000	4000

F = 12,000.00 L/min
200.00 L/s
F = 3170 US GPM

Retirement Facility

$F = 220\ C\ (A)^{1/2}$

Where F= Fire flow in Lpm
C= construction type coefficient
= 0.6 For fire-resistive construction (fully protected frame, floors, roof)
A = total floor area in sq.m. excluding basements, includes garage*

Floor	Area (sq.m)	%
2nd Floor	3400 m^2	100%
3rd Floor	3400 m^2	25%
1st Floor	3400 m^2	25%

Largest Area = 5,100 sq.m.
F = 9,426.69 L/min

Round to nearest 1000 l/min
F = 9,000 L/min

Occupancy Reduction
15% reduction for limited combustible occupancy
F = 7650 L/min

Sprinkler Reduction
30% Reduction for NFPA Sprinkler System
F = 5355 l/min

Separation Charge		Distance
0%	North	>30m
0%	West	>30m
0%	South	>30m
10%	East	10.1-20m
10%	Total Separation Charge	765 L/min
75%	MAX Separation Charge	

F = 6,000.00 L/min
100.00 L/s
F = 1585 US GPM

Row Townhouse Fire Flow > Retirement Facility Fire Flow, Therefore Fire Flow = 200.00 L/s

Fire Flow Required = 200.00 L/s
Fire Flow Required = 12,000 L/min 3,170 US GPM

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
	Delhi GC Development	Checked by:	FG
	Delhi, ON	Project No:	300053741
	Water Demand Calculations - South Site	Date:	23/03/15

II. Domestic Flow Calculations

Type	Quantity	P/Unit	Population
Retirement Unit	150	1.7	255
Single/Semi Detached	595	2.75	1636
Total	745		1891

Average Day Demand =	266	L/cap/day	
=	5.8	L/s	
=	92	US GPM	
Max. Daily Demand Peaking Factor =	2.12		
Max. Daily Demand =	12.34	L/s	
=	196	US GPM	
or			
Max. Hourly Demand Peaking Factor =	3.00		
Max. Hourly Demand =	17.47	L/s	
=	277	US GPM	

Domestic Flow =	**17.47**	**L/s**	**277**	**US GPM**

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Water Demand Calculations - South Site		Date:	23/03/15

Peak Domestic Flow =	**17.47**	**L/s**
Fire Flow =	**200.00**	**L/s**
Max Day Domestic + Fire Demand =	**212.34**	**L/s**
	12740.63	**L/min**

Pressure Loss Calculations

$$h_f = \frac{10.7L}{C^{1.852}D^{4.87}}Q^{1.852}$$

Scenario 1: Peak Hour Domestic Demand (Min. 275 kPa)

Watermain (Section 1)			**Watermain (Section 2)**			**Watermain (Section 3)**		
Length, L =	650	m	Length, L =	600	m	Length, L =	280	m
C =	150		C =	150		C =	150	
Diameter, D =	300	mm	Diameter, D =	300	mm	Diameter, D =	150	mm
Flow, Q =	17.47	L/s	Flow, Q =	17.47	L/s	Flow, Q =	17.47	L/s
Velocity, V =	0.25	m/s	Velocity, V =	0.25	m/s	Velocity, V =	0.99	m/s
Pressure Loss, h_f =	0.13	m	Pressure Loss, I	0.12	m	Pressure Loss, h_f =	1.60	m
=	0.18	psi	=	0.17	psi	=	2.27	psi
=	1.24	kPa	=	1.15	kPa	=	15.67	kPa

Pressure at Connection =	397.73	kPa
Total Pressure Loss =	18.07	kPa
Service Pressure =	**379.66**	**kPa**

*Calculated Residual Pressure at Dalton Road Hydrant

> 275 kPa

Scenario 2: Fire Flow + Max Day Domestic Demand (Min. 140 kPa)

Watermain (Section 1)			**Watermain (Section 2)**			**Watermain (Section 3)**		
Length, L =	1250	m	Length, L =	0	m	Length, L =	0	m
C =	150		C =	150		C =	150	
Diameter, D =	300	mm	Diameter, D =	300	mm	Diameter, D =	300	mm
Flow, Q =	212.34	L/s	Flow, Q =	212.34	L/s	Flow, Q =	212.34	L/s
Velocity, V =	3.00	m/s	Velocity, V =	3.00	m/s	Velocity, V =	3.00	m/s
Pressure Loss, h_f =	24.90	m	Pressure Loss, I	0.00	m	Pressure Loss, h_f =	0.00	m
=	35.43	psi	=	0.00	psi	=	0.00	psi
=	244.31	kPa	=	0.00	kPa	=	0.00	kPa

Pressure at Connection =	309.78	kPa
Total Pressure Loss =	244.31	kPa
Service Pressure =	**65.47**	**kPa**

*Calculated Residual Pressure at St. Michaels Hydrant

> 140 kPa

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
Delhi GC Development		Checked by:	FG
Delhi, ON		Project No:	300053741
Water Demand Calculations - South Site		Date:	23/03/15

IV. Flow Test Results - Test 1

** As per fire flow test completed on fire hydrant ID #188 located on St. Michaels St*

Static Pressure = 60 psi
= 42.19 m head

Pressure (psi)	*Pressure (m)*	*Flow (GPM)*	*Flow (L/s)*
58	40.79	1126	71.04
50	35.16	1957	123.47

Pump Head Equation

$Head(m) = A - B(Q^C)$

A =	42.19
B =	0.000524800
C =	1.85

Theoretical Flow @ 20.3 psi = 359 L/s
= 21511 L/min
= 5683 US GPM

Anticipated Residual Pressures

Scenario	Flow (L/s)	Pressure (psi)		
		Estimated	Required	
Peak Domestic	17.5	***59.8***	39.9	** Minimum pressure of 275 kpa (39.9 psi)*
Fire + Max Day	212.3	***44.9***	20.3	** Minimum pressure of 140 kpa (20.3 psi)*

V. Flow Test Results - Test 2

** As per fire flow test completed on fire hydrant ID #75 located on Dalton Road*

Static Pressure = 58 psi
= 40.8 m head

Pressure (psi)	*Pressure (m)*	*Flow (GPM)*	*Flow (L/s)*
54	37.98	1061	67
42	29.54	1898	120

Pump Head Equation

$Head(m) = A - B(Q^C)$

A =	40.80
B =	0.0012060
C =	1.84

Theoretical Flow @ 20.3 psi = 229 L/s
= 13743 L/min
= 3631 US GPM

Anticipated Residual Pressures

Scenario	Flow (L/s)	Pressure (psi)		
		Estimated	Required	
Domestic	17.5	***57.7***	39.9	** Minimum pressure of 275 kpa (39.9 psi)*
Fire + Domestic	212.3	***25.2***	20.3	** Minimum pressure of 140 kpa (20.3 psi)*

Hydrant Flow Test Report

SITE NAME:

SITE ADDRESS / MUNICIPALITY: **Dalton Road Delhi, On**

TEST HYDRANT LOCATION : **By # 183 Dalton Road (Hydrant ID # 75)**

BASE HYDRANT LOCATION: **# 165 Dalton Road (Hydrant ID #76)**

TEST BY: Luzia Wood

TEST DATE: Nov 02,2022

TEST TIME: 9:56AM

TEST DATA

FLOW HYDRANT — Pipe Diam. (in / mm): 150mm

	PITOT 1	PITOT 2
SIZE OPENING (inches):	2.5	2.5
COEFFICIENT (**note 1**):	0.90	0.90
PITOT READING (psi):	40	32 / 32
FLOW (usgpm):	**1061**	**1898**

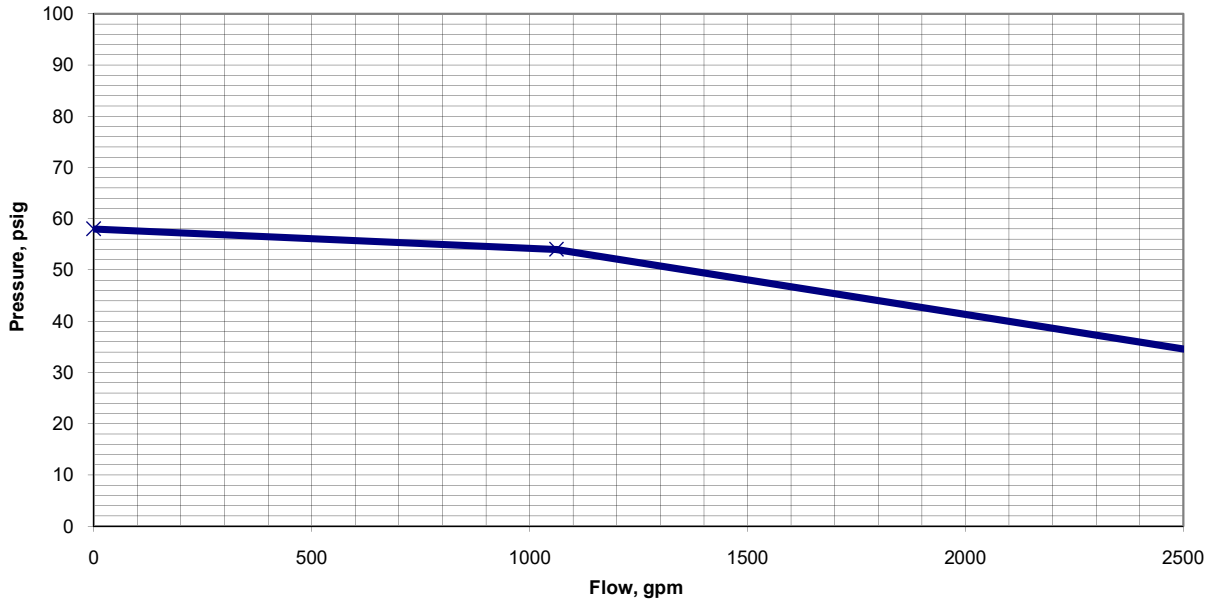
THEORETICAL FLOW @ 20 PSI 3579

BASE HYDRANT — Pipe Diam. (in / mm): 150mm

STATIC READING (psi): 58 RESIDUAL 1 (psi): 54 RESIDUAL 2 (psi): 42

REMARKS:

NOTE 1: Conversion factor of .90 used for flow calculation based on rounded and flush internal nozzle configuration. No appreciable difference in pipe invert between flow and base hydrants.



L & D Waterworks Inc.
491 Port Maitland Rd
Dunnville, ON N1A 2W6
Ph: 289.684.6747

Hydrant Flow Test Report

SITE NAME:

SITE ADDRESS / MUNICIPALITY: **St. Michaels Street Delhi, On**

TEST HYDRANT LOCATION : **72 St. Michaels Street (Hydrant ID # 188)**

BASE HYDRANT LOCATION: **In Front of # 27 Viola Ct (Hydrant ID #164)**

TEST BY: Luzia Wood

TEST DATE: Nov 02,2022

TEST TIME: 9:20AM

TEST DATA

FLOW HYDRANT — Pipe Diam. (in / mm): 150mm

	PITOT 1	PITOT 2
SIZE OPENING (inches):	2.5	2.5
COEFFICIENT (**note 1**):	0.90	0.90
PITOT READING (psi):	45	34 / 34
FLOW (usgpm):	**1126**	**1957**

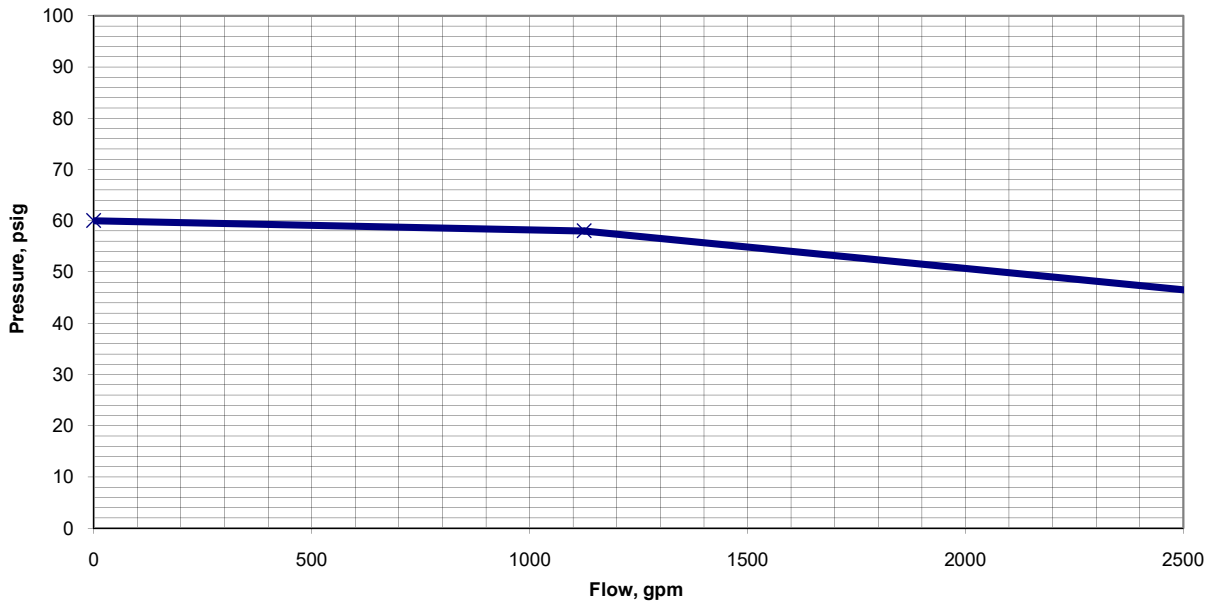
THEORETICAL FLOW @ 20 PSI 5675

BASE HYDRANT — Pipe Diam. (in / mm): 150mm

STATIC READING (psi): 60 RESIDUAL 1 (psi): 58 RESIDUAL 2 (psi): 50

REMARKS:

NOTE 1: Conversion factor of .90 used for flow calculation based on rounded and flush internal nozzle configuration. No appreciable difference in pipe invert between flow and base hydrants.



L & D Waterworks Inc.
491 Port Maitland Rd
Dunnville, ON N1A 2W6
Ph: 289.684.6747

Hydrant Flow Test Report

SITE NAME:

SITE ADDRESS / MUNICIPALITY: **Wilson Ave Delhi, On**

TEST HYDRANT LOCATION : **2nd Hydrant East of Viola Ct By 2nd Ent's to #74 Wilson Ave (Hydrant ID # 178)**

BASE HYDRANT LOCATION: **1st Hydrant East of Viola Ct 1st Ent's to # 74 Wilson Ave (Hydrant ID #177)**

TEST BY: Luzia Wood

TEST DATE: Nov 02,2022

TEST TIME: 8:55AM

TEST DATA

FLOW HYDRANT — Pipe Diam. (in / mm): 300mm

	PITOT 1	PITOT 2
SIZE OPENING (inches):	2.5	2.5
COEFFICIENT (**note 1**):	0.90	0.90
PITOT READING (psi):	50	38 / 38
FLOW (usgpm):	**1186**	**2069**

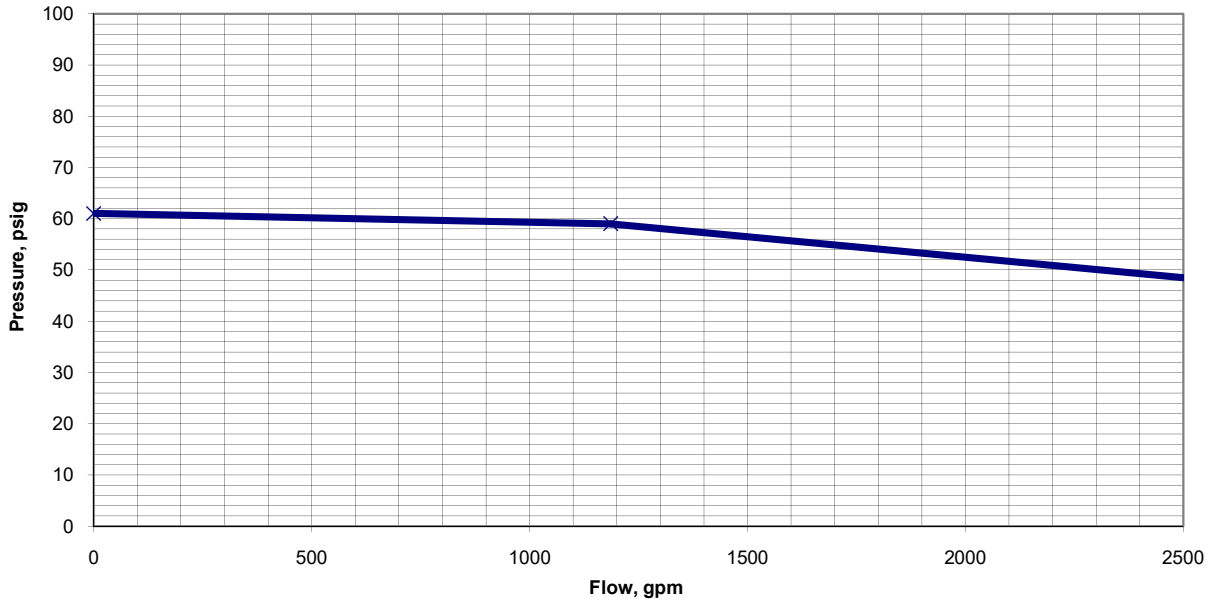
THEORETICAL FLOW @ 20 PSI 6062

BASE HYDRANT — Pipe Diam. (in / mm): 300mm

STATIC READING (psi): 61 RESIDUAL 1 (psi): 59 RESIDUAL 2 (psi): 55

REMARKS:

NOTE 1: Conversion factor of .90 used for flow calculation based on rounded and flush internal nozzle configuration. No appreciable difference in pipe invert between flow and base hydrants.



L & D Waterworks Inc.
491 Port Maitland Rd
Dunnville, ON N1A 2W6
Ph: 289.684.6747

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix B

Sanitary Design Calculations

BURNSIDE

CALCULATION SHEET

Project:	Prepared by:	BF
Delhi GC Development	Checked by:	FG
Delhi, ON	Project No:	300053741
Sanitary Servicing Calculations	Date:	23/03/15

Proposed Site Flows (Street A)

Residential

Type	Quantity	P/Unit	Population
Townhouse	0	2.75	0
Single/Semi Detached	15	2.75	41
Total	15		41

Daily Design Flows = 266 L/cap/day *Norfolk County design standards
Population, P = 41

Peaking Factor, M = 4.33 $M = 1 + \frac{14}{4 + P^{0.5}}$

Peak Flow, Q = 0.55 L/s $Q = \frac{P\ x\ Q\ x\ M}{86400} + (A\ x\ I)$

Infiltration

Infiltration Allowance= 0.26 L/s/ha
Site Area = 1.39 ha
$Q_{infiltration}$= 0.36 L/s

$Q_{proposed\ total}$= 0.91 L/s

Service Connection					
Diameter (mm)	Slope (%)	Full Flow Velocity (m/s)	Capacity (L/s)	Spare Capacity (L/s)	Percent Full (%)
200	0.50	0.74	23.19	22.28	3.93%

Proposed Site Flows (Private Condos)

Residential

Type	Quantity	P/Unit	Population
Townhouse	129	2.75	355
Single/Semi Detached	0	2.75	0
Total	129		355

Daily Design Flows = 266 L/cap/day *Norfolk County design standards
Population, P = 355 *In Thousands

Peaking Factor, M = 4.05 $M = 1 + \frac{14}{4 + P^{0.5}}$

Peak Flow, Q = 4.42 L/s $Q = \frac{P\ x\ Q\ x\ M}{86400} + (A\ x\ I)$

Infiltration

Infiltration Allowance= 0.26 L/s/ha
Site Area = 3.67 ha
$Q_{infiltration}$= 0.95 L/s

$Q_{proposed\ total}$= 5.37 L/s

Service Connection					
Diameter (mm)	Slope (%)	Full Flow Velocity (m/s)	Capacity (L/s)	Spare Capacity (L/s)	Percent Full (%)
200	0.50	0.74	23.19	17.82	23.17%

BURNSIDE

CALCULATION SHEET

Project:		Prepared by:	BF
	Delhi GC Development	Checked by:	FG
	Delhi, ON	Project No:	300053741
	Sanitary Servicing Calculations	Date:	23/03/15

Proposed Site Flows (Main Site)

Residential

Type	Quantity	P/Unit	Population
Retirement	150	1.7	255
Single/Semi Detached/Townhouse	580	2.75	1595
Total	730		1850

Daily Design Flows = 266 L/cap/day *Norfolk County design standards

Population, P = 1850 *In Thousands

Peaking Factor, M = 3.6 $M = 1 + \frac{14}{4 + P^{0.5}}$

Peak Flow, Q = 20.57 L/s $Q = \frac{P\ x\ Q\ x\ M}{86400} + (A\ x\ I)$

Infiltration

Infiltration Allowance= 0.26 L/s/ha

Site Area = 23.86 ha

$Q_{infiltration}$= 6.20 L/s

$Q_{proposed\ total}$= 26.78 L/s

Service Connection					
Diameter (mm)	Slope (%)	Full Flow Velocity (m/s)	Capacity (L/s)	Spare Capacity (L/s)	Percent Full (%)
250	0.50	0.86	42.05	15.27	63.68%

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix C

Floodplain Modelling Figures

START OF OUTLET CHANNEL

PROPOSED FLOODPLAIN STORAGE TO BE FILLED.

PROPOSED AREA OF FLOODPLAIN STORAGE COMPENSATION (CUT).

PROPOSED OUTLET CHANNEL TO BE WIDENED AND NATURALIZED. REFER TO OUTLET CHANNEL SECTION A-A

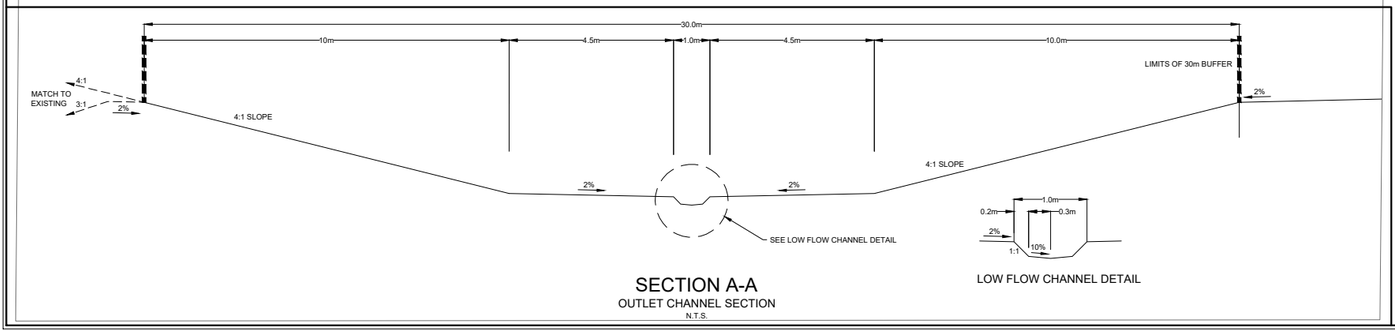
PROPOSED SWM FACILITY

100YR FLOOD LINE

30m BUFFER FROM WATER'S EDGE

PROPOSED FLOODPLAIN STORAGE TO BE FILLED.

END OF OUTLET CHANNEL (APPROX 200m LONG)



SECTION A-A
OUTLET CHANNEL SECTION
N.T.S.

LOW FLOW CHANNEL DETAIL

	FILL VOLUME (m3)			
Elevation	(Pond)	(James Street Lots)	Total	CUT VOLUME (m3)
226.3	*	3	3	225
226.4	*	15	15	324
226.5	0	41	41	458
226.6	105	88	193	633
226.72	233	179	412	926

* Note: Pond water level at 226.5m, therefore floodplain storage available above 226.5m elevation

N

0 10 20 40 60
Metres

BURNSIDE

Client
DELHI DEVELOPMENT INC.

Figure Title
DELHI GOLF COURSE
FLOODPLAIN CUT & FILL STORAGE AREAS

Drawn	Checked	Date	Figure No.
RS	LG	22/12/19	FIG B
Scale		Project No.	
1:750		053741.05	

100 YR STORM FLOODLINE

DELHI

DALSON AVE

DALSON RD

SITE LOCATION

SWAMP RD

HIGHWAY 3

SPRUCE ST

KEY PLAN
SCALE: N.T.S.

Wetland Limit

Development Limit

Floodline

Provincially Significant Wetland

Hazard Land Zone

PSW

Open Space 5.02ha.

6m Trail / Servicing Easement

Street E

Street D

Street C

Street H

Street F

Street G

St. B

Open Space 6.95ha.

Provincially Significant Wetland

Hazard Land Zone

Tisdale Drive

Retirement Home 1.2ha.

Community Commons 1.7ha.

Existing Watercourse (piped)

Wetland

Open Space 1.06ha.

Open Space 0.01ha.

Existing Golf Club Entrance To Remain

Pumping Stn.

SWM 2.27ha.

Open Space 11.13ha.

(HIGHWAY No. 3)

James Street (Hwy 3)

Pine Grove Road

Alpha Street

LEGEND

- CROSS SECTION NUMBER
- CROSS SECTION LOCATION
- 100-YEAR FLOOD LINE ELEVATION (m)
- 100 YR STORM FLOODLINE
- PROPERTY BOUNDARY
- EXISTING CONTOUR

0 25 50 75 100
Metres

BURNSIDE

Client
DELHI DEVELOPMENT INC.

Figure Title
DELHI GOLF COURSE
STONEY CREEK FLOOD PLAIN MAPPING

Drawn	Checked	Date	Figure No.
RS	LG	22/11/24	**FIG A**
Scale		Project No.	
1:1500		053741.05	

R.J. Burnside & Associates Limited

Jade Acoustics Inc. | Consulting Engineers | 411 Confederation Parkway, Unit 19, Concord, Ontario, L4K 0A8 | Tel: (905) 660-2444 | Fax: (905) 660-4110

PRELIMINARY
ENVIRONMENTAL NOISE REPORT

PROPOSED RESIDENTIAL DEVELOPMENT
DELHI GOLF AND COUNTRY CLUB
HIGHWAY 3 AND WILSON AVENUE
DELHI, ONTARIO

PREPARED FOR
Delhi Development Inc. c/o Geranium

Revised March 22, 2023
January 31, 2023
File: 21-181

TABLE OF CONTENTS

	SUMMARY	1
1.0	INTRODUCTION	3
2.0	NOISE SOURCES	5
	2.1 Transportation Sources	5
	2.2 Stationary Sources	5
3.0	ENVIRONMENTAL NOISE CRITERIA	8
	3.1 Transportation Sources	8
	3.1.1 Indoors	8
	3.1.2 Outdoors	9
	3.2 Stationary Sources	10
	3.3 Norfolk County Noise By-Law	11
4.0	NOISE IMPACT ASSESSMENT	12
	4.1 Transportation Sources	12
	4.2 Stationary Sources	12
5.0	NOISE ABATEMENT REQUIREMENTS	14
	5.1 Roads	14
	5.1.1 Indoors	14
	5.1.2 Outdoors	15
	5.2 Stationary Sources	15
6.0	CONCLUSIONS	16
7.0	REFERENCES	17

LIST OF TABLES

TABLE 1	SUMMARY OF ROAD TRAFFIC DATA.....	18
TABLE 2	SUMMARY OF PREDICTED UNMITIGATED SOUND LEVELS OUTDOORS DUE TO ROAD TRAFFIC	19
TABLE 3	SUMMARY OF MINIMUM NOISE ABATEMENT MEASURES.....	20

LIST OF FIGURES

FIGURE 1	KEY PLAN
FIGURE 2	PLAN OF DEVELOPMENT SHOWING MINIMUM NOISE ABATEMENT MEASURES

LIST OF APPENDICES

APPENDIX A	CORRESPONDENCE REGARDING ROAD TRAFFIC INFORMATION	A-1
APPENDIX B	ENVIRONMENTAL NOISE CRITERIA	B-1
APPENDIX C	SAMPLE CALCULATION OF PREDICTED UNMITIGATED SOUND LEVELS.....	C-1
APPENDIX D	SAMPLE CALCULATION OF ARCHITECTURAL COMPONENT SELECTION.....	D-1

SUMMARY

The proposed residential development is located in the community of Delhi, County of Norfolk and is subject to road traffic noise from Highway 3 (James Street), Wilson Avenue and Tisdale Drive. It is not affected by rail or aircraft traffic. There are commercial, industrial and institutional uses in the surrounding area of the proposed redevelopment that have been investigated.

The environmental noise guidelines of the community of Delhi, County of Norfolk and the Ministry of the Environment, Conservation and Parks (previously, MOE) set out sound level limits for both indoor and outdoor space. Sound levels due to the adjacent roads were determined using ORNAMENT, the noise prediction model of the MOE.

Using the road traffic data obtained from the traffic consultant (BA Group) retained by the proponent, the sound levels for various locations within the proposed residential development were determined. It was found that with appropriate mitigative measures, all lots and blocks in the redevelopment will meet the noise guidelines.

There are lots with exposure to Highway 3 (James Street) that require provision for adding central air conditioning by the occupant if noise becomes a concern and a warning clause to this effect is required. Table 3 and Figure 2 show the central air conditioning requirements.

Based on the preliminary analysis, exterior wall, window and exterior door construction above typical building practices will not be necessary. Prior to issuance of building permits, the acoustical requirements should be reviewed to ensure compliance with the applicable guidelines. Prior to final occupancy, the lots should be inspected by an acoustical consultant to ensure the required mitigative measures have been incorporated.

Where minor excesses exist or mitigation is required, future occupants will be advised through the use of warning clauses.

A future pumping station (Block 212), retirement home (Block 203) and Community Commons area (Block 204) are identified as part of the concept plan. Detailed information regarding noise sources associated with these uses is not available at this stage of the project. Once specific information is available, a detailed noise analysis should be prepared by the proponent of each use to ensure the applicable noise guidelines are met at all noise sensitive receptors. See Section 2.2 for further discussion.

To note here for completeness and as discussed with Delhi Development Inc., there will be no golf holes remaining as part of this redevelopment.

Purchasers/tenants in close proximity or with exposure to commercial, industrial and/or institutional uses will be advised through a warning clause that the dwelling is in proximity to existing and/or future commercial, industrial and/or institutional uses whose activities may at times be audible. See Section 2.2 for discussion applicable to the existing stationary noise sources.

There is an existing paintball facility located directly adjacent to the south property line of the subject site limits. As discussed in Section 4.2, a detailed investigation will be needed of the paintball facility to determine the sound level impact at the at the proposed residential dwellings.

1.0 INTRODUCTION

Jade Acoustics Inc. was retained by Delhi Development Inc. to prepare an update to the Preliminary Environmental Noise Report prepared by Jade Acoustics Inc. dated January 31, 2023, to investigate the updated concept plan for the subject site. The latest traffic information (the traffic forecast work by BA Group) has also been used. As before, an investigation has been completed regarding the potential impact of noise on the proposed residential development to the satisfaction of the community of Delhi, in the County of Norfolk.

The proposed site is identified as:

Golf Course
LT 4-7, 12 PL 306; PT LT 10-11 PL 306; PT RDAL BTN CON 13 & CON 14 WINDHAM CLOSED BY NR294320; PT LT 24 CON 13 WINDHAM PT 1 & 2 37R954 & NR508966 EXCEPT PT 1 37R8047; NORFOLK COUNTY

76 Wilson
PT LT 24 CON 13 WINDHAM PT 1 37R836; NORFOLK COUNTY

The proposal includes redevelopment of the existing Delhi Golf and Country Club.

Surrounding land uses include existing residential and Wilson Avenue to the north, agricultural land to the east, commercial uses, industrial uses, agricultural land and residential to the south and existing residential, commercial and Highway 3 (James Street) to the west. In general, there are various provincially significant wetlands that are part of this redevelopment area and will remain as is (i.e. not developed into residential uses). For the north portion of the subject site, the proposed dwellings are surrounded by existing residential uses.

A Key Plan is attached as Figure 1.

The proposed redevelopment is comprised of single detached dwellings, freehold townhouse blocks in the south portion of the development, townhouse blocks in the north portion of the development (which all together will be a condominium block identified as Block 202 Townhouses), a retirement home, community commons area, stormwater pond, a pumping station and new internal roads.

The analysis was based on:

- Concept Plan prepared by GSP Group dated February 23, 2023 and Draft Plan of Subdivision prepared by GSP Group dated March 9, 2023;

- Road traffic turning movement count (TMC) figure (for the year 2038) prepared by BA Group and provided by Delhi Development Inc. to Jade Acoustics Inc. on March 15, 2023. Existing traffic counts (conducted in November 2021 by BA Group) and provided to Jade Acoustics Inc. on December 1, 2021; and
- A site visit conducted by Jade Acoustics Inc. on July 20, 2022.

Figure 2 shows the plan of the proposed residential development.

All dwellings (the singles and townhouses) are expected to be up to two (2) storey residential buildings.

For the townhouse dwellings proposed at the north portion of the subject site (Block 202), it is understood from Delhi Development Inc. that these townhouse dwellings will collectively be considered a condominium block.

The draft plan prepared by GSP Group dated March 9, 2023 included lot and block numbers for the development. However, in the Block 202 area, block specific numbers for each townhouse were not included at this time. For the purpose of clarity in referencing the analyzed townhouse block in the Block 202 area, Jade Acoustics Inc. added a block number to the plan (noted as Block 1 and applicable to the townhouse with the highest exposure to Wilson Avenue).

2.0 NOISE SOURCES

2.1 Transportation Sources

The road traffic on Highway 3 (James Street), Wilson Avenue and Tisdale Drive is the noise source with a potential impact on the proposed redevelopment. Road traffic information is summarized in Table 1. Correspondence regarding the road traffic information is included in Appendix A.

The ultimate road traffic data for Highway 3 (James Street), Wilson Avenue and Tisdale Drive was provided by the traffic consultant (BA Group) in the form of a TMC figure for the year 2038. Peak hour road traffic volumes (a.m. and p.m.) for the respective roadways (year 2038) were used to determine the average annual daily traffic (AADT) volumes for these three (3) roads. As discussed with BA Group on similar projects, the future AADT volumes were calculated by multiplying the higher of the a.m. or p.m. peak hour volumes by ten (10) which means that the peak hour volume was assumed to be 10% of the AADT volumes. This method has been used in the analysis. The percentage of trucks and day/night split for Highway 3 (James Street) and Wilson Avenue were determined by assessing existing traffic counts (the most recent from November 2021) as provided by BA Group.

At current, Tisdale Drive is a relatively short segment of roadway that is serving only a few existing dwellings. For the subject site, Tisdale Drive will be extended east and is the main access point off Highway 3 (James Street). The truck percentage for Tisdale Drive was assumed based on similar subdivision projects in Jade Acoustics Inc. files.

Further to above, it was determined that all other internal roadways would have relatively low traffic volumes. Due to the low traffic volumes, the internal roadways are acoustically insignificant and not considered further in this report.

The site is not affected by aircraft or rail traffic.

2.2 Stationary Sources

Existing Uses

There is an existing Home Hardware and office commercial use along Highway 3 (James Street) that is bounded by existing residential along Viola Court to the east. These commercial uses have existing residential immediately adjacent in all directions, except with Highway 3 (James Street) to the west. The existing residential developments are in closer proximity than any of the proposed residential dwellings at the subject site. The applicable sound level limits are required to be met at the existing residential dwellings and will therefore

consequently be met at the subject site dwellings. The commercial uses were not considered further in this report.

By the northeast corner of Viola Court and St. Michaels Street, there is an existing Sewage Pumping Station. This institutional use is directly adjacent to an existing residential dwelling located to the west. In general, the pumping station is located at the southwest portion of a community park and there is surrounding residential in all directions. The setback distance between the pumping station and adjacent dwelling property to the west is essentially zero. The applicable sound level limits are required to be met at the existing residential dwellings and will therefore consequently be met at the subject site proposed dwellings. The pumping station was not considered further in this report, with exception that a proximity warning clause would be applicable.

The subject site includes two (2) lots proposed along Highway 3 (James Street), generally south of the Tisdale Road entrance to the subject site. There are commercial uses, such as a vehicle dealership (McKee Sport and Garden Ltd) and a commercial sales and service operation for agricultural systems (Vanden Bussche Irrigation) located southwest of these proposed dwellings. These commercial uses have existing residential dwellings located in all directions. To clarify for completeness regarding Vanden Bussche Irrigation, the zoning is considered light industrial and therefore this use is being considered a commercial/industrial use. The existing residential developments are in closer proximity than any of the proposed residential dwellings at the subject site. The applicable sound level limits are required to be met at the existing residential dwellings and will therefore consequently be met at the subject site dwellings. The commercial/industrial uses were not considered further in this report, with exception that a proximity warning clause would be applicable.

W.E. Saunders and Sons Painting is a retail paint store located along Highway 3 and generally east of Pine Grove Road. This commercial building includes a paint booth and air conditioning unit. There are no loading docks associated with this building. Adjacent to the building on the west side is an area used for outdoor storage of materials, such as boats and camper trailers. There are existing residential dwellings to the south and east of this facility. The applicable sound level limits are required to be met at the existing residential dwellings and will therefore consequently be met at the subject site dwellings. The commercial uses were not considered further in this report.

Judgement Day Paintball is located immediately south of the subject site property limits (and shares a common property line with the subject site). There is an outdoor paintball field setup with obstacles that allows teams to compete with one another. An office/storefront type trailer unit is on the property as well. The main noise source of concern at this facility is the firing of paintball guns. It is understood that the paintball guns use compressed air to fire the paintball ammunition/balls and the noise produced is similar in nature to a compressed air gun that is

used by framers during house construction. This facility operates during daytime hours only according to information on their website. There are noise sensitive receptors proposed at the subject site that are perhaps the worst case location relative to any other existing residential dwellings. Further discussion on this specific commercial use is included in Section 4.2.

Future Uses

A future pumping station (Block 212) is identified as part of the concept plan. Detailed information regarding noise sources associated with the pumping station is not available at this stage of the project. Once specific information is available, a detailed noise analysis should be prepared by the proponent of the pumping station to ensure the applicable noise guidelines are met at the proposed and existing noise sensitive receptors.

There is a future Community Commons area (Block 204) proposed just south of the proposed retirement home. At this time, details of the community commons area are unknown. It is expected that this area will include park space and potentially other recreational amenities. Once specific information is available, a detailed noise analysis should be prepared by the proponent of the buildings in the Community Commons area to ensure the applicable noise guidelines are met at the proposed and existing noise sensitive receptors.

A future retirement home (Block 203) is identified as part of the concept plan. Detailed information regarding noise sources associated with the retirement home is not available at this stage of the project. Once specific information is available, a detailed noise analysis should be prepared by the proponent of the retirement home to ensure the applicable noise guidelines are met at the proposed and existing noise sensitive receptors and including the noise sensitive receptors associated with the retirement home itself.

For all the future uses noted above, the general noise sources of concern, but not limited to, includes the following: heating, ventilation and air conditioning (HVAC) equipment, generators and/or other mechanical equipment that produces noise into the outdoor environment. The mechanical equipment is unknown at this preliminary stage of the redevelopment for these future uses.

3.0 ENVIRONMENTAL NOISE CRITERIA

The MOE document "Environmental Noise Guideline Stationary and Transportation Sources – Approval and Planning, Publication NPC-300", dated August, 2013, released October 21, 2013 (updated final version # 22) was used in the analysis. A brief summary of the NPC-300 guidelines is given in Appendix B.

The County of Norfolk follows the MOE environmental noise criteria which are summarized below.

3.1 Transportation Sources

3.1.1 Indoors

If the nighttime (11:00 p.m. to 7:00 a.m.) sound level in terms of Leq at the exterior face of a bedroom or living/dining room window is greater than 60 dBA and/or if the daytime (7:00 a.m. to 11:00 p.m.) sound level in terms of Leq at the exterior face of a bedroom or living/dining room window is greater than 65 dBA, means must be provided so that windows can be kept closed for noise control purposes and central air conditioning is required.

For nighttime sound levels (LeqNight) greater than 50 dBA to less than or equal to 60 dBA on the exterior face of a bedroom or living/dining room window and/or daytime sound levels (LeqDay) greater than 55 dBA to less than or equal to 65 dBA on the exterior face of a bedroom or living/dining room window, there need only be the provision for adding central air conditioning by the occupant at a later date. This typically involves a ducted heating system sized to accommodate the addition of central air conditioning by the occupant at a later date. A warning clause advising the occupant of the potential interference with some activities is also required.

In all cases, air cooled condenser units must not exceed an AHRI sound rating of 7.6 bels. As noted in MOE document NPC-300, the location and installation of the outdoor air conditioning device should comply with the sound level limits of Publication NPC-216 or should comply with other criteria specified by the municipality. The air cooled condenser units must be sited in accordance with the zoning by-laws with respect to setbacks as well as location.

The current County of Norfolk Noise By-law Number 2010-84, with amendments 2012-155 and 2016-11, which regulates, prohibits and otherwise controls noise, indicates that air conditioner units should comply with MOE NPC documents. It is therefore implied that Publication NPC-216 is applicable.

As required by the MOE, the indoor noise criteria for road traffic noise is 40 dBA (Leq8hour) for the bedrooms during nighttime hours, 45 dBA (Leq8hour) for the living/dining rooms during

nighttime hours and 45 dBA (Leq16hour) for the living/dining rooms and bedrooms during daytime hours. These criteria are used to determine the architectural requirements.

3.1.2 Outdoors

Based on the MOE guidelines, for outdoor amenity areas (Outdoor Living Area – OLA) a design goal of 55 dBA daytime (7:00 a.m. to 11:00 p.m.) sound level is used with an excess not greater than 5 dBA considered acceptable in some cases. Where the unmitigated sound level during the day exceeds 55 dBA (LeqDay) but is less than 60 dBA (LeqDay), a warning clause is required, and mitigation should be considered. When the unmitigated sound level exceeds 60 dBA, sound barriers and warning clauses are generally required to achieve as close to 55 dBA as is technically, economically and administratively feasible.

The definition of outdoor amenity area as defined by the MOE is given below.

"Outdoor Living Area (OLA)

> (applies to impact assessments of transportation sources) means that part of a noise sensitive land use that is:
>
> - intended and designed for the quiet enjoyment of the outdoor environment; and
> - readily accessible from the building.

The OLA includes:

- backyards, front yards, gardens, terraces or patios;
- balconies and elevated terraces (e.g. rooftops), with a minimum depth of 4 metres, that are not enclosed, provided they are the only outdoor living area (OLA) for the occupant; or
- common outdoor living areas (OLAs) associated with high-rise multi-unit buildings."

In this case, it is expected that any proposed balconies and/or elevated terraces associated with the single detached and townhouse dwellings will be less than 4.0 m deep and as such are not considered to be noise sensitive receptors. The rear yards associated with the residential dwellings have been investigated. See Section 4.1 for further discussion.

For both indoor and outdoor conditions, where the acoustic criteria are exceeded, warning clauses must be placed in offers of purchase and sale or lease agreements and in the subdivision agreement.

3.2 Stationary Sources

The guidelines of the Ontario Ministry of the Environment, Conservation and Parks (MOE) for stationary sources are to be used for commercial/industrial facilities.

The MOE has recently published the document NPC-300 titled “Environmental Noise Guideline Stationary and Transportation Sources – Approval and Planning”.

The MOE also has vibration guidelines with respect to stationary sources, NPC-207. These guidelines require that the peak vibration velocities not exceed 0.3 mm/s at the point of reception during the day or night. To note here for completeness, there are no stationary noise vibration sources in the surrounding area that impact the proposed subject site dwellings.

The MOE recognizes the need for back-up beepers/alarms as safety devices and as such does not have any guidelines or criteria to address these sources.

It should be noted that the MOE guidelines do not require that the source be inaudible, but rather that specific sound level limits be achieved.

With respect to stationary sources of noise in urban areas, the MOE guidelines require that the sound level due to the stationary source at the building façade and outdoor amenity spaces not exceed the sound level due to road traffic and in certain situations due to rail traffic in any hour of source operation, subject to specific exclusions. Tables C-5, C-6, C-7 and C-8 included in Appendix B provide the exclusion limit values of one-hour equivalent sound level (Leq, dBA) and impulsive sound level (L_{LM}, dBAI).

In addition, the MOE guidelines require that most industries have a valid Environmental Compliance Approval (ECA) or its precursor, a Certificate of Approval (C of A) to operate.

In general, if the criteria for a stationary source of noise are exceeded, the MOE recommends that control be implemented at the source rather than at the receiver. Alternatively, if the receiver is set back from the source or if a physical barrier is constructed so that the criteria can be met at the receiver, no additional mitigative measures are required. Treatment of the receptor building by the use of suitable wall and window construction and central air conditioning to keep windows closed is not an acceptable solution to the MOE in Class 1 and 2 areas (urban). In addition, a warning clause in offers of purchase and sale and/or lease agreement noting the proximity of dwellings to such a source should be considered.

For the subject site in question, as current, a Class 1 designation would be applicable considering the already existing residential and commercial establishments and the presence of Highway 3 (James Street) through this general site area.

Based on the NPC-300 document, Class 4 Areas can only be established in Class 1 or 2 Areas in proximity to existing, lawfully established and approved stationary sources. This is not applicable in areas with existing noise sensitive land use(s) unless they are redeveloped/rezoned/replaced with new noise sensitive land use(s). Classification of a Class 4 Area is subject to formal confirmation from the land use planning authority and continues as long as the stationary source(s) can potentially operate (i.e. until change in zoning).

Sound level limits for Class 4 Area shown in Tables C-5, C-6, C-7 and C-8 assume closed windows together with a ventilation system which is, in most situations, central air conditioning.

3.3 Norfolk County Noise By-law

The County of Norfolk has a noise by-law to prohibit or regulate noise likely to disturb the inhabitants of the County; Noise By-law Number 2010-84 dated April 13, 2010, with amendments 2012-155 and 2016-11. The by-law does not provide specific sound level limits but rather provide qualitative information with respect to sources and provides prohibitions by time and place. The by-law amendment 2012-115 does clearly indicate that the sound level limits of the MOE NPC document applies. It is therefore implied that NPC-300, being the most current NPC document relevant to this situation, would be applicable.

4.0 NOISE IMPACT ASSESSMENT

4.1 Transportation Sources

For road traffic noise, the sound level in terms of Leq, the energy equivalent continuous sound level for both day (Leq16hour, daytime) and night (Leq8hour, nighttime) was determined using the MOE Traffic Noise Prediction Model (ORNAMENT).

Table 2 provides a summary of the predicted sound levels outdoors due to road traffic at specific locations without any mitigative measures. Appendix C gives sample calculations. Shielding provided by the existing and proposed buildings has also been accounted for in the analysis. The rear yard receiver was assumed to be 3 m from the centre of the rear wall of the house.

For Lot 113 that is fronting Highway 3 (James Street), the unmitigated daytime sound level in the rear yard is predicted to be 45 dBA. The unmitigated daytime and nighttime sound levels at the front wall (second storey) are predicted to be 64 dBA and 58 dBA, respectively.

For Lot 120 that is flanking Tisdale Drive and with some exposure to Highway 3 (James Street), the unmitigated daytime sound level in the rear yard is predicted to be 54 dBA. The unmitigated daytime and nighttime sound levels at the side wall (second storey) are predicted to be 57 dBA and 50 dBA, respectively.

Block 1 (north unit) has exposure to Wilson Avenue and the unmitigated daytime sound level in the rear yard is predicted to be 48 dBA. The sound level at the side wall (second storey) is predicted to be 51 dBA (daytime) and 44 dBA (nighttime).

Table 2 provides a summary of the predicted sound levels outdoors due to road traffic at specific locations (the lots and blocks listed above) without any mitigative measures. Appendix C includes sample calculations.

Where the sound level limits are expected to be exceeded, mitigative measures and warning clauses are required.

4.2 Stationary Sources

As discussed in Section 2.2, the existing commercial, industrial and institutional uses in the surrounding area are not expected to be acoustically significant and were not assessed further, with exception to the Judgement Day Paintball facility.

For the future retirement home, pumping station and community commons associated with this development, a detailed noise analysis should be prepared by the proponent of these uses to ensure the MOE noise guidelines are met at the existing and proposed noise sensitive receptors.

Judgement Day Paintball facility

As noted in Section 2.2, the main noise source of concern at this operation is the firing of paintball guns during competitive games (or other similar events). At this time, the respective paintball facility was not contacted to complete sound level measurements at the facility. This process (sound measurements) should be completed as a Condition of Draft Approval at the detailed design stage, when a Detailed Environmental Noise Report will be required.

A preliminary noise model was created to investigate the potential noise impact of the outdoor paintball facility at the proposed noise sensitive receptors. The CadnaA computer program (Version 2022 MR2) which uses International Standard Analytical Code ISO 9613-2 was used for the analysis. The compressed air firing of the paintball guns is considered to be an impulsive noise source. The preliminary noise model used a sound power level of 95 dBAI to represent the paintball field activities. These activities were assumed to happen during daytime hours when the facility is in operation (and as per the noise guidelines, the worst case hour was assessed). The sound power level was based on online information applicable to paintball activities. In this preliminary noise model, the predicted sound levels at the proposed noise sensitive receptors are in compliance with the noise guidelines.

Further to above, confirmation of the sound power level associated with the paintball facility activities will be needed during the detailed design stage. This work can be completed as part of a detailed noise report when the refined subdivision plan is available. Mitigation measures are available if sound level compliance is not predicted to be achieved. The mitigation measures include acoustic barriers, investigation of Class 4 sound level limits and/or special dwelling designs (or a combination of these measures).

5.0 NOISE ABATEMENT REQUIREMENTS

The noise mitigation requirements for both the indoor and outdoor locations are detailed below. Table 3 and Figure 2 provide a summary of the acoustical mitigative requirements for the lots and blocks in this development.

5.1 Roads

5.1.1 Indoors

Architectural Component Requirements

The indoor sound level criteria for road traffic can be achieved in all cases by using appropriate architectural elements for external walls, windows, exterior doors, and roof construction. The indoor sound level limit for road traffic noise is 40 dBA (Leq8hour) for the bedrooms during nighttime hours, 45 dBA (Leq8hour) for the living/dining rooms during nighttime hours and 45 dBA (Leq16hour) for the living/dining rooms and bedrooms during daytime hours. These criteria have been used in this analysis. The characteristic spectrum for road traffic has been accounted for in the determination of the architectural components. Appendix D contains a sample calculation of the architectural component selection.

Since house plans are not yet available, the final architectural choices cannot be made. Therefore, a preliminary analysis using assumed window and exterior wall percentages has been conducted to provide an indication of the architectural requirements. Once house plans are available, the architectural component requirements should be re-evaluated.

Calculations were completed for the second storey corner bedroom of the worst case location with exposure to Highway 3 (James Street), for example, Lot 113 that is directly adjacent to the roadway. For the bedroom, the wall parallel to Highway 3 (James Street), the front wall, was assumed to be 55% of the floor area and the wall perpendicular to Highway 3 (James Street), the side wall, was also assumed to be 55% of the floor area. The windows were assumed on both the walls and to be 25% of the associated floor area.

Based on the ratios mentioned above, windows and exterior doors need to be up to STC 25 and exterior walls need to be up to STC 33. These STC ratings comply with the minimum structural and safety requirements provided by standard construction practices; therefore, standard window and exterior wall construction is acoustically acceptable for all proposed residential dwellings.

As a general note here, an STC 54 rating for the roof, normally met by most residential roof construction with ventilated attic space, would be acoustically acceptable.

Ventilation Requirements

Where the sound level from road traffic is greater than 60 dBA (LeqNight) or greater than 65 dBA (LeqDay) on the outside face of a bedroom or living/dining room window, the indoor sound level criteria would not be met with open windows and provisions must be met to permit the windows to remain closed. The MOE guidelines require central air conditioning. Based on the analysis, central air conditioning is not required for any of the proposed lots and blocks.

Where the nighttime sound level (Leq8hour) is between 51 dBA and 60 dBA inclusive and daytime sound level (Leq16hour) is between 56 dBA and 65 dBA inclusive, the provision for adding central air conditioning by the occupants must be made. Based on the analysis, Lots 113, 114 and 120 (See Figure 2) require the provision for adding central air conditioning and a warning clause. See Table 3 and Figure 2 for details.

In general, the outdoor air conditioning condensing units must meet the applicable sound level limits and be sited in accordance with the applicable zoning by-laws.

Warning clauses will be required in offers of purchase and sale, lease agreements, and in the subdivision agreement for all relevant lots to make future occupants aware of the potential noise situation. See Table 3 for details.

5.1.2 Outdoors

The outdoor amenity area is required to be exposed to a sound level of less than or equal to 55 dBA during the day. A 5 dBA increase is considered acceptable in certain situations. Typically, if the sound level is above 55 dBA, some form of mitigation and a warning clause is required.

For all the proposed lots and blocks, the unmitigated predicted sound level in the rear yards is less than 55 dBA. Therefore, no acoustic barriers are required for the proposed redevelopment.

5.2 Stationary Sources

As discussed in Section 4.2, the Judgement Day Paintball facility will require further investigation during the detailed design stage, when the Detailed Environmental Noise Report is prepared.

For the future retirement home, pumping station and community commons associated with this redevelopment, a detailed noise analysis should be prepared by the proponent of these uses to ensure the MOE noise guidelines are met at the existing and proposed noise sensitive receptors. This will occur at the detailed design stage.

6.0 CONCLUSIONS

With the incorporation of the items discussed (see Table 3, Notes to Table 3 and Figure 2), the sound levels will be within the appropriate MOE, community of Delhi, County of Norfolk environmental noise criteria. In accordance with the community of Delhi, County of Norfolk and Ministry implementation guidelines where mitigation is required, future occupants will be advised through the use of warning clauses.

A detailed environmental noise report will need to be prepared as a Condition of Draft Approval, through the detailed design stage to confirm the appropriate criteria are achieved. As discussed in Section 4.2, the Judgement Day Paintball facility is to be investigated in more detail by completing sound level measurements of the activities (the noise sources) at this use.

Prior to the issuance of building permits, the house plans should be reviewed by an acoustical consultant to ensure compliance with the applicable guidelines.

Prior to final occupancy, an acoustical consultant shall confirm that the acoustical requirements are in compliance with the acoustical report.

Respectfully submitted,

JADE ACOUSTICS INC.

Per: _____
Aaron Keey, P.Eng.

LICENSED PROFESSIONAL ENGINEER
Mar. 22, 2023
A. J. KEEY
100164712
PROVINCE OF ONTARIO

Per: _____
Chris B. Kellar, P.Eng.

LICENSED PROFESSIONAL ENGINEER
Mar. 22, 2023
C B KELLAR
100069415
PROVINCE OF ONTARIO

AK/CK/jg
L:\Reports\21-181 Mar 22-23 Hwy 3 & Wilson Avenue-Delhi Golf Club (PENR).doc

7.0 REFERENCES

1. "Model Municipal Noise Control By-Law" Final Report, by the Ontario Ministry of the Environment, August, 1978.

2. "ORNAMENT – Ontario Road Noise Analysis Method for Environment and Transportation", Ontario Ministry of the Environment, October, 1989.

3. "Building Practice Note No. 56: Controlling Sound Transmission into Buildings", by J.D. Quirt, Division of Building Research, National Research Council of Canada, September, 1985.

4. "Environmental Noise Guideline Stationary and Transportation Sources – Approval and Planning", Ontario Ministry of the Environment, Conservation and Parks, Publication NPC-300, August, 2013, released October 21, 2013 (updated final version # 22).

5. County of Norfolk Noise By-law Number 2010-84 dated April 13, 2010, with amendments 2012-155 and 2016-11.

6. Preliminary Environmental Noise Report prepared by Jade Acoustics Inc. dated January 31, 2023.

TABLE 1

PROPOSED RESIDENTIAL DEVELOPMENT

DELHI GOLF AND COUNTRY CLUB

HIGHWAY 3 AND WILSON AVENUE

DELHI, ONTARIO

SUMMARY OF ROAD TRAFFIC DATA

ROAD	HIGHWAY 3 (James Street)	WILSON AVENUE	TISDALE DRIVE
Ultimate AADT*	13,350	5,400	4,050
No. of Lanes	2	2	2
Posted Speed (km/h)	70	50	50
Trucks (%)	5.5	3.2	2**
Medium/Heavy Split (%)	70/30	75/25	50/50**
Gradient (%)	1	1	1
Day/Night Split (%)	90/10**	90/10**	90/10**
R.O.W. Width (m)	25	12	24

* AADT: Ultimate Annual Average Daily Traffic (year 2038).

** Assumed based on other roadways assessed in Jade Acoustics Inc. files.

TABLE 2

PROPOSED RESIDENTIAL DEVELOPMENT

DELHI GOLF AND COUNTRY CLUB

HIGHWAY 3 AND WILSON AVENUE

DELHI, ONTARIO

SAMPLE OF PREDICTED UNMITIGATED SOUND LEVELS OUTDOORS DUE TO ROAD TRAFFIC

Lots/Blocks (Units)*	Location**	Source	Distance (m)	Leq (dBA)			
				Day		Night	
				Separate	Combined	Separate	Combined
Lot 113	Front Wall	Highway 3 (James Street)	22.5	64	--	58	--
	Rear Yard	Highway 3 (James Street)	51.3	45	--	--	--
Lot 120	Side Wall	Highway 3 (James Street)	78.0	47	57	40	50
		Tisdale Drive	16.0	56		50	
	Rear Yard	Highway 3 (James Street)	74.0	49	54	--	--
		Tisdale Drive	21.0	53			
Block 1 (North Unit)	Side Wall	Wilson Avenue	28.9	51	--	44	--
	Rear Yard	Wilson Avenue	32.5	48	--	--	--

* See Figure 2.

** Rear yard location taken 3 m from rear wall and 1.5 m above grade. Wall locations were taken at 4.5 m above ground for both daytime and nighttime hours.

TABLE 3

PROPOSED RESIDENTIAL DEVELOPMENT

DELHI GOLF AND COUNTRY CLUB

HIGHWAY 3 AND WILSON AVENUE

DELHI, ONTARIO

SUMMARY OF MINIMUM NOISE ABATEMENT MEASURES

Lots/Blocks (Units)*	Air Conditioning[1]	Exterior Wall[2]**	Window STC Rating[3]**	Sound Barrier[4]	Warning Clauses[5]
Lots 113 and 114	Provision for Adding	Standard	Standard	No	A, B, C
Lot 120	Provision for Adding	Standard	Standard	No	A, B
Lots 1, 91 to 102 and 112, Block 18 (all units), Block 176 (all units) to Block 180 (all units), Block 192 (all units) and Block 198 (all units) to Block 201 (all units) and the Retirement Home block (Block 203)	--	Standard	Standard	No	C
All other lots and blocks	No Special Requirements				

* See Figure 2.

** Based on preliminary calculations. See Section 5.1 for details.

See Notes to Table 3 on following pages.

NOTES TO TABLE 3

1. Provision for adding central air conditioning would involve a ducted heating system sized to accommodate the addition of central air conditioning by the occupant at a later date. The air cooled condenser unit must be located in compliance with NPC-216 (or other criteria specified by the municipality) and must not exceed an AHRI sound rating of 7.6 bels.

2. STC – Sound Transmission Class Rating (Reference ASTM-E413). Results shown are based on preliminary calculations using standard assumptions. See text for details.

3. STC – Sound Transmission Class Rating (Reference ASTM-E413). Results shown are based on preliminary calculations using standard assumptions. See text for details.

4. Sound barriers must be of solid construction with no gaps and have a minimum surface density of 20 kg/m^2. Earthen berms, solid walls/fences of adequate density or combinations of berms and walls/fences may be used. See text for details.

5. Warning Clauses to be placed in the subdivision agreement and to be included in offers of purchase and sale or lease agreements on designated lots and blocks:

   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 road traffic may on occasions interfere with some activities of the dwelling occupants as the sound levels exceed the sound level limits of the Municipality and the Ministry of the Environment, Conservation and Parks."

   B. "Purchasers/tenants are advised that this dwelling unit has been designed with the provision for adding central air conditioning at the occupant's discretion. Installation of central air conditioning by the occupant will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the sound level limits of the Municipality and the Ministry of the Environment, Conservation and Parks. (Note: locate air cooled condenser unit in a noise insensitive area and ensure that the unit has an AHRI sound rating not exceeding 7.6 bels.)".

   C. "Purchasers/tenants are advised that the dwelling unit is in proximity to existing commercial, industrial and/or institutional uses or future institutional uses, whose activities may at time be audible use."

6. Conventional ventilated attic roof construction meeting typical construction practices is satisfactory in all cases.

N.T.S

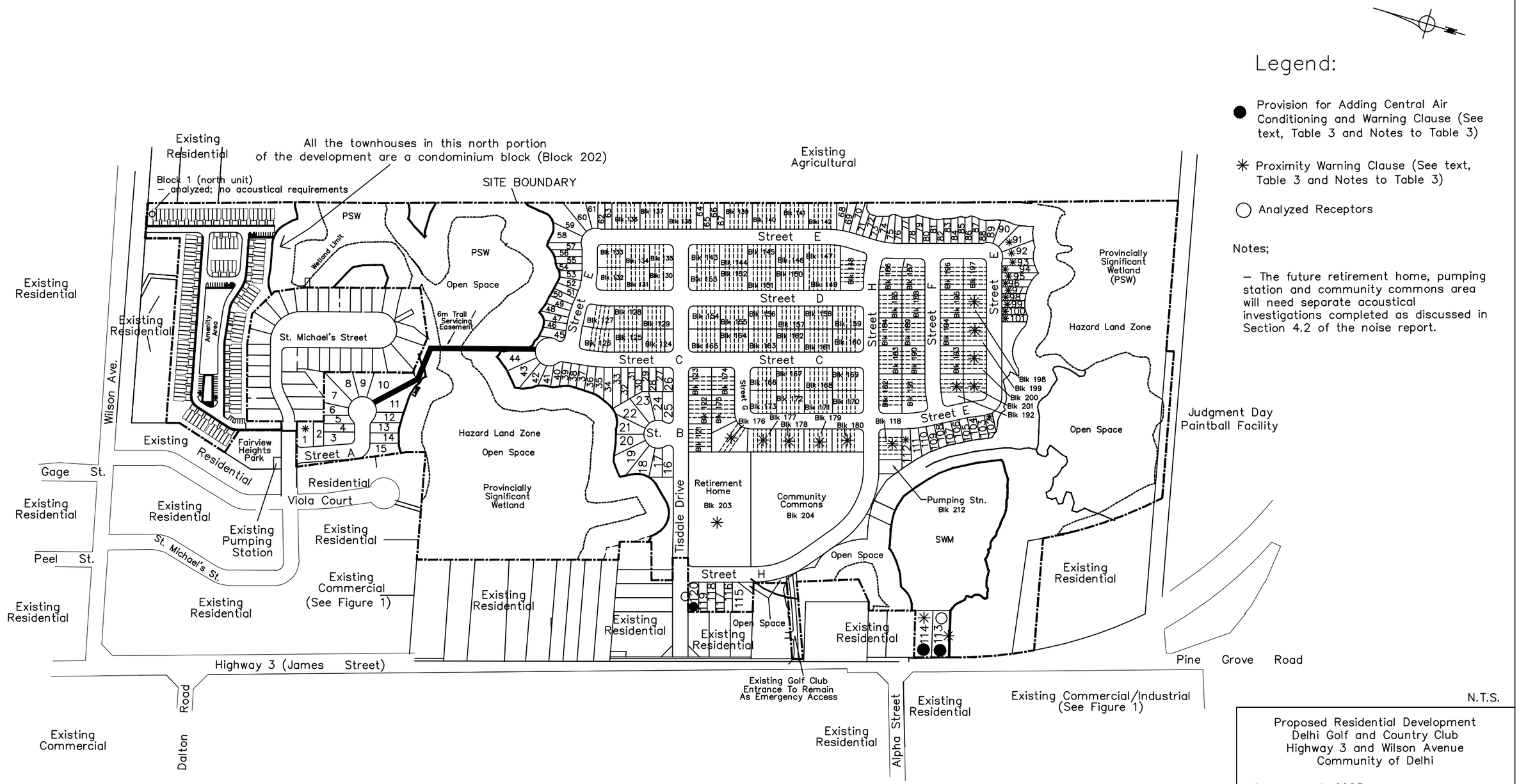
Proposed Residential Development
Delhi Golf and Country Club
Highway 3 and Wilson Avenue
Delhi, Ontario

Date: March 2023 **File: 21-181**

KEY PLAN

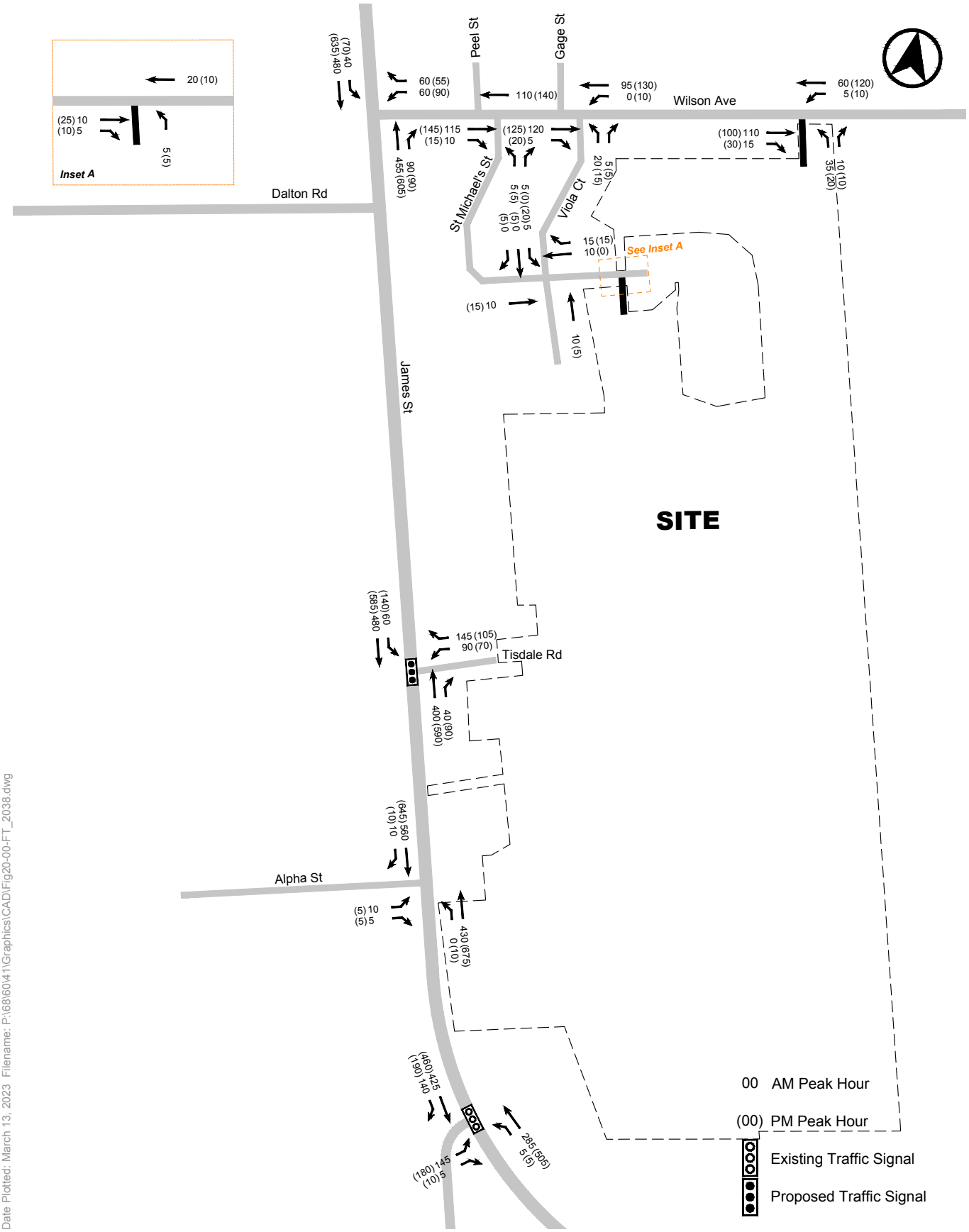
FIGURE 1

JADE ACOUSTICS


Legend:
Provision for Adding Central Air Conditioning and Warning Clause (See text, Table 3 and Notes to Table 3)
Proximity Warning Clause (See text, Table 3 and Notes to Table 3)
Analyzed Receptors
Notes;
– The future retirement home, pumping station and community commons area will need separate acoustical investigations completed as discussed in Section 4.2 of the noise report.
Existing Residential
Existing Agricultural
All the townhouses in this north portion of the development are a condominium block (Block 202)
Block 1 (north unit) – analyzed; no acoustical requirements
SITE BOUNDARY
PSW
Wetland Limit
Open Space
6m Trail Servicing Easement
St. Michael's Street
Amenity Area
Fairview Heights Park
Street A
Street B
Street C
Street D
Street E
Street F
Street G
Street H
Hazard Land Zone
Provincially Significant Wetland (PSW)
Provincially Significant Wetland
Retirement Home Blk 203
Community Commons Blk 204
Pumping Stn. Blk 212
SWM
Tisdale Drive
Wilson Ave.
Gage St.
Peel St.
Viola Court
St. Michael's St.
Existing Pumping Station
Existing Commercial (See Figure 1)
Existing Commercial/Industrial (See Figure 1)
Existing Golf Club Entrance To Remain As Emergency Access
Highway 3 (James Street)
Pine Grove Road
Dalton Road
Alpha Street
Judgment Day Paintball Facility
N.T.S.
Proposed Residential Development
Delhi Golf and Country Club
Highway 3 and Wilson Avenue
Community of Delhi
Date: March 2023
Our File: 21–181
JADE ACOUSTICS
PLAN OF DEVELOPMENT SHOWING MINIMUM NOISE ABATEMENT MEAUSURES
FIGURE 2

APPENDIX A

CORRESPONDENCE REGARDING ROAD TRAFFIC INFORMATION



Date Plotted: March 13, 2023 Filename: P:\68\6041\Graphics\CAD\Fig20-00-FT_2038.dwg

FIGURE 20 FUTURE TOTAL TRAFFIC VOLUMES (2038)

BA Group
300 45 ST. CLAIR AVE W
TORONTO ONTARIO, M4V 1K9
CANADA

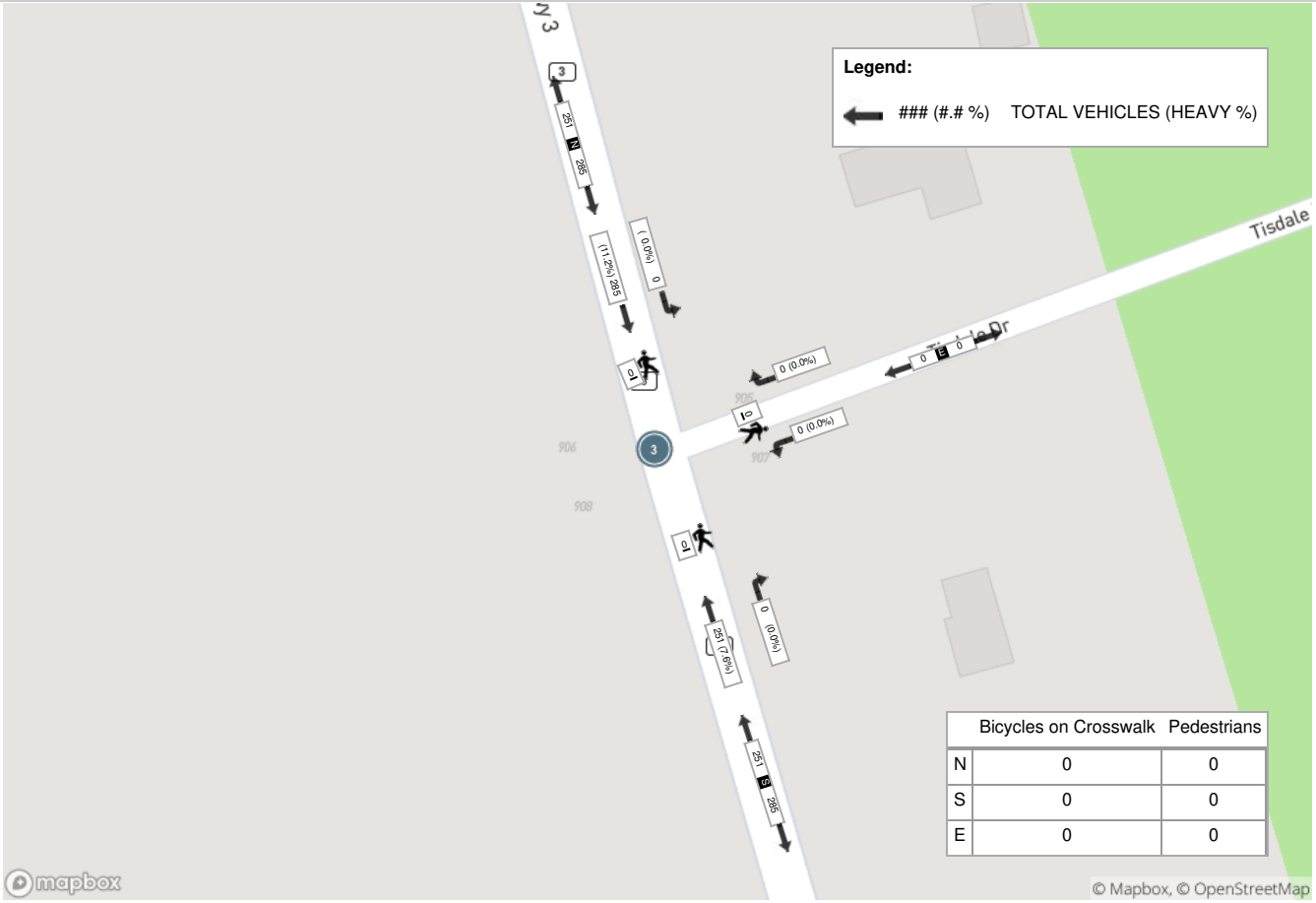
Turning Movement Count (3 . JAMES ST & DELHI GOLF COURSE ACCESS)

Start Time	N Approach JAMES ST					E Approach DELHI GOLF COURSE ACCESS					S Approach JAMES ST					Int. Total (15 min)	Int. Total (1 hr)
	Thru N:S	Left N:E	UTurn N:N	Peds N:	Approach Total	Right E:N	Left E:S	UTurn E:E	Peds E:	Approach Total	Right S:E	Thru S:N	UTurn S:S	Peds S:	Approach Total		
07:00:00	44	0	0	0	44	0	0	0	0	0	0	36	0	0	36	80	
07:15:00	82	0	0	0	82	0	0	0	0	0	0	53	0	0	53	135	
07:30:00	77	0	0	0	77	0	0	0	1	0	0	42	0	0	42	119	
07:45:00	73	0	0	0	73	0	0	0	0	0	0	57	0	0	57	130	464
08:00:00	64	0	0	0	64	0	0	0	0	0	0	57	0	0	57	121	505
08:15:00	74	0	0	0	74	0	0	0	0	0	0	75	0	0	75	149	519
08:30:00	74	0	0	0	74	0	0	0	0	0	0	62	0	0	62	136	536
08:45:00	64	0	0	0	64	0	0	0	0	0	0	53	0	0	53	117	523
BREAK																	
16:00:00	83	0	0	0	83	1	0	0	1	1	1	84	0	0	85	169	
16:15:00	86	2	0	0	88	0	1	0	0	1	0	79	0	0	79	168	
16:30:00	78	0	0	0	78	1	0	0	0	1	0	81	0	0	81	160	
16:45:00	85	0	0	0	85	0	0	0	0	0	0	68	0	0	68	153	650
17:00:00	80	0	0	0	80	0	0	0	1	0	0	99	0	0	99	179	660
17:15:00	77	0	0	0	77	0	0	0	0	0	0	108	0	0	108	185	677
17:30:00	74	0	0	0	74	0	0	0	0	0	0	64	0	0	64	138	655
17:45:00	59	0	0	0	59	0	0	0	0	0	0	73	0	0	73	132	634
Grand Total	1174	2	0	0	1176	2	1	0	3	3	1	1091	0	0	1092	**2271**	-
Approach%	99.8%	0.2%	0%		-	66.7%	33.3%	0%		-	0.1%	99.9%	0%		-	**-**	-
Totals %	51.7%	0.1%	0%		51.8%	0.1%	0%	0%		0.1%	0%	48%	0%		48.1%	**-**	-
Heavy	62	0	0		-	0	0	0		-	0	59	0		-	**-**	-
Heavy %	5.3%	0%	0%		-	0%	0%	0%		-	0%	5.4%	0%		-	**-**	-
Bicycles	0	0	0		-	0	0	0		-	0	1	0		-	**-**	-
Bicycle %	0%	0%	0%		-	0%	0%	0%		-	0%	0.1%	0%		-	**-**	-

Peak Hour: 07:45 AM - 08:45 AM Weather: Scattered Clouds (-0.89 °C)

Start Time	N Approach JAMES ST					E Approach DELHI GOLF COURSE ACCESS					S Approach JAMES ST					Int. Total (15 min)
	Thru	Left	UTurn	Peds	Approach Total	Right	Left	UTurn	Peds	Approach Total	Right	Thru	UTurn	Peds	Approach Total	
07:45:00	73	0	0	0	73	0	0	0	0	0	0	57	0	0	57	130
08:00:00	64	0	0	0	64	0	0	0	0	0	0	57	0	0	57	121
08:15:00	74	0	0	0	74	0	0	0	0	0	0	75	0	0	75	149
08:30:00	74	0	0	0	74	0	0	0	0	0	0	62	0	0	62	136
Grand Total	285	0	0	0	285	0	0	0	0	0	0	251	0	0	251	**536**
Approach%	100%	0%	0%		-	0%	0%	0%		-	0%	100%	0%		-	**-**
Totals %	53.2%	0%	0%		53.2%	0%	0%	0%		0%	0%	46.8%	0%		46.8%	**-**
PHF	0.96	0	0		0.96	0	0	0		0	0	0.84	0		0.84	**-**
Heavy	32	0	0		32	0	0	0		0	0	19	0		19	**-**
Heavy %	11.2%	0%	0%		11.2%	0%	0%	0%		0%	0%	7.6%	0%		7.6%	**-**
Lights	253	0	0		253	0	0	0		0	0	232	0		232	**-**
Lights %	88.8%	0%	0%		88.8%	0%	0%	0%		0%	0%	92.4%	0%		92.4%	**-**
Single-Unit Trucks	16	0	0		16	0	0	0		0	0	5	0		5	**-**
Single-Unit Trucks %	5.6%	0%	0%		5.6%	0%	0%	0%		0%	0%	2%	0%		2%	**-**
Buses	10	0	0		10	0	0	0		0	0	5	0		5	**-**
Buses %	3.5%	0%	0%		3.5%	0%	0%	0%		0%	0%	2%	0%		2%	**-**
Articulated Trucks	6	0	0		6	0	0	0		0	0	9	0		9	**-**
Articulated Trucks %	2.1%	0%	0%		2.1%	0%	0%	0%		0%	0%	3.6%	0%		3.6%	**-**
Pedestrians	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	**-**
Pedestrians%	-	-	-	0%		-	-	-	0%		-	-	-	0%		**-**
Bicycles on Crosswalk	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	**-**
Bicycles on Crosswalk%	-	-	-	0%		-	-	-	0%		-	-	-	0%		**-**
Bicycles on Road	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	**-**
Bicycles on Road%	-	-	-	0%		-	-	-	0%		-	-	-	0%		**-**

Peak Hour: 07:45 AM - 08:45 AM Weather: Scattered Clouds (-0.89 °C)



BA Group
300 45 ST. CLAIR AVE W
TORONTO ONTARIO, M4V 1K9
CANADA

Turning Movement Count (7 . WILSON AVE & VIOLA CT)

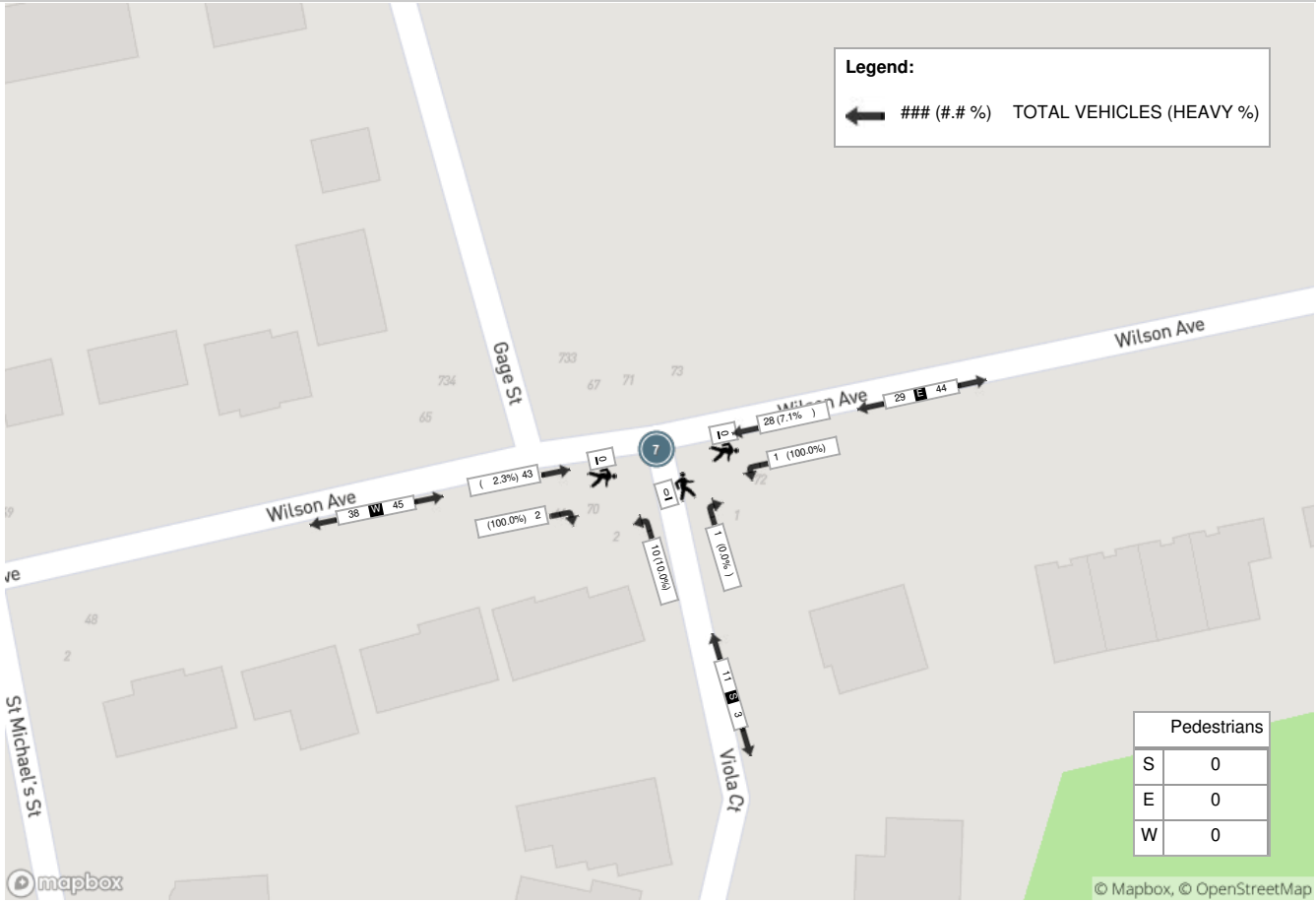
Start Time	E Approach WILSON AVE					S Approach VIOLA CT					W Approach WILSON AVE					Int. Total (15 min)	Int. Total (1 hr)
	Thru E:W	Left E:S	UTurn E:E	Peds E:	Approach Total	Right S:E	Left S:W	UTurn S:S	Peds S:	Approach Total	Right W:S	Thru W:E	UTurn W:W	Peds W:	Approach Total		
07:00:00	5	0	0	0	5	0	1	0	0	1	0	10	0	0	10	16	
07:15:00	9	0	0	0	9	0	1	0	0	1	0	5	0	0	5	15	
07:30:00	2	0	0	0	2	1	3	0	0	4	2	19	0	0	21	27	
07:45:00	6	0	0	0	6	0	3	0	0	3	0	11	0	0	11	20	78
08:00:00	11	1	0	0	12	0	3	0	0	3	0	8	0	0	8	23	85
08:15:00	6	0	0	0	6	0	1	0	0	1	1	4	0	0	5	12	82
08:30:00	7	0	0	0	7	0	4	0	0	4	1	10	0	0	11	22	77
08:45:00	5	1	0	0	6	1	2	0	0	3	2	6	0	0	8	17	74
BREAK																	
16:00:00	10	1	0	0	11	0	0	0	0	0	5	6	0	0	11	22	
16:15:00	9	0	0	0	9	0	2	0	0	2	4	3	0	0	7	18	
16:30:00	13	4	0	1	17	0	1	0	2	1	2	16	0	0	18	36	
16:45:00	5	1	0	0	6	1	1	0	0	2	3	5	0	0	8	16	92
17:00:00	9	0	0	0	9	2	2	0	0	4	2	8	0	0	10	23	93
17:15:00	15	0	0	0	15	0	0	0	0	0	5	8	0	0	13	28	103
17:30:00	8	1	0	0	9	0	2	0	0	2	3	12	0	0	15	26	93
17:45:00	5	1	0	0	6	0	1	0	0	1	2	5	0	0	7	14	91
Grand Total	125	10	0	1	135	5	27	0	2	32	32	136	0	0	168	**335**	-
Approach%	92.6%	7.4%	0%		-	15.6%	84.4%	0%		-	19%	81%	0%		-	**-**	-
Totals %	37.3%	3%	0%		40.3%	1.5%	8.1%	0%		9.6%	9.6%	40.6%	0%		50.1%	**-**	-
Heavy	4	1	0		-	1	1	0		-	2	3	0		-	**-**	-
Heavy %	3.2%	10%	0%		-	20%	3.7%	0%		-	6.3%	2.2%	0%		-	**-**	-
Bicycles	-	-	-		-	-	-	-		-	-	-	-		-	**-**	-
Bicycle %	-	-	-		-	-	-	-		-	-	-	-		-	**-**	-

BA Group
300 45 ST. CLAIR AVE W
TORONTO ONTARIO, M4V 1K9
CANADA

Peak Hour: 07:15 AM - 08:15 AM Weather: Scattered Clouds (-0.89 °C)

Start Time	E Approach WILSON AVE					S Approach VIOLA CT					W Approach WILSON AVE					Int. Total (15 min)
	Thru	Left	UTurn	Peds	Approach Total	Right	Left	UTurn	Peds	Approach Total	Right	Thru	UTurn	Peds	Approach Total	
07:15:00	9	0	0	0	9	0	1	0	0	1	0	5	0	0	5	15
07:30:00	2	0	0	0	2	1	3	0	0	4	2	19	0	0	21	27
07:45:00	6	0	0	0	6	0	3	0	0	3	0	11	0	0	11	20
08:00:00	11	1	0	0	12	0	3	0	0	3	0	8	0	0	8	23
Grand Total	28	1	0	0	29	1	10	0	0	11	2	43	0	0	45	**85**
Approach%	96.6%	3.4%	0%		-	9.1%	90.9%	0%		-	4.4%	95.6%	0%		-	**-**
Totals %	32.9%	1.2%	0%		34.1%	1.2%	11.8%	0%		12.9%	2.4%	50.6%	0%		52.9%	**-**
PHF	0.64	0.25	0		0.6	0.25	0.83	0		0.69	0.25	0.57	0		0.54	**-**
Heavy	2	1	0		3	0	1	0		1	2	1	0		3	**-**
Heavy %	7.1%	100%	0%		10.3%	0%	10%	0%		9.1%	100%	2.3%	0%		6.7%	**-**
Lights	26	0	0		26	1	9	0		10	0	42	0		42	**-**
Lights %	92.9%	0%	0%		89.7%	100%	90%	0%		90.9%	0%	97.7%	0%		93.3%	**-**
Single-Unit Trucks	1	0	0		1	0	1	0		1	1	1	0		2	**-**
Single-Unit Trucks %	3.6%	0%	0%		3.4%	0%	10%	0%		9.1%	50%	2.3%	0%		4.4%	**-**
Buses	1	1	0		2	0	0	0		0	1	0	0		1	**-**
Buses %	3.6%	100%	0%		6.9%	0%	0%	0%		0%	50%	0%	0%		2.2%	**-**
Articulated Trucks	0	0	0		0	0	0	0		0	0	0	0		0	**-**
Articulated Trucks %	0%	0%	0%		0%	0%	0%	0%		0%	0%	0%	0%		0%	**-**
Pedestrians	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	**-**
Pedestrians%	-	-	-	0%		-	-	-	0%		-	-	-	0%		**-**

Peak Hour: 07:15 AM - 08:15 AM Weather: Scattered Clouds (-0.89 °C)



APPENDIX B

ENVIRONMENTAL NOISE CRITERIA

ONTARIO MINISTRY OF THE ENVIRONMENT, CONSERVATION AND PARKS (MOE)

Reference: "Environmental Noise Guidelines Stationary and Transportation Sources – Approval and Planning", Publication NPC-300, August, 2013, released October 21, 2013 (updated final version #22).

SOUND LEVEL CRITERIA FOR ROAD AND RAIL NOISE

TABLE C-1

Sound Level Limit for Outdoor Living Areas

Road and Rail

Time Period	L_{eq} (16) (dBA)
16 hr., 07:00 - 23:00	55

TABLE C-2

Indoor Sound Level Limits
Road and Rail

Type of Space	Time Period	L_{eq} (dBA)	
		Road	Rail
Living/dining, den areas of residences, hospitals, nursing homes, schools, daycare centres, etc.	07:00 – 23:00	45	40
Living/dining, den areas of residences, hospitals, nursing homes, etc. (except schools or daycare centres)	23:00 – 07:00	45	40
Sleeping quarters	07:00 – 23:00	45	40
	23:00 – 07:00	40	35

SOUND LEVEL CRITERIA FOR AIRCRAFT NOISE

TABLE C-3

Outdoor Aircraft Noise Limit

Time Period	NEF/NEP
24-hour	30

TABLE C-4

Indoor Aircraft Noise Limit
(Applicable over 24-hour period)

Type of Space	Indoor NEF/NEP*
Living/dining/den areas of residences, hospitals, nursing/retirement homes, schools, daycare centres, etc.	5
Sleeping Quarters	0

* The indoor NEF/NEP values in Table C-4 are used to determine acoustical insulation requirements based on the NEF/NEP contour maps.

SOUND LEVEL CRITERIA FOR STATIONARY SOURCES

TABLE C-5

Exclusion Limit Values of One-Hour Equivalent Sound Level (L_{eq}, dBA)
Outdoor Points of Reception

Time of Day	Class 1 Area	Class 2 Area	Class 3 Area	Class 4 Area
07:00 – 19:00	50	50	45	55
19:00 – 23:00	50	45	40	55

TABLE C-6
Exclusion Limit Values of One-Hour Equivalent Sound Level (L_{eq}, dBA)
Plane of Window of Noise Sensitive Spaces

Time of Day	Class 1 Area	Class 2 Area	Class 3 Area	Class 4 Area
07:00 – 19:00	50	50	45	60
19:00 – 23:00	50	50	40	60
23:00 – 07:00	45	45	40	55

TABLE C-7

Exclusion Limit Values for Impulsive Sound Level (L_{LM}, dBAI)
Outdoor Points of Reception

Time of Day	Actual Number of Impulses in Period of One-Hour	Class 1 Area	Class 2 Area	Class 3 Area	Class 4 Area
07:00 – 23:00	9 or more	50	50	45	55
	7 to 8	55	55	50	60
	5 to 6	60	60	55	65
	4	65	65	60	70
	3	70	70	65	75
	2	75	75	70	80
	1	80	80	75	85

TABLE C-8

Exclusion Limit Values of Impulsive Sound Level (L_{LM}, dBAI)
Plane of Window - Noise Sensitive Spaces (Day/Night)

Actual Number of Impulses in Period of One-Hour	Class 1 Area (07:00-23:00)/ (23:00-07:00)	Class 2 Area (07:00-23:00)/ (23:00-07:00)	Class 3 Area (07:00-19:00)/ (19:00-07:00)	Class 4 Area (07:00-23:00)/ (23:00-07:00)
9 or more	50/45	50/45	45/40	60/55
7 to 8	55/50	55/50	50/45	65/60
5 to 6	60/55	60/55	55/50	70/65
4	65/60	65/60	60/55	75/70
3	70/65	70/65	65/60	80/75
2	75/70	75/70	70/65	85/80
1	80/75	80/75	75/70	90/85

SUPPLEMENTARY SOUND LEVEL LIMITS

Indoor limits for transportation sources applicable to noise sensitive land uses are specified in Table C-2 and Table C-4. Table C-9 and Table C-10 are expanded versions of Table C-2 and Table C-4, and present guidelines for acceptable indoor sound levels that are extended to land uses and developments which are not normally considered noise sensitive. The specified values are maximum sound levels and apply to the indicated indoor spaces with the windows and doors closed. The sound level limits in Table C-9 and Table C-10 are presented as information, for good-practice design objectives.

TABLE C-9

Supplementary Indoor Sound Level Limits
Road and Rail

Type of Space	Time Period	L_{eq} (Time Period) (dBA)	
		Road	Rail
General offices, reception areas, retail stores, etc.	16 hours between 07:00 – 23:00	50	45
Living/dining areas of residences, hospitals, schools, nursing/retirement homes, daycare centres, theatres, places of worship, libraries, individual or semi-private offices, conference rooms, reading rooms, etc.	16 hours between 07:00 – 23:00	45	40
Sleeping quarters of hotels/motels	8 hours between 23:00 – 07:00	45	40
Sleeping quarters of residences, hospitals, nursing/retirement homes, etc.	8 hours between 23:00 – 07:00	40	35

TABLE C-10

Supplementary Indoor Aircraft Noise Limit
(Applicable over 24-hour period)

Type of Space	Indoor NEF/NEP*
General offices, reception areas, retail stores, etc.	15
Individual or semi-private offices, conference rooms, etc.	10
Living/dining areas of residences, sleeping quarters of hotels/motels, theatres, libraries, schools, daycare centres, places of worship, etc.	5
Sleeping quarters of residences, hospitals, nursing/retirement homes, etc.	0

* The indoor NEF/NEP values in Table C-10 are not obtained from NEF/NEP contour maps. The values are representative of the indoor sound levels and are used as assessment criteria for the evaluation of acoustical insulation requirements.

APPENDIX C

SAMPLE CALCULATION OF PREDICTED UNMITIGATED SOUND LEVELS

APPENDIX C-1
SAMPLE CALCULATION OF PREDICTED SOUND LEVELS

FILE: 21-181
NAME: Delhi Golf and Country Club
REFERENCE DRAWINGS: Concept Plan
LOCATION: Lot 113, 4.5 m above grade, front wall, daytime

Noise Source:	Highway 3 (James Street)
Segment Angle:	-90 to 90
Time Period:	16 hr. (day)
Distance (m):	22.5

CALCULATION OF PREDICTED SOUND LEVELS*

Reference Leq (dBA)*:	68.17
Height and/or Distance Correction (dBA):	-2.78
Finite Element Correction (dBA):	-1.32
Allowance for Screening (dBA):	0.00
Allowance for Future Growth (dBA):	incl.
LeqDay (dBA):	64.06

* Leq determined using the computerized model of the Ministry of the Environment, Conservation and Parks Noise Assessment Guidelines, STAMSON Version 5.04 (ORNAMENT). See attached printouts.

APPENDIX C-2
SAMPLE CALCULATION OF PREDICTED SOUND LEVELS

FILE: 21-181
NAME: Delhi Golf and Country Club
REFERENCE DRAWINGS: Concept Plan
LOCATION: Lot 113, 4.5 m above grade, side wall, nighttime

Noise Source:	Highway 3 (James Street)
Segment Angle:	-90 to -90
Time Period:	8 hr. (night)
Distance (m):	22.5

CALCULATION OF PREDICTED SOUND LEVELS*

Reference Leq (dBA)*:	61.63
Height and/or Distance Correction (dBA):	-2.78
Finite Element Correction (dBA):	-1.32
Allowance for Screening (dBA):	0.00
Allowance for Future Growth (dBA):	incl.
LeqNight (dBA):	57.52

* Leq determined using the computerized model of the Ministry of the Environment, Conservation and Parks Noise Assessment Guidelines, STAMSON Version 5.04 (ORNAMENT). See attached printouts.

```
STAMSON 5.0        NORMAL REPORT        Date: 14-03-2023 11:22:15
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: lot113br.te            Time Period: Day/Night 16/8 hours
Description: Lot 113 building requirement

Road data, segment # 1: James Hwy3 (day/night)
-----------------------------------------------
Car traffic volume  : 11354/1262  veh/TimePeriod  *
Medium truck volume :   463/51    veh/TimePeriod  *
Heavy truck volume  :   198/22    veh/TimePeriod  *
Posted speed limit  :    70 km/h
Road gradient       :     1 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):  13350
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   3.85
    Heavy Truck  % of Total Volume     :   1.65
    Day (16 hrs) % of Total Volume     :  90.00

Data for Segment # 1: James Hwy3 (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  :  22.50 / 22.50  m
Receiver height           :   4.50 / 4.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: James Hwy3 (day)
-------------------------------------

Source height = 1.13 m

ROAD (0.00 + 64.06 + 0.00) = 64.06 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.58  68.17   0.00  -2.78  -1.32   0.00   0.00   0.00  64.06
-------------------------------------------------------------------------------

Segment Leq : 64.06 dBA

Total Leq All Segments: 64.06 dBA
```

```
Results segment # 1: James Hwy3 (night)
---------------------------------------

Source height = 1.13 m

ROAD (0.00 + 57.52 + 0.00) = 57.52 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.58  61.63   0.00  -2.78  -1.32   0.00   0.00   0.00  57.52
-------------------------------------------------------------------------------

Segment Leq : 57.52 dBA

Total Leq All Segments: 57.52 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 64.06
                           (NIGHT): 57.52
```

APPENDIX C-3
SAMPLE CALCULATION OF PREDICTED SOUND LEVELS

FILE: 21-181
NAME: Delhi Golf and Country Club
REFERENCE DRAWINGS: Concept Plan
LOCATION: Lot 113, 1.5 m above grade, rear yard

Noise Source:	Highway 3 (James Street)
Segment Angle:	-90 to -70
Time Period:	16 hr. (day)
Distance (m):	51.3

CALCULATION OF PREDICTED SOUND LEVELS*

Reference Leq (dBA)*:	68.7
Height and/or Distance Correction (dBA):	-8.86
Finite Element Correction (dBA):	-14.79
Allowance for Screening (dBA):	0.00
Allowance for Future Growth (dBA):	incl.
LeqDay (dBA):	44.52

* Leq determined using the computerized model of the Ministry of the Environment, Conservation and Parks Noise Assessment Guidelines, STAMSON Version 5.04 (ORNAMENT). See attached printouts.

```
STAMSON 5.0        NORMAL REPORT        Date: 14-03-2023 11:22:50
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: lot113ry.te            Time Period: Day/Night 16/8 hours
Description: Lot 113 rear yard

Road data, segment # 1: James Hwy3 (day)
---------------------------------------
Car traffic volume  : 11354       veh/TimePeriod  *
Medium truck volume :   463       veh/TimePeriod  *
Heavy truck volume  :   198       veh/TimePeriod  *
Posted speed limit  :    70 km/h
Road gradient       :     1 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):  13350
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   3.85
    Heavy Truck  % of Total Volume     :   1.65
    Day (16 hrs) % of Total Volume     :  90.00

Data for Segment # 1: James Hwy3 (day)
---------------------------------------
Angle1   Angle2           : -90.00 deg   -70.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  51.30 m
Receiver height           :   1.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: James Hwy3 (day)
---------------------------------------

Source height = 1.13 m

ROAD (0.00 + 44.52 + 0.00) = 44.52 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90    -70   0.66  68.17   0.00  -8.86 -14.79   0.00   0.00   0.00  44.52
-------------------------------------------------------------------------------

Segment Leq : 44.52 dBA

Total Leq All Segments: 44.52 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 44.52
```

APPENDIX D

SAMPLE CALCULATION OF ARCHITECTURAL COMPONENT SELECTION

APPENDIX D-1
SAMPLE CALCULATION OF ARCHITECTURAL COMPONENT SELECTION*

FILE: 21-181
NAME: Delhi Golf and Country Club
REFERENCE DRAWINGS: Concept Plan
LOCATION: Lot 113, corner bedroom

ROAD

Wall area as a percentage of floor area:	Front:	55%
	Side:	55%
Window area as a percentage of floor area:	Front:	25%
	Side:	25%
Number of components:	4	
Outdoor Leq:	Front:	64 (+3 for reflections) = 67 dBA
	Side:	61 (+3 for reflections) = 64 dBA
Indoor Leq:	45	
Noise Reduction (dBA):	Front:	22
	Side:	19
Noise Spectrum:	Mixed Road Traffic	Angle Correction: 0
Absorption:	Medium	

APPROPRIATE ELEMENTS

		Configuration	STC Rating
Wall	Front	Standard	STC 33
	Side	Standard	STC 30
Window	Front	Standard	STC 25
	Side	Standard	STC 22

* Based upon "Controlling Sound Transmission into Buildings", Building Practice Note 56 by National Research Council of Canada, September, 1985.

Economic Benefits of Delhi Golf and Country Club ReDevelopment

Independent Real Estate Intelligence

March 21, 2023

Altus Group

Economic Benefits of Delhi Golf and Country Club Redevelopment

Prepared for:

Delhi Development Inc.

Prepared by:

Altus Group Economic Consulting

33 Yonge Street Toronto Ontario M5E 1G4

Phone: (416) 641-9500 Fax: (416) 641-9501

economics@altusgroup.com

altusgroup.com

March 21, 2023

EXECUTIVE SUMMARY

Altus Group Economic Consulting was retained by Delhi Development Inc., in the care of Geranium, to examine the potential economic benefits of a proposed residential development on the Delhi Golf and Country Club lands in the Delhi community in the County of Norfolk "the subject lands".

The proposed Redevelopment includes 874 new residential units and 1.7 hectares of Community Park and 11.3 hectares of open space.

The Delhi Golf and Country Club land is adjacent to the urban boundary in Delhi. The redevelopment will require an urban boundary expansion.

Updated population forecasts from the Ministry of Finance suggest the County will have to accommodate just over 4,253 new households between 2021 and 2031.

However, the municipality is facing significant water servicing constraints in some of its fastest growing communities. Most notably, Port Rowan and Port Dover do not have capacity to accommodate residential developments in the short-term.

Norfolk County is seeking to invest $180 million in an Inter-Urban Water Supply System and upgrades to water and wastewater facilities to expand water supply across the region. However, these investments will not reach full completion until 2026 to 2031.

Policy 1.4.1 of the Provincial Policy Statement requires municipalities to maintain three -years' worth of short-term land supply. That is, to have enough units in the development pipeline that are draft approved and registered. Accounting for servicing issues in Port Rowan and Port Dover, Norfolk County only had 0.7 years of short-term land supply in the pipeline as of October 2021.

Delhi, in contrast, has enough water servicing capacity to accommodate the Delhi Development Inc redevelopment proposal. The benefits of the redevelopment include:

- It will facilitate the delivery of more homes in a timely manner, helping the Province achieve its goal of building 1.5 million homes by 2031.

- It will accommodate 874 housing units, which, if approved will increase the short-term land supply to 2.6 years.
- Will help accommodate population growth, while investments in water servicing capacity are being made elsewhere. The development could accommodate 1,642 new persons.
- The redevelopment will generate $13.9 million in development charges that could be used to help pay for the Inter-urban water system and facility upgrades.
- The construction activity of the project could generate $518 million in economic activity.
- The permanent housing could generate roughly $3.2 million in on-going annual property taxes for the County.
- The residents of the proposed neighbourhood will have the potential to spend $23 million per year at local businesses; and
- The increase in the working-aged population will boost the labour force by 914 jobs.

Overall, the Delhi Golf and Country Club redevelopment will help the County meet growth objectives, provide attainable housing for families and bring economic benefits to the community.

page

1 INTRODUCTION 1

1.1 The Proposed Redevelopment 1

1.2 Key Considerations for the Redevelopment 2

1.3 Planning Context 4

1.4 Structure of This Report 6

2 MAINTAINING AN ADEQUATE SUPPLY OF HOUSING 8

2.2 Optimizing the Use of Existing Infrastructure and Public Services 15

3 MUNICIPAL FINANCE BENEFITS 19

3.1 On-Time Development Charges and building permit fees 19

3.2 On-Going Property Taxes 20

4 ECONOMIC BENEFITS OF THE REDEVELOPMENT 21

4.1 One-time economic benefits of construction 21

4.2 On-going Benefits of Enhancing the Vitality of Downtown Delhi 22

4.3 On-Going Boosts the Local Labour Pool 23

4.4 Preservation of the County's Agricultural Base 25

5 CONCLUSIONS 26

1 INTRODUCTION

Altus Group Economic Consulting was retained by Delhi Development Inc., in the care of Geranium, to examine the potential economic benefits of a proposed residential development on the grounds of the Delhi Golf and Country Club "the subject lands" in the Delhi community in the County of Norfolk.

Delhi Development Inc is asking for an urban boundary expansion to accommodate a proposed residential subdivision.

1.1 THE PROPOSED REDEVELOPMENT

1.1.1 The Subject Lands

Delhi Development Inc is proposing to redevelop the Delhi Golf and Country Club located at 905 James Street and 76 Wilson Avenue, immediately adjacent to the Delhi Urban Area. Figure 1 shows the location of the subject lands.

Figure 1

Location of Proposed Redevelopment

Source: Altus Group, based on Google Earth

The site is 55.32 hectare, of which 29.73 hectares are proposed for redevelopment. The other 25.59 hectares are proposed to remain as open space and Provincially Significant Wetlands.

1.1.2 The Proposed Redevelopment

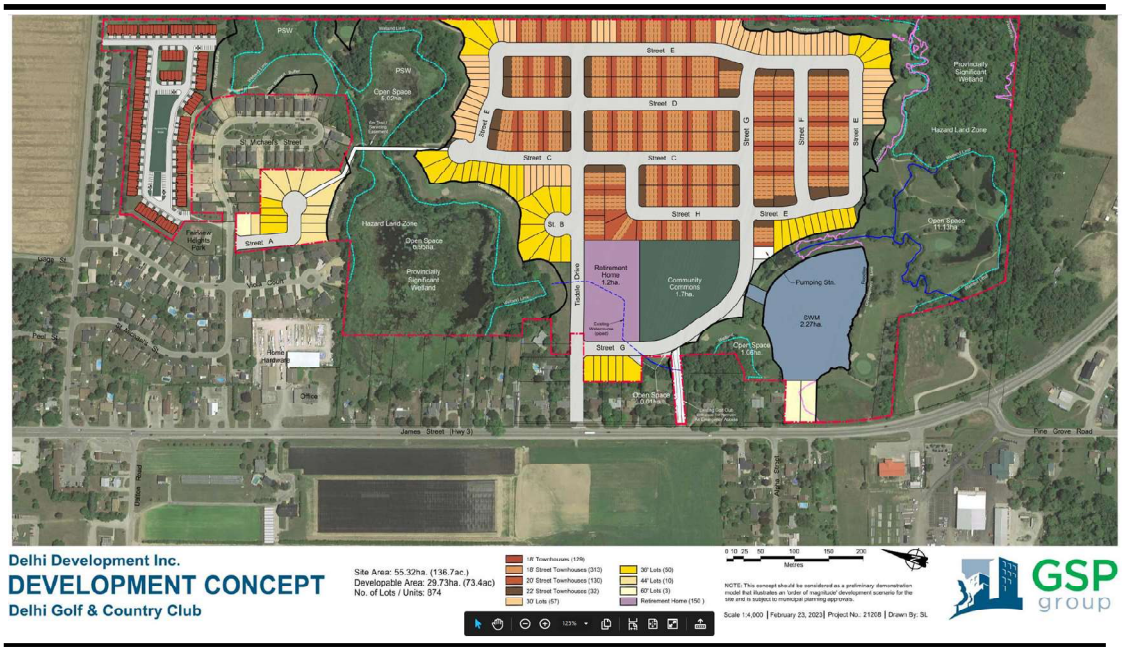
Delhi Development Inc. propose to redevelop the subject lands to facilitate a new residential neighbourhood. The preliminary concept plan includes:

- 604 townhouses;
- 120 Single-detached homes;
- A senior residence with 150 units; and
- A 1.7-hectare community park and 11.3 hectares of open space.

The redevelopment will provide a total of 874 units and accommodate an estimated 1,642[1] people.

The concept plan for the proposed subdivision is presented in Figure 2.

Figure 2



1.2 KEY CONSIDERATIONS FOR THE REDEVELOPMENT

Norfolk County is facing growth constraints due to limited water infrastructure. Its key population centres do not have enough water servicing capacity to meet their population growth forecasts. Figure 3 is taken from a council update on the progress of the municipality's investments in an inter-

[1] This estimate assumes an average person per unit of 2.2, as taken from the Census of Canada Population data tables on person per unit by dwelling type.

urban water supply system (IUWS) and water facility upgrades. This system will carry water between Norfolk's population centres, as described in Figure 3. The system is meant to deliver water from areas with a surplus of water inventory (for example, Delhi) to areas with water capacity constraints. Most of this investment will be debt-financed.

The investments will be made in stages, as outlined in Figure 3, with many of these investments not expected to be in service until 2026 to 2031. The overall cost is expected to be $180 million.

Figure 3

Norfolk County Inter-Urban Water Supply and Facility 10-Year Delivery Plan

Priority/Project*	Estimated Total Value	RFP & Award	Tender & Award	Substantial Completion	In Service
Simcoe-Townsend	$37M	2022	2023	Dec 2025	Jan 2026
Nanticoke WTP by Haldimand	$30M	2022	2023	Dec 2025	Jan 2026
Simcoe-Port Dover-Nanticoke	$33.35M	2023	2025	Dec 2027	Jan 2028
Simcoe-Delhi and Simcoe-Waterford	$31.8M	2024	2026	Sept 2029 Oct 2029	Oct 2030 Delhi Dec 2030 Waterford
Simcoe-Port Dover-St. Williams-Port Rowan	$47.85M	2024	2026	Dec 2030	Jan 2031
Total Program	$180M	2022$ not indexed to inflation; approx. 96 km of pipelines			

Scope for each project includes transmission watermains, storage, metering chambers, future interconnections, booster stations, SCADA integration, HVAC, piping, mechanical and electrical systems.

Source: Norfolk County Inter-Urban Water Supply Program Update, April 12, 2022

In the meanwhile, two of the fastest growing population centres in Norfolk County, Port Rowan and Port Dover, are facing growth constraints due to shortages of water servicing capacity.

Delhi currently has excess water capacity. This development can help Norfolk County meet its growth objectives in the near-term, while the County continues to invest in its water servicing capacity. In addition, the development charges from the proposed redevelopment can help pay for the infrastructure investments currently being made to expand water capacity in its other communities.

1.3 PLANNING CONTEXT

1.3.1 Norfolk County Official Plan January 2022

Norfolk County Official Plan January 2022 put an emphasis on building affordable and attainable housing in areas that allow developments to take advantage of current infrastructure and public services.

Policy 5.3a on Housing in the Official Plan states:

a) At all times, the County shall maintain the ability to accommodate residential growth for a minimum of 10 years through land which is designated and available for residential development. ***Additionally, the County shall ensure that where new development is to occur, land with servicing capacity sufficient to provide at least a 3-year supply of residential units in draft approved and registered plans, or in cases of residential intensification and redevelopment, land appropriately zoned in the Zoning By-law and available for development or redevelopment (page 64)***

1.3.2 Comprehensive Review of the Norfolk County Official Plan

Norfolk County is currently undertaking a comprehensive review of its Official Plan, which started in June 2021 and is expected to be completed in 2023. Norfolk County staff report CD 21-47 regarding the Growth Management Study Kick-Off and Terms of Reference (June 8, 2021) said:

> *"… Community Planning is embarking on a Growth Management Study that will ultimately establish growth management principles as well as identify opportunities and options to consider to accommodate growth to 2051. …*
>
> *….The study would be considered a comprehensive review that would be utilized during the next five year Official Plan review process or development of a new Official Plan."* (page 2)

The subject lands are currently outside the settlement area boundary for the Delhi community. Under policy 1.1.3.8 of the Provincial Planning Statement, the County may allow the expansion of a settlement area boundary at the time of a comprehensive review.

1.3.3 Provincial Policy Objectives

An objective of the Ontario Government is to build more houses, faster. An Affordable Housing Task Force, commissioned by the provincial government, highlighted that the province needs to build 1.5 million in the next ten years to address its affordability issues.

The Province, in turn, has introduced the Housing Supply Action Plan dedicated to implementing recommendations from the task force to meet that target. The Plan is set out to achieve three objectives[2]:

- Cut red tape to make it easier to build the right types of housing in the right places.
- Make housing more affordable.
- Help taxpayers keep more of their hard-earned dollars.

The Province set housing pledges for 29 municipalities within the Greater Toronto and Hamilton Area (GTHA) to accommodate 1.2 million of the homes needed in the next decade. That leaves another 300,000 homes to be built in areas outside of the GTHA, such as Norfolk County.

1.3.4 Norfolk County Strategic Priorities

The strategic priorities of Norfolk County Council for the 2019 to 2022 period included:

- *Fostering vibrant, creative communities;*
- *Building a strong economy and an environment that is open for business;*
- *Providing reliable infrastructure, from essential community amenities to transportation networks and water and wastewater services;*
- *Establishing responsive, collaborative customer service; and*
- *Securing a solid foundation for success by improving Norfolk County's financial health and strategic asset management and continuous improvement.* (Norfolk County Council Strategic Priorities, 2019 – 2022, page 3).

At that time, one of Norfolk County Council's guiding principles was to:

[2] More Housing, More Choice: Ontario's Housing Supply Action Plan.

> *… create an environment of opportunity in Norfolk, becoming a magnet for young people and facilitating places for them to collaborate, have fun, raise a family and build a future.* (Norfolk County Council Strategic Priorities, 2019 – 2022, page 5)

Priority initiatives under Vibrant, Creative Communities included:

- *Address vacancies in the downtown through programs and incentives for redevelopment and occupancy, and*
- *Facilitate and promote a diverse and attractive mix of housing options to increase affordability*. (Norfolk County Council Strategic Priorities, 2019 – 2022, page 8)

Priority initiatives under Quality Infrastructure included:

- *Approve and invest in a strategy to address water and wastewater management and unlock potential for future development; and*
- *Facilitate innovative new public transit solutions that address rural realities and economies of scale.* (Norfolk County Council Strategic Priorities, 2019 – 2022, page 10).

1.3.5 The Role of Agriculture

The Vision for Norfolk County's economic development department highlights the role of agriculture in the County's economy:

> *Being home to a flourishing agricultural base and some of the most fertile land in Ontario, Norfolk County has become "Ontario's Garden". The agricultural industry continues to be a driving force behind our local economy. Norfolk is a top producing area and the most diversified agricultural region in Canada.* (Norfolk County Economic Development web site).

1.4 STRUCTURE OF THIS REPORT

The rest of the report will highlight the economic benefits of the redevelopment of the Delhi Golf and Country Club by showing:

- How the proposed redevelopment of the Delhi Golf and Country Club can help Norfolk County achieve its strategic objectives and the Ontario Government's housing targets.

- Updates to population and household growth in the County of Norfolk and how the proposed redevelopment can help accommodate that growth.
- How the redevelopment will allow this growth to be accommodated in areas with available community infrastructure, especially water servicing capacity.
- The one-time and on-going economic benefits to accommodating that growth, including increased retail spending, attracting a young labour force and the government revenues generated from the redevelopment.

2 MAINTAINING AN ADEQUATE SUPPLY OF HOUSING

2.1 PROVIDING A RANGE OF HOUSING

Provincial Policy Statement 1.1.1 b states that a component of building healthy liveable communities includes:

"*accommodating an appropriate affordable and market-based range and mix of residential types (including single-detached, additional residential units, multi-unit housing, affordable housing and housing for older persons), employment (including industrial and commercial), institutional (including places of worship, cemeteries and long-term care homes), recreation, park and open space, and other uses to meet long-term needs*" (page 7, Provincial Policy Statement).

Policy 5.3 c of the Norfolk County Official Plan updated as of January 2022 states that the county would like to target townhouses as a dwelling type in the County:

"The County shall ensure that a full range of housing types and densities are provided to meet the anticipated demand and demographic change. All forms of housing required to meet the social, health and well-being of current and future residents, including those with special needs shall be encouraged. The County shall target that 15 percent of all new housing built in Norfolk County be multi-residential dwellings and 15 percent be semi-detached and townhouse dwellings."(page 65)

The redevelopment of the Delhi Golf and Country Club will deliver most units as townhouses (604 units/874) and multi-residential (150 senior residences).

These units will offer young families a lower purchase price point than single-family homes, which continue to be the predominant type of dwelling built in Norfolk County. This development supports Provincial and local policy objectives for municipalities to provide a full range of housing and may contribute to towards anticipated goals regarding attainable housing[3].

[3] Definitions of what attainable housing means in provincial policy are not yet available.

2.2 POPULATION AND HOUSEHOLD FORECASTS

Watson Consulting produced a population and household forecast for Norfolk County and its population centres in December 2021.

Since then, Statistics Canada has released more updated annual population estimates for the 2016 to 2022, including data for Norfolk County. In addition, the Ministry of Finance released an updated set of population forecasts, by age, for Ontario and its 49 Census Divisions, including Haldimand-Norfolk County.

These updates showed that the actual population in Norfolk County (including a population undercount) grew faster than expected by Watson Consulting between 2016 and 2021.

These forecasts do not include the new immigration targets set out by the Federal Government in November 2022, which could result in higher population growth for the County if achieved. The Canadian Government increased its immigration target to 500,000 per year to 2025, up from 375,000 in 2021.

Figure 4 compares Altus Group's more recent population forecast for Norfolk County, using the updated population estimates and the Ministry of Finance data, to the population forecast produced by Watson Consulting in December 2021.

The key takeaways from the figure are that:

- The population in Norfolk County grew faster than was expected between 2016 and 2021. The population increased by 923 persons per year in this five-year period. That is 355 more persons per year than was estimated in the December2021 report.
- The overall forecast for population growth between 2021 and 2046 is similar to that produced by Watson Consulting in December 2021. However, the updated forecasts expect more of that growth to be realized in the 2021 to 2031 period.

Figure 4

Population Growth Forecasts, Norfolk County, 2021-2046, in 5-year, 10-year and 15-year Periods, Average Annual Growth

Forecasts Updated with New Ministry of Finance Population Projections

	Average Annual Change				
	2016-2021	2021-2026	2026-2031	2031-2046	2021-2046
	Actual	Forecasts			
Altus Group 2022 Forecast	923	840	883	597	773
Watson Consulting December 2021 Forecast	6,098	9,191	12,591	15,911	10,690
Difference Between Updated Projections and Watson 2021 Forecasts	(5,175)	(8,351)	(11,708)	(15,314)	(9,917)

Source: Altus Group, based on Watson Consulting, Ministry of Finance and Statistics Canada

Figure 5 further translates the above population forecasts into a household growth forecast. The forecast assumes that the number of households formed for every 1,000 persons increase in the population (also known as headship rates) remains at 2021 levels for the forecast horizon.

The Figure then compares Altus Group's household forecast for Norfolk County derived from the Ministry of Finance population forecasts to the Watson Consulting forecast produced in December 2021.

The figure shows that:

- There were an additional 598 households created between 2016 and 2021 than was expected by Watson Consulting in December 2021.
- Altus Group estimates that if housing preferences by age group remain constant over time, there will be a 2,078 increase in the number of households between 2021 and 2026 in Norfolk County. The region will have to accommodate an additional 1,005 households over this five-year period beyond what was previously expected.
- Norfolk County will have to accommodate an additional 623 new households between 2026 and 2031 above what was published in Watson Consulting's December 2021 report.

Figure 5

Household Growth Forecasts, Norfolk County, 2021-2046, in 5-year, 10-year and 15-year Periods

Forecasts Updated with New Ministry of Finance Population Projections

	Change				Average Annual Change
	2016-2021	2021-2026	2026-2031	2031-2046	2021-2026
Altus Group 2022 Forecast	1,874	2,305	1,948	3,734	**461**
Watson Consulting December 2021 Forecast	1,276	1,300	1,325	4,056	**260**
Difference Between Updated Projections and Watson 2021 Forecasts	598	1,005	623	(322)	**201**

Source: Altus Group, based on Watson Consulting, Ministry of Finance and Statistics Canada

Figure 6 further breaks down the household forecast found in Figure 5 by the five population centres in Norfolk County, using the same geographical distribution as in the Watson December 2021 forecast.

Figure 6

Household Growth Forecasts, Norfolk County and its Population Centres, 2021-2046, in 5-year, 10-year and 15-year Periods

Forecasts Updated with New Ministry of Finance Population Projections

	Change			
	2016-2021	2021-2026	2026-2031	Annual Average (2021-2026)
Delhi	110	223	188	45
Port Dover	489	628	551	126
Port Rowan	60	74	63	15
Simcoe	615	775	657	155
Courtland	18	11	9	2
Waterford	142	387	315	77
Rest of Norfolk	439	207	165	41
Norfolk County Total	**1,874**	**2,305**	**1,948**	**461**

Source: Altus Group 2022 Forecast, based on Ministry of Finance and Watson Consulting

2.2.1 Short-term Land Supply

The ability of Norfolk County to maintain an adequate supply of housing, as defined in Policy 5.3a of the Norfolk County January 2022 Official Plan, to meet the needs of current and future residents over the next decade could be threatened by constraints in the existing water supply systems serving the communities of Port Dover and Port Rowan/St Williams. Development of

much of the vacant residential land in these communities has been halted due to water servicing constraints.

A Servicing Monitoring Report – Water and Wastewater presented to Council on September 20, 2022 noted that Port Dover has been subject to a development moratorium:

> *"….. Port Dover Area has been subject to a development moratorium for building permits that require new service connections and was subject to an Interim Control By-Law until October 2021 that limited development applications. As such, many development files were on hold and new ones did not progress*[4]*.*

Figure 7 highlights that Port Dover cannot accommodate any new population growth with current water service capacity, and capacity in Port Rowan/St Williams is limited. Port Dover is over capacity already and Port Rowan/St. Williams can accommodate just 474 new additions to its population before it hits its maximum capacity.

Figure 7

Water and Wastewater Capacity and Demand, Norfolk County, as of September 2022

	Simcoe	Port Dover	Delhi/Courtland	Port Rowan/St Williams	Waterford
Water Service (m^3/day)					
Capacity	10,612	4,200	6,894	1,700	5,875
Demand	7,362	4,282	3,722	1,507	1,590
Peak Per Capita Consumption	0.46	0.54	0.56	0.82	0.38
Wastewater Service (m^3/day)					
Capacity	15,400	5,400	3,182	1,140	2,200
Demand	7,282	4,236	1,275	626	1,136
Peak Per Capita Consumption	0.45	0.54	0.24	0.46	0.27
Population Growth that Can be Accomodated	4,741	(2,023)	6,037	474	15,625

Source: Altus Group, based on Norfolk County Servicing Monitoring Report dated September 20, 2022

The county has made significant investments in an inter-urban water system. However, construction on the system to help supply Port Dover and Port Rowan is not expected to be completed until 2031.

Development cannot proceed until this costly new water supply infrastructure is built.

[4] Norfolk County Environmental and Infrastructure Services., Servicing Monitor Report – Water and Waste Water EIS-22-077.

In contrast, Delhi and Waterford have the largest water servicing capacity in the County and can accommodate more growth than is forecasted for these communities.

Provincial and County housing policies acknowledge the need to plan to maintain sufficient land designated for residential development and intensification to meet long term needs (a minimum of 15 years under the policy 1.4.1 of the Provincial Policy Statement) and, also the need to maintain at all times sufficient residential land with servicing capacity to meet short term needs.

Policy 5.3.a of the Norfolk County Official Plan says:

> *"….. the County shall ensure that where new development is to occur, land with servicing capacity sufficient to provide at least a 3-year supply of residential units in draft approved and registered plans, or in cases of residential intensification and redevelopment, land appropriately zoned in the Zoning By-Law and available for development or redevelopment."*

Figure 8 summarizes short-term (3-year) land supply and demand for housing in Norfolk County and its key population centres at the end of 2021.

Figure 8

Estimates of Short-term Land Supply, Norfok County (Exclusing Courtland) as of End of 2021

	Simcoe	Port Dover	Delhi and Courtland	Waterford	Port Rowan	Rest of Norfolk	Norfolk Total	**Norfolk Ex.Housing Supply in Port Rowan and Port Dover**
Total (Estimated by GSP Group as of Report dated October 28, 2021)	281	1,172	321	174	63	-	2,011	**602**
Draft approved and Registered	93	288	237	17	63	-	698	**330**
Under Review /Proposed	188	884	84	157	-	-	1,313	**272**
Total (Estimated by Watson Consulting as of December 2021)	787	1,620	183	513	256	-	3,359	**970**
Draft approved and Registered	228	222	74	171	20	-	715	**302**
Under Review /Proposed	559	1,398	109	342	236	-	2,644	**668**
						-	-	
Average Annual New Housing Demand (2021-2026) From Figure 6	155	126	47	77	15	41	461	**461**
Year's Supply of Draft Approved and Registered								
GSP Estimate	0.6	2.3	5.1	0.2	4.2	-	1.5	0.7
Watson Consulting Estimates	1.5	1.8	1.6	2.2	1.3	-	1.6	0.7

Surce: Altus Group, based on Statistics Canada, Watson Consulting Norfolk County Land Needs Report (December 2021), GSP Group Memo on Land Supply in Norfolk County (October 2021)

This report relies on two sources for short-term land supply:

- A memo produced for Delhi Developments Inc by GSP Group in October 2021; and
- Watson Consulting's Long-term growth forecast document produced for Norfolk County in December 2021.

As of October 2021, Norfolk County was expected to grow by 461 households per year between 2021 and 2026. It is estimated that at that time, the County had between 698 and 715 applications draft approved and registered, or in short-term supply.[5]

This would be enough housing to accommodate just 1.5 years of hosuing demand.

The conditions of approval for some draft approved subdivisions include a hold on development until servicing is available. Almost half of these applications are in Port Rowan and Port Dover. However, both regions have

[5] Watson & Associated Economists Ltd., Comprehensive Review Phase 1: Long-Term Growth Analysis Norfolk County, Final Draft Report, December 2021, pages 4-1 to 4-3.

significant water servicing constraints that will not be addressed until the investments in the inter-urban water system are completed in 2031[6].

If we remove the land supply in Port Rowan and Port Dover, Norfolk County would have just 0.7 years' of available short-term land supply (or units that are draft approved and registered).

As there is sufficient capacity available in the Delhi water supply and wastewater treatment systems to accommodate the proposed redevelopment of the Delhi Golf and County Club, it can help the County maintain the production of an adequate supply of new housing until the infrastructure required to address servicing constraints in other communities is completed. The redevelopment proposes 874 units, which, if approved will bring the short-term land supply up to 2.6 years of supply.

The proposed plan for the redevelopment of the Delhi Golf & County Club lands provides for a mix of housing options suitable for young families including detached houses on small lots, semi-detached houses and row houses.

Attracting and retaining young families in Norfolk County will help support the local economy by:

- Stabilizing and growing the local labour force which will make the County a more attractive location for business development;
- Stabilizing and growing the school-aged population which will help local schools remain open and operate efficiently[7]; and
- Growing the local customer base for local businesses.

2.3 OPTIMIZING THE USE OF EXISTING INFRASTRUCTURE AND PUBLIC SERVICES

2.3.1 Water and wastewater Infrastructure

The proposed redevelopment of the subject lands will help meet the housing needs of Norfolk County by optimizing the use of existing infrastructure and public services.

[6] Inter-Urban Water Supply Program Status Update, April 12, 2022.

[7] Provincial funding for schools is directly linked to the number of children enrolled in the local school board.

According to the Norfolk County 2022 to 2031 Capital Plan, the County plans to spend $163,385,000 on water and wastewater infrastructure over the 2022 to 2031 period, of which:

- $148,649,000 is to be debt financed;
- $6,261,000 is to be funded from development charges; and
- $9,928,000 from other reserves and reserve funds.

The update to the inter-urban water supply system pegged the required investment at a higher $180 million over that period.

Expanding the Delhi settlement area boundaries to facilitate the redevelopment of the subject lands will unlock potential for development in the immediate future by optimizing the use of the County's existing water and wastewater infrastructure. Efficient use of existing infrastructure in Delhi will help the County's plans to invest in the new water and wastewater infrastructure required to unlock potential for future development in other communities in Norfolk County.

2.3.2 Community Facilities and Services

Efficient development patterns optimize the use of existing community facilities and services. Future residents of the proposed redevelopment will have easy access to existing community facilities in Delhi including schools.

Figure 9 shows that public elementary school enrollment in Delhi fell between the 2018/2019 and 2022/2023 school years, leaving the school with excess capacity. Schools in Waterford are over capacity, in contrast. The redevelopment of the subject lands will allow families to locate where there is school capacity.

Figure 9 **Grand Erie District School Board, Schools and Enrollment, Norfolk County, 2018/2019 and 2022/2023 School Years**

	Number of Schools	Capacity	2018/2019 Enrollment Level	2022/2023 Enrollment Level	Change in Enrollment
Elementary Schools					
Delhi	**1**	**412**	**421**	**375**	**-46**
Courtland	**1**	**--**	**215**	**208**	**-7**
Waterford	**3**	**786**	**735**	**790**	**55**
Port Rowan	**1**	**--**	**227**	**230**	**3**
Port Dover	**1**	**--**	**528**	**610**	**82**
Simcoe	**3**	**--**	**936**	**938**	**2**
Rest of Norfolk County	**4**	**--**	**1,129**	**1,061**	**-68**
High Schools					
Delhi	**1**	--	**493**	**539**	**46**
Courtland	**0**	--	**0**	**0**	**0**
Waterford	**1**	--	**370**	**342**	**-28**
Port Rowan	**0**	--	**0**	**0**	**0**
Port Dover	**0**	--	**0**	**0**	**0**
Simcoe	**1**	--	**672**	**636**	**-36**
Rest of Norfolk County	**0**	--	**0**	**0**	**0**

Source: Altus Group, Based on Grand Erie District School Board Data. *'-- reflects missing data

Other available amenities include:

- Delhi Community Arena
- Delhi Community Health Centre
- Fire station
- EMS base
- Public library
- Saint Frances Cabrini School
- Places of worship; and
- Other community clubs and services.

Norfolk County is building a public transit system with connections to neighbouring transit systems in Tillsonburg and Brantford and GO Transit. An existing bus route runs along James Street adjacent to the subject site, with a scheduled stop at the Delrose Retirement Residence located north of Dalton Road. The proposed redevelopment of the subject lands will generate

new potential riders for Norfolk's public transit system. Increased ridership is needed to facilitate new public transit solutions for the County that address rural realities and economies of scale.

3 MUNICIPAL FINANCE BENEFITS

The proposed redevelopment will generate development charges, property taxes and user fees to help fund the expansion of community facilities, as required to meet growth related needs in Delhi and across Norfolk County.

3.1 ON-TIME DEVELOPMENT CHARGES AND BUILDING PERMIT FEES

Based on current development charge rates, the proposed redevelopment will generate approximately $13.9 million in total development charges for the County including $4.5 million for County-wide services (libraries, fire stations, etc) and $9.5 million for water and wastewater services.

Figure 10

Development Charges and Building Permit Fees to Be Generated by Redevelopment of Delhi Golf and Country Club

Residential Development Charges

	Number of Units	County-Wide Service Rates		County-Wide Service Fees	Water and Wasterwater Service Rates		Water and Wasterwater Service Fees	**Total Municipal Fee**
Single/Semi	120	7,160	"/unit	859,200	15,248	"/unit	1,829,760	**2,688,960**
Other Multiples	604	5,003	"/unit	3,021,812	10,653	"/unit	6,434,412	**9,456,224**
Apartments 2+ Bedrooms	75	4,585	"/unit	343,875	9,763	"/unit	732,225	**1,076,100**
Apartments Bach and 1 Bedroom	75	3,022	"/unit	226,650	6,441	"/unit	483,075	**709,725**
Total	**874**			**4,451,537**			**9,479,472**	**13,931,009**

Building Permit Fees

	Construction Costs ($ Mil)	**Rate**		
Total	**263**	**$75**	**/First $3,000 Construction Costs**	
		$13	**/$1,000 thereafter**	**3,413,243**
Development Charge and Building Permit Fees				**17,344,252**

Source: Altus Consulting, Based on Municpal Rate Schedule for January 1st, 2023 to December 31st, 2023

Much of the development charge revenue generated by the proposed redevelopment will be available for the County to help cover the capital costs arising from development in other parts of the County because the proposed redevelopment will utilize existing infrastructure and municipal services in Delhi.

Residential development in Delhi can generate a reliable stream of development charge revenues for the County when servicing constraints delay development in other communities.

Building permit fees are used to fund the County's building inspection services. Servicing constraints in Port Dover, Simcoe and other local communities threaten to slow down the rate of new home construction in the County, which in turn will result in a sharp reduction in building permit fees.

Redevelopment of the subject lands will generate approximately $3.4 million in building permit fees for Norfolk County. Maintaining a steady stream of building permit fee revenue will help the County retain skilled building inspection staff, without having to increase funding from the wider tax base.

3.2 ON-GOING PROPERTY TAXES

When completed and occupied, the proposed redevelopment will generate approximately $3.2 million in property taxes per year including:

- $3 million for Norfolk County; plus
- $344,525 for education purposes.

Figure 11

Estimated Annual On-Going Property Tax from Redevelopment of Delhi Golf and Country Club

	Single-detached homes	Townhouses	Senior Residence	Total
Number of Units	604	120	150	
Average Assesment Value as of 2020	270,000	230,000	182,000	
Property Assesment Value	163,080,000	27,600,000	34,500,000	
Norfolk County Tax Rate (Per $1 of Property Value)	0.0119	0.0119	0.020143	
Education Tax Rate (Per $1 of Property Value)	0.00153	0.00153	0.00153	
Less Ontario Senior Rebate			75,000	75,000
Norfolk County Levies	1,940,407	328,399	694,934	2,963,739
Education Levies	249,512	42,228	52,785	344,525
Total Annual Property Tax	**2,189,920**	**370,627**	**672,719**	**3,233,265**

Source: Altus Group Economic Consulting based on Norfolk County property tax fee schedule and Statistics Canada Housing Statistics Program

4 ECONOMIC BENEFITS OF THE REDEVELOPMENT

The proposed redevelopment of the subject lands will provide significant one-time and on-going economic benefits to Norfolk County.

4.1 ONE-TIME ECONOMIC BENEFITS OF CONSTRUCTION

The construction of 874 new homes will generate a positive economic benefit to Norfolk County in the following three ways;

- ***Direct.*** The project represents a $302 million investment in construction activity. The 2016 Census reported that 2,560 Norfolk County residents worked in the construction industry. Redevelopment of the subject lands and construction on the site will generate employment opportunities for local residents.
- ***Indirect.*** The construction investment will generate additional demand for the businesses that provide goods and services to the construction industry in Norfolk.
- ***Induced.*** The additional spending could have knock-on benefits to the rest of the economy as the increased employment and wages and salaries will lead to higher consumer spending.

Figure 12 on page 20 highlights the one-time economic benefits of the construction activity of the proposed redevelopment, which include:

- 1,848 person-years of employment and $99 million in wages and salaries;
- $518 million in total economic activity; and
- $59 billion in provincial and federal government revenues tied to income taxes, $19.6 million of which are personal income taxes and $39.3 million in corporate profit taxes.

Figure 12

Estimated Economic Impact from Construction of Delhi Golf and Country Club, Norfolk County

	Direct	Indirect	Induced	Total
Economic Activity ($millions)	302	142	74	518
Gross Domestic Product ($millions)	137	73	54	264
Number of Jobs*	937	580	330	1,848
Wages ($millions)	55	38	16	109
Tax Revenue ($millions)				
Personal Income Taxes				19.6
Corporate Profit Taxes				39.3
Total Government Revenues				**59.0**

* Person-years of employment

Source: Altus Group Economic Consulting based on Input / Output Model and Other Sources

4.2 ON-GOING BENEFITS OF ENHANCING THE VITALITY OF DOWNTOWN DELHI

Redevelopment of the Delhi Golf & County Club will increase the population of the Delhi community by approximately 1,642 persons. Altus Group estimates that consumers spend roughly $14,000 per year per person in retail stores and services within a 10km radius of where they live. Local Delhi businesses will have an opportunity to benefit from this additional spending.

It is estimated that the redevelopment and resulting population base will generate roughly $23 million per year in retail spending for Delhi and Norfolk County, combined. This will result in $2.7 million in provincial sales tax per year.

Figure 13

Estimated Annual On-Going Retail Spending from Residents of Delhi Golf and Country Club

	Dollar Value
Spending Per Persons	14,000
Number of Persons	1,642
Total Annual Spending	**22,990,800**
Taxable Consumer Spending	20,691,720
Estimated Provincial Sales Tax	**2,689,924**

Source: Altus Group Economic Consulting based on Statistics Canada

A larger local population base can support a larger and more diverse set of local retail stores and services in Downtown Delhi, which will in turn make it a more attractive place for local residents to spend time.

4.3 ON-GOING BOOSTS THE LOCAL LABOUR POOL

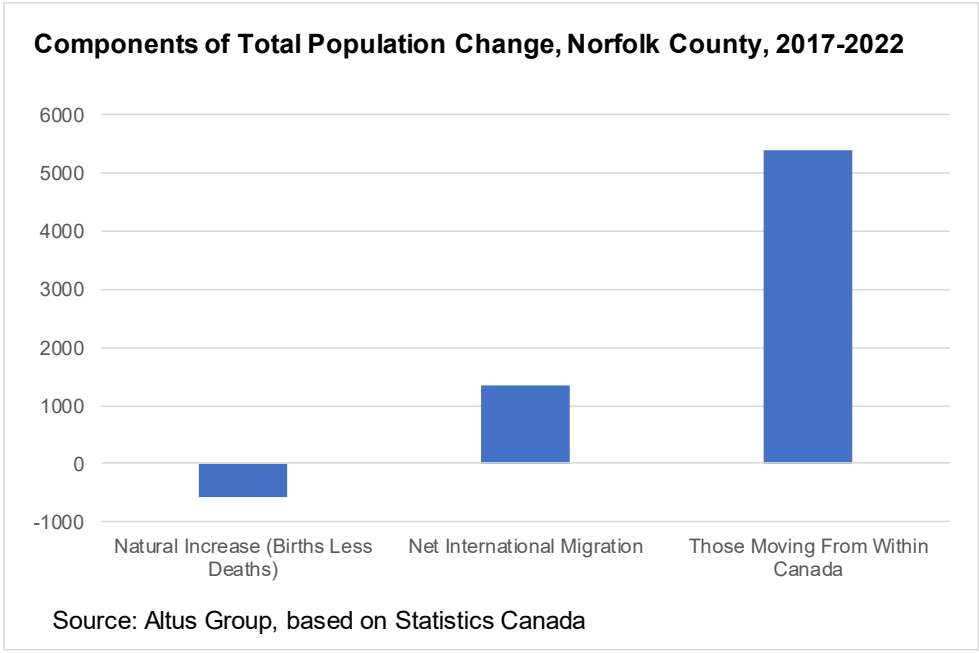
Residential development, particularly of affordable housing, helps to attract a young working-age population.

A 2020 blog from the Centre for Urban Research and Land Development at Toronto Metropolitan University highlighted that a deterioration in housing affordability was driving population out of the Toronto CMA and into other parts of Ontario, Haldimand-Norfolk being a top destination for these flows at that time. Population flows into the region were driven by those of the working-aged population. [8]

[8] Petramala, Diana. "Toronto CMA Losing Existing Population of All Ages to More Affordable Regions in Ontario", March 2020. Accessed: https://www.torontomu.ca/centre-urban-research-land-development/blog/blogentry46/

Norfolk County has an aging population and is one of few regions in Ontario where natural population (births less deaths) is negative. Figure 14 shows that the region is highly dependent on migration into the region to grow its population and labour force.

Figure 14



The residential redevelopment proposed for the subject lands alone could boost the labour pool in Norfolk County by 914 people.

The Norfolk County 2018 Development Charge Background Study stated that the region had an employment activity rate of almost 0.65. That means that it is expected that there are roughly 66 jobs created for every increase in the population of 100.

Figure 15 shows that there is potential for the redevelopment to house 1,387 working-aged residents (excluding the senior-residence). This could result in 914 new jobs through an increase in the labour supply.

Figure 15

Estimated Impact on the Local Labour Force , the Redevelopment of Delhi Golf And Country Club, Norfolk County

	Jobs/Residents	Non-Senior Population	Jobs Created
Primary	0.021	1,387	29.1
Work at Home	0.042	1,387	58.3
Industrial	0.057	1,387	79.1
Commercial/Population Related	0.117	1,387	162.3
Institutional Related	0.064	1,387	88.8
No Normal Place of Work	0.358	1,387	496.6
Total Redevelopment	**0.659**	**1,387**	**914.2**

Source: Altus Group, based on Census of Canada data and the Norfolk County 2018 Development Background Study

4.4 PRESERVATION OF THE COUNTY'S AGRICULTURAL BASE

Agriculture is a vital part of the Norfolk economy. Often, the development of new housing results in the loss of agricultural land. Redevelopment of the Delhi Golf & Country Club presents a rare opportunity to accommodate growth with no loss of agricultural land and no adverse impact on agricultural operations or agriculture-related businesses in the County.

The growth accommodated through the redevelopment of the golf course will offset the need for growth elsewhere in the County potentially on agricultural land.

5 CONCLUSIONS

As part of the comprehensive review currently underway, Norfolk County must review population and employment projections and determine:

> *…. how best to accommodate the development while protecting provincial interests.*[9]

The Provincial Policy Statement provides policy direction on matters of provincial interest related to land use planning and development. The efficient use of infrastructure and public facilities is a key theme that runs through the objectives and policies of the Provincial Policy Statement.

The Vision for Ontario's Land Use Planning System in Part IV of the Provincial Policy Statement says:

> *Land use must be carefully managed to accommodate appropriate development to meet the full range of current and future needs, while achieving efficient development patterns ….*
>
> *Efficient development patterns optimize the use of land, resources and public investment in infrastructure and public service facilities.*

According to Part V section 1.0 of the Provincial Policy Statement:

> *Ontario's long-term prosperity, environmental health and social well-being depend on wisely managing change and promoting efficient land use and development patterns*.

Policy 1.1.1.a) links efficient development with the financial well-being of municipalities:

> *Healthy, liveable and safe communities are sustained by:*
>
> *a) promoting efficient development and land use patterns which sustain the financial well-being of the Province and municipalities over the long-term …*

Policy 1.6.3 in the infrastructure section of the Provincial Policy Statement says:

> *Before consideration is given to developing new infrastructure and public service facilities:*

[9] Provincial policy statement section 6.0 definition of "comprehensive review".

> *a) the use of existing infrastructure and public service facilities should be optimized ….*

Policy 1.6.6.1 says:

> *Planning for sewage and water systems shall:*
>
> *a) accommodate forecasted growth in a manner that promotes the efficient use and optimization of existing:*
>
> *1. Municipal sewage systems and municipal water systems ….*

Redevelopment of the Delhi Golf & Country Club would accommodate growth in a manner that promotes efficient use of existing municipal water, wastewater and road infrastructure and existing community services in Delhi. The redevelopment will help increase the short-term years supply of housing from an estimated 0.7 to 2.1.

This will result in economic and financial benefits for the municipality including:

- $12.6 million in development charge revenues;
- $4.3 million in building permit fees; and
- $4.4 million in annual property taxes.

Policy 1.7.1 of the Provincial Policy Statement says:

> *Long-term economic prosperity should be supported by:….*
>
> *b) encouraging residential uses to respond to dynamic market-based needs and provide necessary housing supply and range of housing options for a diverse workforce;*
>
> *c) optimizing the long-term availability and use of land, resources, infrastructure and public service facilities;*
>
> *d) maintaining and, where possible, enhancing the vitality and viability of downtowns and mainstreets; ….*
>
> *i) sustaining and enhancing the viability of the agricultural system through protecting agricultural resources, minimizing land use conflicts, providing opportunities to support local food, and maintaining and improving the agri-food network ….*

Redevelopment of the Delhi Golf & Country Club will support long-term economic prosperity by:

- Providing a range of market-based housing options for a diverse work force, increasing the labour force by 914 jobs.
- Generating $518 million in economic activity, contributing to more than 1,848 jobs. This will add almost $55.9 million to provincial and federal income tax revenue.
- Optimizing the use of existing infrastructure and public service facilities.
- Enhancing the vitality and viability of Downtown Delhi by bringing $23 million in additional retail spending per year; and
- Sustaining the viability of the agricultural system through the protection of agricultural land.

Therefore, consideration of how best to accommodate growth while protecting provincial interests and advancing the Province's Housing Mandate, should include expansion of the Delhi settlement area boundary to include the subject lands.

REPORT

Preliminary Geotechnical Investigation

Proposed Residential Development, Delhi Golf & Country Club, 905 James Street, Delhi, Ontario

Submitted to:

Delhi Development Inc. c/o Geranium

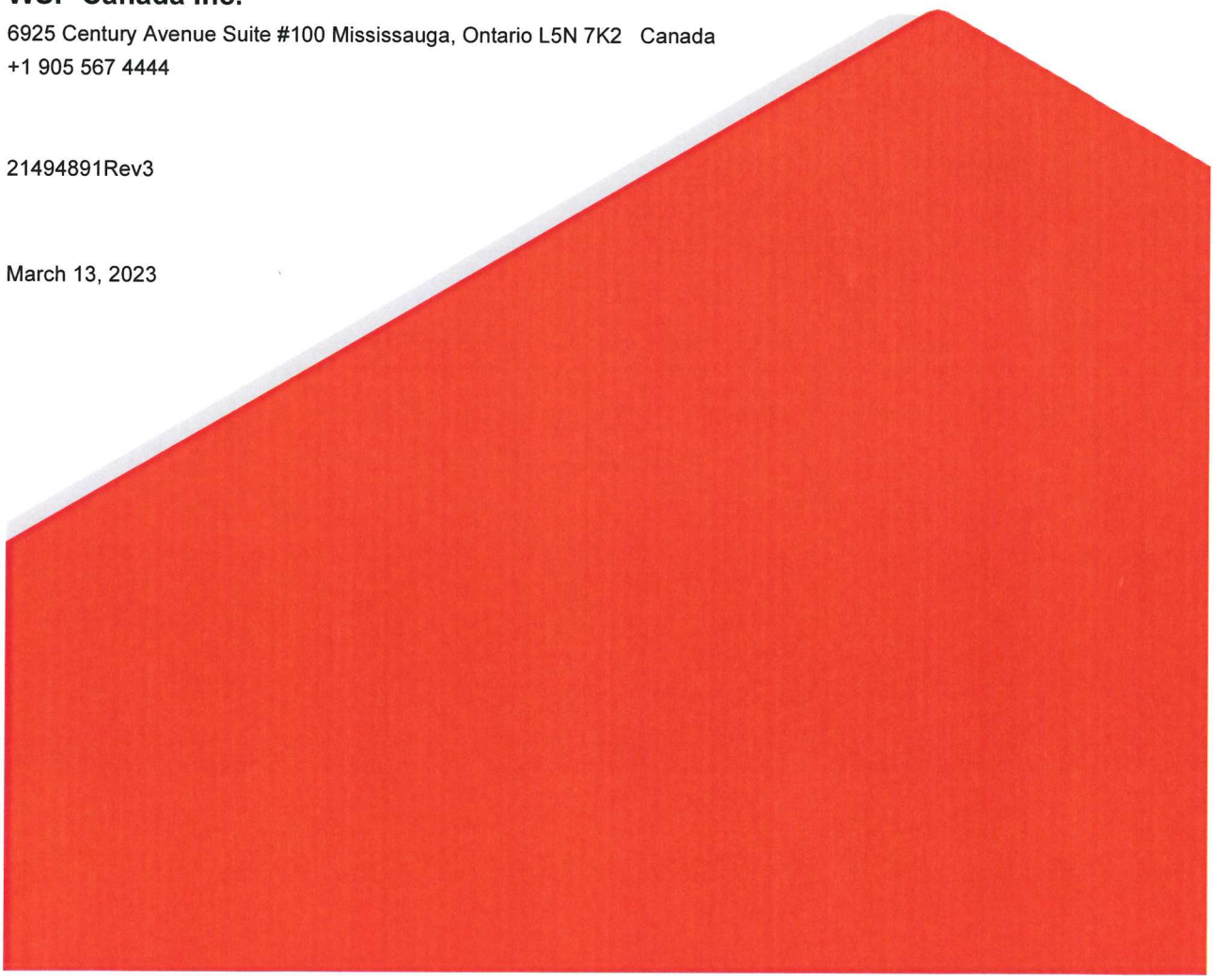
3190 Steeles Avenue West, Suite 300
Markham, ON L3R 1G9
Attention: Ms. Jennifer Ormiston

Submitted by:

WSP Canada Inc.
6925 Century Avenue Suite #100 Mississauga, Ontario L5N 7K2 Canada
+1 905 567 4444

21494891Rev3

March 13, 2023



Distribution List

1 eCopy: Delhi Development Inc. c/o Geranium

1 eCopy: Norfolk County

1 eCopy: WSP Canada Inc.

Table of Contents

1.0 INTRODUCTION 1

2.0 SITE DESCRIPTION 1

3.0 FIELD INVESTIGATION PROCEDURE 1

4.0 SUBSURFACE CONDITIONS 2

4.1 Topsoil and Organics 2

4.2 (SP) Clayey Sand to (ML) Silt to Clayey Silt to (CL-ML) Silty Clay-Clayey Silt to (CL) Silty Clay 2

4.3 (ML) Silt to sandy silt to (SM) Silty Sand to (SP) Sand to (SP/GP) Sand and Gravel 3

4.4 (ML) Sandy Silt to Clayey Silt Till 3

4.5 Groundwater Conditions 4

5.0 GEOTECHNICAL ENGINEERING DISCUSSION 6

5.1 Site Preparation 7

5.1.1 Topsoil Stripping and Reuse 7

5.1.2 Engineered Fill Requirements 7

5.1.3 Settlement Associated with Engineered Fill Placement 8

5.2 Installation of Underground Services 10

5.2.1 Temporary Excavations 10

5.2.2 Pipe Bedding and Cover 11

5.2.3 Trench Backfill 11

5.3 Building Foundations 12

5.3.1 Other Considerations 13

5.4 Seismic Site Classification 14

5.5 Storm Water Management (SWM) Pond Excavations and Recommendations 14

6.0 OBSTRUCTIONS 16

7.0 INSPECTION AND TESTING 16

8.0 CLOSURE 16

FIGURES

Figure 1 – Borehole Location Plan

APPENDICES

APPENDIX A
Important Information and Limitations of This Report

APPENDIX B
Method of Soil Classification Abbreviations and Terms Used On Record of Boreholes List of Symbols Record of Boreholes BH 21-2 to 21-13

APPENDIX C
Laboratory Test Results

1.0 INTRODUCTION

WSP Canada Inc. (WSP), formerly Golder Associates Ltd. (Golder), was retained by Delhi Development Inc. c/o Geranium to carry out Geotechnical and Hydrogeological Investigations, Phase One and Two Environmental Site Assessments (ESA), and Stage 1 Archaeological Assessment to accompany an Official Plan Amendment (for an urban boundary expansion, redesignation of lands), a Zoning By-law Amendment, and Draft Plan of Subdivision and Condominium Applications ('development applications') for the proposed residential development on the existing Delhi Golf & Country Club, located at 905 James Street in Delhi, Ontario (the Site). As such, outlined below are the results and recommendations related to the geotechnical investigation. The Hydrogeological Investigation, Phase One and Two Environmental Site Assessments (ESA), and Stage 1 Archaeological Assessment are reported under separate cover.

This report should be read in conjunction *with "Important Information and Limitations of this Report"*, in Appendix A. The reader's attention is specifically drawn to this information, as it is essential for the proper use and interpretation of this report.

2.0 SITE DESCRIPTION

The main project Site is located at the east side of Highway 3 on the existing Delhi Golf & Country Club property in the south end of the former Township of Delhi, in Norfolk County. The site is a 55.32-hectare parcel of land currently occupied by grass fields, a residential house, wooded and wetland areas and a golf course.

We understand that Delhi Development Inc. is proposing to redevelop the site as a municipal-serviced residential development. The conceptual plan provided by Delhi Development Inc. indicates that the proposed redevelopment area is approximately 29.73 ha. (73.4 ac.) and will include 724 residential lots (including 120 single-detached homes, and a residential condominium block consisting of 604 townhouses), a 1.21 ha. retirement home block, a 1.71 ha. community common area, a 2.27 ha. Stormwater Management Pond/Facilities, and a 24.36 ha. Open Space/Natural Heritage area along with associated roads and utilities. For preparation of this report, it has been assumed that the residential structures will be designed using shallow footings with a slab-on-grade including a single basement level, typical with residential structures.

Based on the conceptual plan, it is our understanding that a majority of the proposed redevelopment area is located within the current golf course and that the wooded areas and wetlands are generally to remain.

3.0 FIELD INVESTIGATION PROCEDURE

The field work for the current geotechnical investigation was carried out between December 1 and December 16, 2021, during which time thirteen (13) boreholes (designated as Boreholes BH21-1 to BH21-13) were advanced at the site. Boreholes were advanced to depths between about 6 m and 10 m below existing ground surface at the approximate locations shown on the Borehole Location Plan, Figure 1, attached.

The boreholes were advanced using a track-mounted drill rig supplied and operated by a specialist drilling contractor, subcontracted by WSP. Standard Penetration Testing (SPT) and sampling was carried out at regular intervals of depth in the boreholes using conventional 35 mm internal diameter split spoon sampling equipment advanced using an automatic hammer, in accordance with ASTM D1586 (99). The groundwater conditions were recorded in the open boreholes immediately following drilling procedures for all boreholes. Ten (10) boreholes

advanced on site were equipped with 50 mm diameter monitoring wells (including bi-level nested wells at BH21-11) to permit further monitoring of the groundwater levels. The well installation details and groundwater level readings are presented on the Record of Borehole sheets in Appendix B.

The field work for this investigation was directed by a member of our technical staff who located the boreholes in the field, directed the sampling and in situ testing operation, logged the boreholes and cared for the samples obtained. The samples were identified in the field, placed in appropriate containers, labelled and transported to WSP's Mississauga geotechnical laboratory for further examination and laboratory testing. Index and classification tests, consisting of water content determinations, Atterberg limits and grain size distribution, were carried out on selected soil samples. The results of the geotechnical laboratory tests are included in Appendix C and on the Record of Borehole sheets in Appendix B.

The borehole locations and elevations were surveyed by the project surveyor and are shown on the Borehole records in UTM coordinates and Geodetic elevation (CGVD2013).

4.0 SUBSURFACE CONDITIONS

As noted above, the subsurface soil and shallow groundwater conditions encountered in the boreholes are shown on the Record of Borehole sheets, in Appendix B, and the results of laboratory testing are shown in Appendix C. Method of Soil Classification, Abbreviations and Terms used on Records of Boreholes and Test Pits, and List of Symbols are provided in Appendix B to assist in the interpretation of the borehole records. It should be noted that the boundaries between the strata have been inferred from drilling observations and non-continuous sampling, and generally represent a transition from one soil type to another and should not be inferred to represent an exact plane of geological change. Further, conditions will vary between and beyond the boreholes. The following is a description of the subsurface soil and groundwater conditions encountered of the boreholes advanced during this investigation.

4.1 Topsoil and Organics

Topsoil ranging in classification from clayey silt to sandy silt to silty sand containing varying amounts of organics and rootlets was encountered in all boreholes, ranging in thickness from about 0.15 m to 0.9 m.

Organic content testing was carried out on a sample of the sandy silt topsoil in borehole BH21-8 which recorded an organic content of about 3 per cent and a water content of about 25 per cent.

With the exception of the sample collected from BH21-8, materials identified as topsoil in this report were classified based on visual and textural evidence as no other testing for organic content or other nutrients was carried out. As such, the ability for these materials to support vegetation has not been assessed.

4.2 (SP) Clayey Sand to (ML) Silt to Clayey Silt to (CL-ML) Silty Clay-Clayey Silt to (CL) Silty Clay

A cohesive deposit ranging in composition from clayey sand to silt to clayey silt to silty clay was encountered below the topsoil and surficial organic materials in boreholes BH21-1 and BH21-6, and interlayered within the sandy deposits in BH21-2, BH21-3, BH21-4, BH21-8 and BH21-10 to BH21-13. At some borehole locations, the near surface portions of this deposit contained trace amounts of organics, and an organic content test carried out on a sample of this deposit from BH21-4 measured an organic content of about 1.4 per cent. The top of this

deposit was encountered between depths of about 0.2 m and 2.2 m below ground surface (Elevation 238.4 m to 227.5 m) and extended to depths of between 2.2 m and 5.6 m below ground surface (Elevation 236.7 m to 226.4 m) (including the sandy interlayers) where the deposit was fully penetrated. Boreholes BH21-2, BH21-3, BH21-8, and BH21-10 to BH21-13 were terminated within this deposit at depths between 6.2 m and 9.8 m below ground surface (Elevations 232.6 m to 218.0 m).

Cobbles and boulders are inferred to be present within this deposit based on field observations of refusal to auger penetration, as noted on the borehole records.

The SPT 'N' values measured in the cohesive deposits ranged from 0 blows to 45 blows per 0.3 m of penetration, suggesting a very soft to hard (but generally firm to stiff) consistency.

The results of grain size distribution tests carried out on four selected samples collected from this deposit are presented on Figure C1, in Appendix C. Atterberg limits tests were carried out on six samples from this deposit and measured liquid limits between about 15 and 21 per cent, plastic limits between about 13 and 16 per cent, and corresponding plasticity indices of about 2 to 7 per cent. These results, which are plotted on Figure C2 in Appendix C, indicate that the deposit can be classified as silt to clayey silt to silty clay-clayey silt of low plasticity.

The water content measured on selected samples collected from the cohesive deposits ranged from about 1 per cent to 25 per cent, but were generally between about 10 and 20 per cent.

4.3 (ML) Silt to sandy silt to (SM) Silty Sand to (SP) Sand to (SP/GP) Sand and Gravel

A non-cohesive deposit ranging in composition from silt to sandy silt to silty sand to sand to sand and gravel was encountered underlying the cohesive deposit in BH21-1, underlying the topsoil in BH21-5, BH21-7 and BH21-9, interlayered with the cohesive deposits in BH21-3, BH21-4, BH21-8 and BH21-10 to BH21-13, and interlayered with the till deposits in BH21-2 and BH21-6. The top of this deposit was encountered between depths of about 0.2 m and 4.5 m below ground surface (Elevation 239.7 m to 227.0 m) and extended to depths of between 1.5 m and 8.0 m below ground surface (Elevation 234.3 m to 220.0 m) (including the cohesive interlayers) where the deposit was fully penetrated. Boreholes BH21-1, BH21-4 to BH21-7, and BH21-9 were terminated within this deposit at depths between 6.2 m and 6.7 m (Elevation 233.2 m to 222.6 m).

Cobbles and boulders are inferred to be present within this deposit based on field observations of auger grinding and refusal to auger penetration, as noted on the borehole records.

The SPT 'N' values measured in the cohesive deposit range from 0 blows to 93 blows per 0.3 m of penetration, indicating a very loose to very dense (but generally loose to compact) state of compactness.

The result of grain size distribution tests carried out on eight selected samples of silty sand to sand some silt are shown on Figure C3, in Appendix C.

The water content measured on selected samples ranged from about 4 to 25 per cent.

4.4 (ML) Sandy Silt to Clayey Silt Till

A glacial till deposit consisting of sandy silt to sandy clayey silt to clayey silt was encountered interlayered within the cohesive and non-cohesive deposits (discussed above) at depths between about 2.2 m and 3.0 m below ground surface (Elevation 236.3 m to 235.9 m) in BH21-2, BH21-4 and BH21-6. The deposit extended to a depth of about 3.0 m to 4.5 m (Elevation 235.8 m and 234.1 m).

The SPT 'N' values measured in the glacial till ranged from 13 blows to 50 blows per 0.3 m of penetration, indicating a dense to very dense compactness or stiff to hard consistency.

The results of grain size distribution tests carried out on two selected samples of the glacial till are shown on Figure C4, in Appendix C.

The measured water content of selected samples from this deposit ranged between 9 and 15 per cent.

4.5 Groundwater Conditions

Groundwater level measurements were recorded following drilling procedures and are noted on the borehole records in Appendix B.

Groundwater was not encountered during drilling at boreholes BH21-3 and BH21-6. Groundwater was encountered in the remaining boreholes and ranged from about 2.1 m to 6.1 m below ground surface on completion of drilling. Groundwater levels in the installed monitoring wells were measured between 0.2 m and dry to 6.0 m, with one borehole (BH21-10) measuring artesian (above ground surface) levels, between December 2021 and May 2022.

As noted above, monitoring wells were installed in boreholes to monitor the groundwater level at the site. Details of the monitoring well installations are shown on the borehole logs in Appendix B. Groundwater level readings following drilling are provided below:

Table 1: Summary of Groundwater Levels

Borehole No.	Depth to Water Level / Elevation (m)	Date	Notes
BH21-1	6.1 / 232.5	December 15, 2021	Open Borehole on completion
BH21-2	6.1 / 232.7	December 16, 2021	On Completion
	4.8 / 233.9	December 22, 2021	
	4.8 / 233.9	January 14, 2022	
	4.7 / 234.0	May 2, 2022	
	5.7 / 233.1	October 22, 2022	
BH21-3	Dry / --	December 15, 2021	On Completion
	3.1 / 234.2	December 22, 2021	
	3.4 / 234.0	January 14, 2022	
	3.5 / 233.8	May 2, 2022	
	4.3 / 233.0	October 22, 2022	
BH21-4	5.3 / 233.6	December 3, 2021	Open Borehole on completion
BH21-5	5.8 / 234.1	December 3, 2021	On Completion
	Dry / --	December 14, 2021	
	Dry / --	December 22, 2021	
	Dry / --	January 14, 2022	

Borehole No.	Depth to Water Level / Elevation (m)	Date	Notes
	6.0 / 233.9	May 2, 2022	
	6.0 / 233.9	October 22, 2022	
BH21-6	Dry / --	December 15, 2021	Open Borehole on completion
BH21-7	3.0 / 228.6	December 1, 2021	On Completion
	0.9 / 230.7	December 14, 2021	
	1.3 / 230.2	December 22, 2021	
	1.3 / 230.2	January 14, 2022	
	1.1 / 230.4	May 2, 2022	
	2.6 / 228.9	October 22, 2022	
BH21-8	2.3 / 230.4	December 3, 2021	On Completion
	0.6 / 232.2	December 14, 2021	
	0.7 / 232.1	December 22, 2021	
	0.6 / 232.2	January 14, 2022	
	0.8 / 232.0	May 2, 2022	
	2.4 / 230.4	October 22, 2022	
BH21-9	4.6 / 225.2	December 2, 2021	On Completion
	1.1 / 228.7	December 14, 2021	
	1.2 / 228.7	December 22, 2021	
	1.1 / 228.7	January 14, 2022	
	1.0 / 228.8	May 2, 2022	
	2.2 / 227.6	October 22, 2022	
BH21-10	5.2 / 222.5	December 21, 2021	On Completion
	-0.2 / 227.6	December 22, 2021	
	-0.2 / 227.6	January 14, 2022	
	-0.2 / 227.6	May 2, 2022	
BH21-11 (Deep Well)	3.0 / 225.7	December 2, 2021	On Completion
	0.3 / 228.4	December 14, 2021	
	0.4 / 228.3	December 22, 2021	
	0.5 / 228.3	January 14, 2022	
	0.2 / 228.5	May 2, 2022	
	1.1 / 227.7	October 22, 2022	
BH21-11B (Shallow Well)	3.0 / 225.7	December 2, 2021	On Completion

Borehole No.	Depth to Water Level / Elevation (m)	Date	Notes
	0.5 / 228.2	December 14, 2021	
	0.8 / 228.0	December 22, 2021	
	0.9 / 227.9	January 14, 2022	
	0.5 / 228.2	May 2, 2022	
	2.0 / 226.8	October 22, 2022	
BH21-12	2.1 / 234.6	December 16, 2021	On Completion
	2.2 / 234.5	December 22, 2021	
	2.3 / 234.5	January 14, 2022	
	2.2 / 234.5	May 2, 2022	
	3.1 / 233.6	October 22, 2022	
BH21-13	2.6 / 226.7	December 3, 2021	Open Borehole on completion

It should be noted that the groundwater level in the area is subject to seasonal fluctuations and precipitation events and should be expected to be higher during wet periods of the year. Further details of the groundwater levels and additional readings are be provided in WSP's Hydrogeology Investigation Report, submitted under separate cover.

5.0 GEOTECHNICAL ENGINEERING DISCUSSION

This section of the report provides preliminary geotechnical engineering recommendations on the geotechnical aspects of the proposed redevelopment based on our interpretation of the limited borehole information and on our understanding of the project scope and requirements. The information in this portion of the report is provided for the guidance of the design engineers and professionals.

Based on the results of this investigation, the subsurface soil conditions encountered at the site are considered to be generally suitable for the proposed residential development.

The recommendations made herein are based on our understanding the project requirements based on the current preliminary grading plan (by Burnside, dated November 15, 2022) and the current site servicing pan (by Burnside dated, November 3, 2022) The following engineering recommendations regarding the geotechnical design aspects of the project including underground services, pavements and building foundations should be considered as preliminary only and should be reviewed when the design grades and utility invert levels have been finalized as part of the detailed design.

Where comments are made on construction, they are provided only in order to highlight aspects of construction which could affect the design of the project. Contractors bidding on or undertaking any work at the site should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction and make their own interpretation of the factual data as it affects their proposed construction techniques, schedule, equipment capabilities, costs, sequencing and the like.

5.1 Site Preparation

The existing site vegetation, surficial topsoil/organics, and other near surface soils containing significant amounts of organic matter are not considered to be suitable for the subgrade support of building foundations and/or engineered fill materials and should be completely stripped from the site prior to placing any engineered fill. In addition, any below - grade features associated with the existing buildings at the site (e.g., foundations, services etc.) should also be removed prior to engineered fill placement.

5.1.1 Topsoil Stripping and Reuse

The following geotechnical comments are provided regarding organic and topsoil stripping and reuse at the site:

- As noted above, surficial vegetation and topsoil should be stripped from the proposed development area. The surficial topsoil deposit encountered at the borehole locations ranged from 150 mm to 680 mm in thickness but was generally about 200 mm to 250 mm thick. The upper portion of the near-surface native soils below the topsoil layer were noted to be organic stained and to contain organic materials (e.g. roots). In this regard, portions of these stained materials containing organic matter would also need to be removed prior to engineered fill placement. For estimating purposes, it is recommended that an allowance be included for stripping a thickness of approximately 350 mm to 400 mm of these materials in addition to the complete removal of the overlying topsoil. The actual amount of stripping of the organic-stained soils will need to be determined at the time of construction. The stripping activities should be monitored by qualified geotechnical personnel to confirm that the extent of removal of surficial soils containing organics is suitable for the project requirements. Based on our recent experience at golf course sites, it is noted that the topsoil thickness may vary significantly over short distances due to the use of topsoil for grading purposed to create mounds/undulations, etc. typically found on golf courses. Additional test pit or drilling investigations into specific site landscape/grading features may be warranted at a future design stage to more accurately predict the topsoil thickness in some areas;
- Consideration may be given to selective stripping operations, consisting of road allowances and building envelopes (including driveways) and any other settlement sensitive features;
- Outside of road allowances and building envelopes, topsoil, if encountered, may be buried and/or reused as general lot fill to raise grades. The primary factor controlling methane generation is the organic carbon content of the topsoil. The loss on ignition (LOI) test provides an indication of the organic carbon content of the sample. If topsoil is to be reused as general lot fill to raise grades, then LOI testing should be carried out and further recommendations provided by the geotechnical engineer in regard to the reuse of topsoil and the potential for methane generation; and
- Where low organic content material (trace organics) is used as general lot fill, its thickness should be limited to about 0.6 m. The trace organics fill should be placed in maximum 300 mm loose lifts and uniformly compacted to 95 per cent of standard Proctor maximum dry density (SPMDD). To have any success in placing topsoil as lot grading fill, it must be placed at or very close to its optimum water content to achieve workability and adequate compaction, in order to minimize post-construction settlements and/or lateral movements (e.g., of fences, etc.).

5.1.2 Engineered Fill Requirements

Based on the latest grading plan provided by R.J. Burnside & Associates Ltd. (November 15, 2022), the anticipated site grading activities will include both cutting and raising (filling) the original grade to meet the final

design site grades. At the time of this report, the design cut and fill depths provided indicate that the site will largely require imported material to fill to design grade, generally between about 0.1 m and 3.0 m, with localized areas in the northwest and southeast requiring up to about 3.5 m of fill placement.

Groundwater was encountered at relatively shallow depths in the winter/spring of 2022, particularly in the southern portion of the site (i.e., south of about the existing clubhouse) which could potentially impact stripping and filling operations depending on the actual groundwater levels at the time of construction.

In general, the existing native soils are considered to be acceptable for reuse as engineered fill. Based on the laboratory test results, the water content of soils present at the site are considered to be near or slightly above their optimum water contents for compaction, and therefore will likely require only drying prior to placement.

It should be noted that some of the native materials at the site are silty/clayey in nature, and as such are susceptible to over-wetting and subsequent freezing during inclement weather. Therefore, it is recommended that site grading activities not be carried out during late fall, winter, early spring seasons or any periods of inclement weather conditions. All oversized cobbles (i.e., greater than 150 mm in size) and boulders, as inferred from auger grinding during advancement of the boreholes, should be removed from excavated material that will be used as engineered fill material.

It is anticipated that imported material may be required for the engineered fill process. The material that is proposed for use as engineered fill should be approved by the geotechnical engineer at its source, prior to importing the material to the site. Suitable soils, free of topsoil, organic matter or other deleterious materials can be used as engineered fill provided that the water content of the soil at the time of placement does not vary by more than 2 per cent above or below its optimum water content for compaction. Otherwise, the soils may require treatment (i.e., drying or wetting) prior to placement.

Following the inspection and approval of the subgrade as described previously in this report, engineered fill materials should be placed in maximum 300 mm-thick loose lifts and uniformly compacted to at least 98 per cent of SPMDD. Filling should continue until the design elevations are achieved.

Full-time monitoring and in situ density testing should be carried out by WSP during placement of engineered fill.

The final surface of the engineered fill should be protected as necessary from construction traffic and should be sloped to provide positive drainage for surface water during the construction period. If the engineered fill materials will be left exposed (i.e., uncovered) during periods of freezing weather, additional soil cover should be placed above final subgrade to provide some level of frost protection. Prior to placing the granular subbase and/or base courses within pavement areas, the surface of the engineered fill/subgrade should be inspected by WSP.

5.1.3 Settlement Associated with Engineered Fill Placement

Settlement of the site will occur due to compression of the newly placed fill (engineered fill) itself, as well as due to settlement of the underlying stiff to hard clayey silt till deposit as a result of the weight of the engineered fill.

Settlement of Engineered Fill

The magnitude of the settlement of the engineered fill is estimated to be approximately 2 per cent of the total grade raise height. Therefore, provided that the engineered fill material consists of properly compacted select fill, the estimated settlement and time for approximately 90 per cent of the settlement to occur for grade raises of 1 m, 2 m and 3 m are provided in Table 2.

Table 2: Magnitude and Timing of Settlement – Engineered Fill

Engineered Fill Thickness (m)	Estimated Settlement of Engineered Fill (mm)	Anticipated Time for Approximately 90% Settlement to Occur (months)
1	>25	2
2	40	3
3	60	4 to 6

The above estimates of settlement and anticipated time for the majority of this settlement to occur assumes that the engineered fill will be cohesive in nature and will have the following minimum characteristics:

a) the material is free of organic matter and other deleterious materials;

b) the water content of the soil at the time of placement does not vary by more than 2 per cent above or below the optimum water content for compaction; and

c) the plasticity index is equal to or greater than 7 per cent and does not exceed 15 per cent.

The use of granular fill will reduce the estimated magnitude of settlement, and the majority of the settlement of granular fill will occur during construction.

Settlement of the Native Materials

The estimated magnitude of settlement and time for this settlement to occur when subjected to the load increase imposed by 1 m, 2 m and 3 m of engineered fill are provided in Table 3.

Table 3: Magnitude and Timing of Settlement – Native Materials

Engineered Fill Thickness (m)	Anticipated Settlement of Native Clayey Silt to Silty Clay Till (mm)	Estimated Time for Approximately 90% Settlement to Occur (months)
1	<25	4 to 6
2	25	
3	50	

The anticipated time for approximately 90 per cent of the settlement to occur in the native clayey silt to silty clay till assumes that a drainage layer of granular material will be placed as the first lift of engineered fill overlying the native soil.

5.2 Installation of Underground Services

5.2.1 Temporary Excavations

Based on the Conceptual Underground Servicing Plan prepared by Burnside (dated November 3, 2022), the maximum depth of the underground services is at about 5.3 m below finished grade, and about 3.7 m below the existing ground surface, with the exception of the proposed pumping station, the depth of which will be confirmed at detailed design. Once detailed design is completed, review of the underground services should be completed by this office for compliance with the recommendations contained herein. Additional boreholes may be required as part of the detailed geotechnical investigation to support the detailed design of the underground services, including at the proposed pumping station location.

The founding soils are anticipated to generally consist of the native sand to silty sand, silty clay, glacial till or engineered fill. These materials are considered to be suitable for supporting the underground services provided that the integrity of the base of the trench excavations is maintained during construction. Where softened or disturbed native soils or other deleterious materials are encountered at the base of excavations for settlement-sensitive services, these materials should be subexcavated and replaced with compacted fills approved by the geotechnical engineer.

Care should be taken to direct surface water away from any open excavations and all temporary excavations should be carried out in accordance with the Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects.

As described above, the site soils typically consist of a mixture of cohesive and cohesionless soils varying in composition from sand to silty sand interlayered with deposits of silty clay to clayey silt and silty clay to clayey silt glacial till. Based on the measurements of water levels within the monitoring wells, the groundwater level at the site varies greatly throughout the site but is anticipated to be at depths of about 3 m and 6 m below ground surface in the northern portion of the site, and between about 0.3 m and 1.5 m below existing ground surface in the southern portion of the site.

Groundwater seepage through the clayey silt to silty clay and glacial till deposits is anticipated to be minor and can probably be handled by pumping from properly constructed and filtered sumps located within the excavations. For excavations that extend nominally into the wet cohesionless soils (i.e., to depths of less than 0.5 m below the water table), groundwater seepage may also be controlled with the use of sumps and pumps. For deeper excavations that will extend below the groundwater table (i.e., excavations extending more than about 0.5 m below the water level), significant groundwater inflow into the excavations may be expected and there is a potential for sloughing of excavation side slopes and/or disturbance/boiling of the base of the excavations. In order to reduce the potential for instability of the sidewalls and base of the excavation in these areas, an external groundwater control system (e.g., well point or eductor dewatering systems) is recommended to sufficiently lower the groundwater level in the granular deposits (e.g., to a level a minimum of 0.5 m below the base of the excavation) before the excavation is carried out. The dewatering system should be designed and installed by a specialist dewatering company.

If dewatering is required at the site, a Permit to Take Water (PTTW) from the Ministry of Environment, Conservation and Parks (MECP) may be required. This permit should be obtained prior to the start of construction to minimize the potential for delays to the construction schedule.

The generally loose to compact sandy soils and firm to stiff clayey soils are classified as "Type 3" soils and the very stiff to hard/dense to very dense native till soils are classified as a "Type 2" soils under the OH&S Act provided the groundwater level is adequately controlled/lowered to below the base of the excavation. As such, all conventional temporary trench excavations should consist of open cuts with side slopes not steeper than 1 horizontal to 1 vertical in the overburden soils. Where engineered fill (based on silty clay material) is used or the native soil deposits exhibit signs of water seepage or soft to firm consistency, the soil is classified as a "Type 3", as such all conventional temporary trench excavations should consist of a gradient of 1 horizontal to 1 vertical.

Where the side slopes of excavations are required to be steepened to limit the extent of the excavation, then some form of trench support may be required. Some trench excavations could be carried out using a vertically-excavated, unsupported excavation (using a properly-engineered trench liner box for protection, certified by an experienced engineer); or by a supported (sheeted) excavation if conditions warrant so; such as in wet areas and/or in close proximity to adjacent underground services.

5.2.2 Pipe Bedding and Cover

The bedding for the sewers and watermains should be compatible with the size, type and class of pipe and the surrounding subsoil and the requirements of Norfolk County. If granular bedding is deemed to be acceptable, then Ontario Provincial Standard Specifications (OPSS) Granular A should be used from at least 150 mm below invert of the pipe to the springline. From springline to 300 mm above the obvert of the pipe, sand cover could be used. All bedding and cover material should be placed in 150 mm loose lifts and uniformly compacted to at least 95 per cent of SPMDD. Where variable fill materials, softened or disturbed native soils or other deleterious materials are encountered at the base of excavations for settlement-sensitive services, these materials should be subexcavated and replaced with compacted fills approved by the geotechnical engineer.

Should groundwater seepage be of sufficient volume that the bedding material cannot be adequately compacted, it will be necessary to use 19-millimetre clear stone with a non-woven geotextile surround. A complete non-woven geotextile surround is considered critical with the crushed stone bedding to prevent migration of fines into the bedding, which could subsequently result in loss of ground and loss of support of the pipe. The crushed stone bedding would also facilitate pumping from sumps as a supplemental groundwater control measure.

5.2.3 Trench Backfill

The excavated materials from the site will consist predominantly of either silty sand or sandy silt. Based on the measured water contents, in general, the native materials encountered at the site are estimated to be at or slightly above their optimum water contents for compaction, and therefore, may require minor drying prior to placement.

Care should be taken to maintain the water content of the soils close to/at the optimum water content for compaction during the construction operations. Soils that contain significant quantities of organics or construction debris are also not suitable for use as trench backfill within settlement-sensitive areas. In addition, all boulders and cobbles greater than 150 mm in size should be removed from the trench backfill materials. If there is a shortage of suitable in situ material, an approved imported material such as Ontario Provincial Standard Specifications Select Subgrade Material should be used for trench backfill. Again, as noted above, the trench

backfill materials are silty/clayey in nature and are very susceptible to wetting/freezing temperatures. Backfilling trenches during cold or wet weather is not recommended.

Trench backfill should be placed in maximum 300 mm loose lift thicknesses and uniformly compacted to at least 98 per cent of the SPMDD of the material. Soil that is frozen should not be used as backfill.

Normal post-construction settlement of the compacted trench backfill should be anticipated with the majority of such settlement taking place within about 6 to 12 months following the completion of trench backfilling operations. If the trench backfill operations are completed during the winter months, post-construction settlements may increase beyond typical anticipated values. These settlements will be reflected at the ground surface. If the asphalt binder course is laid shortly following the completion of the trench backfilling operations, any settlement that may be reflected by subsidence of the surface of the binder asphalt should be compensated for by placing an additional thickness of binder asphalt or by padding. If possible, the surface course asphalt should not be placed over the binder course asphalt for about 12 months. Where scheduling requires that the surface course be placed over the binder course asphalt before this period, trench backfill settlement would be reflected by subsidence and possible cracking of the finished pavement surface in these areas which, depending upon the extent and magnitude, may require local repairs.

5.3 Building Foundations

As previously indicated, the existing site vegetation, surficial topsoil/organics and other near-surface soils containing significant amounts of organic matter are not considered to be suitable for the subgrade support of engineered fill, building foundations, floor slabs, or other settlement sensitive structures. These materials should be completely stripped prior to placing any engineered fill or construction of foundations or interior or exterior slab-on-grades.

Based on the subsurface conditions encountered in the boreholes, strip and spread footings may be used, provided that the footings are founded on the native deposits or on engineered fill (based on existing site soils) placed in accordance with the recommendations outlined in Section 5.1.2, and maintained a minimum depth of soil embedment below finished adjacent ground surface and top of slab of 1.2 m.

For such strip footings founded on native silty sand to sandy silt or engineered fill, a factored geotechnical resistance at Ultimate Limit States (ULS) of 200 kPa and a geotechnical reaction at Serviceability Limit States (SLS) of 75 kPa may be assumed for design purposes, provided that the strip footings dimensions are between about 0.6 m and 1.0 m in width. For spread footings founded on native silty sand to sandy silt a factored geotechnical resistance at ULS of 200 kPa and a geotechnical reaction at SLS of 100 kPa may be assumed for design purposes, provided that the spread footings have a minimum width of 1.0 m and a maximum width of 2.0 m. For spread footings founded on properly placed and compacted engineered fill a factored geotechnical resistance at ULS of 250 kPa and a geotechnical reaction at SLS of 150 kPa may be assumed for design purposes, provided that the spread footings have a minimum width of 1.0 m and a maximum width of 2.0 m.

In general, for any houses placed wholly or in part on engineered fill, it is recommended that the foundations be provided with nominal reinforcement, consisting of reinforcing steel at the top and bottom of the foundation walls. However, once the final thicknesses and extent of engineered fill are known, the need for and design of any reinforcement can be determined on a lot-by-lot basis by the builder's structural engineer, in consultation with WSP.

The near surface (less than about 2.0 m below ground surface) soft clayey silt and very loose to loose silty sand deposits have variable SPT 'N' values. Based on the boreholes, the northeast corner of site and the centre of site have slightly lower SPT 'N' values. In general, the competency of these materials are not considered to be suitable for support of building foundations, floor slabs, or other settlement sensitive structures. In any areas where the design calls for founding of structural elements at an elevation, the surficial loose or soft material should be reviewed by a geotechnical engineer through a proof-rolling operation and if required, removed and replaced with engineered fill. As an alternative, these near surface soils could be further evaluated through an additional investigation.

All exterior footings, and interior footings in unheated areas, should be founded at a minimum depth of 1.2 m below finished grade level in order to provide adequate protection against frost penetration.

Where spread footings are constructed at different elevations, the difference in elevation between the individual footings should not be greater than one half the clear distance between the footings. In addition, the lower footings should be constructed first so that if it is necessary to construct the lower footings at a greater depth than anticipated, the elevation of the upper footings can be adjusted accordingly. Stepped strip footings should be constructed in accordance with the latest version of the Ontario Building Code, Section 9.15.3.8.

The perimeter house basement walls should be backfilled with a free draining, non-frost susceptible granular material carefully placed and compacted in lifts and should be designed using a lateral earth pressure coefficient of 0.5 and a unit weight of backfill of 21 kN/m^3. Alternatively, where site excavated material is to be reused for backfill, an approved geocomposite drainage system should be used directly against the wall. The upper 0.3 m of backfill should be clayey material to provide a relatively impermeable cap and should be sloped away from the house.

Relatively shallow groundwater levels (i.e., less than about 1 m) were measured in several boreholes in the southern portion of the site (BH21-7, BH21-8, BH21-9, BH21-10 and BH21-11). This area of the site is generally at a lower existing ground surface elevation; however, the site grading plan indicates that this area will be raised by between about 1.5 and 3 m to achieve design grades. The design basement elevations should be compared to the seasonal high groundwater levels to assess the need for waterproofing or drainage systems.

The native soils are susceptible to disturbance from construction activity, especially during wet or freezing weather. Care should be taken to preserve the integrity of the materials as bearing strata. It is essential that the founding surface for the footings be inspected by qualified geotechnical personnel prior to placing concrete. If the concrete for the footings cannot be placed immediately after excavation and inspection of the subgrade, it is recommended that a working mat of lean concrete be placed in the excavation to protect the integrity of the bearing stratum.

Resistance to lateral forces/sliding resistance between the concrete footings and the subgrade should be calculated in accordance with Section 6.7.5 of the CHBDC. The unfactored coefficient of friction, tan δ, for the interface between the cast-in-place concrete footing and the properly prepared subgrade can be assumed to be 0.35.

5.3.1 Other Considerations

Due to the variability of the soils that exist at the site, properly filtered perimeter drains at foundation level leading to a permanent outlet such as a pumped sump and/or a direct outlet to a sewer line, should be provided. The groundwater table at the site is typically located at depths of less than 0.5 m below existing ground surface and

about 2.0 to 2.5 m below the design final grades. The subsurface soils consist primarily of cohesive and cohesionless materials of variable permeability, and are expected to promote infiltration; therefore, the perimeter drainage system for the residential structures are expected to collect water on a continuous basis. In this regard, it is recommended that the perimeter drainage system in accordance with Section 9.14 of the Ontario Building Code be permanently connected to a sewer line outlet and not to sump pumps located inside the structures.

Water vapour may collect within the fill materials beneath the floor slabs as a result of capillary action. In this regard, a robust vapour barrier should be provided beneath the floor slabs unless migration of water vapour through floor slabs can be tolerated.

5.4 Seismic Site Classification

Seismic hazard is defined in the 2012 Ontario Building Code (OBC) by uniform hazard spectra (UHS) at spectral coordinates of 0.2 second, 0.5 second, 1.0 second, 2.0 seconds, 5.0 seconds and 10.0 seconds and a probability of exceedance of 2% in 50 years. The OBC method uses a site classification system defined by the average soil/bedrock properties (e.g., shear wave velocity, Standard Penetration Test (SPT) resistance, undrained soil shear strength, etc.) in the 30 m below the foundation level. There are six site classes from A to F, decreasing in ground stiffness from A, hard rock, to E, soft soil; with site class F used to denote problematic soils (e.g., sites underlain by thick peat deposits and/or liquefiable soils). The site class is then used to obtain acceleration and velocity-based site coefficients F_a and F_v; respectively, used to modify the UHS to account for the effects of site-specific soil conditions in design.

Based on the results of the preliminary geotechnical investigation and assuming soils below the maximum depth investigated exhibit similar properties / strengths, a Site Class C is estimated for planning purposes. The Site Class will need to be verified and adjusted as necessary once the final footing elevations have been determined during detail design.

5.5 Storm Water Management (SWM) Pond Excavations and Recommendations

A SWM pond is proposed in the vicinity of BH21-10 and BH21-13. As only preliminary pond designs have been prepared to date, the following comments and recommendations are general in nature. They should be considered preliminary and are provided to assist in the preliminary design of the pond. Once the pond design is more advanced, the recommendations should be revised and updated as appropriate along with additional investigatory field work carried out as needed.

The subsurface soil conditions encountered in these boreholes consist of interlayered deposits of silty sand, sandy silt, and clayey silt to silty clay. Monitoring wells were not installed in BH21-10 and BH21-13. The groundwater level measured in the bi-level monitoring wells installed in BH21-11 (approximately 50 m north of the SWM pond location) was at depths between about 0.2 m and 0.5 m below ground surface (Elevation 228.3 m to 228.5 m) in the deep well, and 0.5 m and 0.9 m below ground surface (Elevation 228.2 m to 227.9 m) in the shallow well.

- Due to the fluctuating groundwater elevations in this area of the site and the nature of the site soils, it is anticipated that a pond liner may be required. However, additional analysis (and possibly additional shallow investigation within the pond footprint) can be carried out once the base elevation and pond operating level are known to confirm the requirement for a liner. Further, a pond liner and appropriate ballast material will likely be required to maintain the stability of the pond base and liner during dewatering;

- Given the generally cohesionless nature of the soils encountered below the groundwater table at the proposed pond location, dewatering will be required for pond construction below the groundwater table. It is anticipated that active dewatering in the form of well points and/or eductors will be required to adequately lower the groundwater table for construction of the pond in the dry;
- Any constructed berms around the pond should have a top width of at least 3 m to allow access by maintenance vehicles. The material used to construct the berms should be approved by the geotechnical engineer prior to placement. In this regard, the silt materials excavated to construct the ponds would be suitable for reuse provided they are at suitable moisture content. The natural water content of the clayey silt and silty clay is above the estimated optimum water content for compaction. The approved material used to construct berms should be placed in maximum 300 mm loose lifts and uniformly compacted to at least 98 per cent of SPMDD. Strict control over placement water content of the material will be necessary. In this regard some drying of the excavated soils will likely be required. Care should be taken to ensure homogeneity of the constructed berm (i.e., no erodible layers). Higher conductivity soils (i.e., sandy soils) should be removed from the footprint of the berm. The prepared foundation for the berm should be inspected by the geotechnical engineer prior to placement of berm fill material;
- Pond side slopes are proposed to be constructed above and below the permanent water level in the pond at about 5 horizontal to 1 vertical (5H:1V). Slope stability analysis of the proposed slope geometry has been carried out and indicate that the Factor of Safety against global instability is greater than 1.5 for the long term and 1.3 for short term conditions. These Factors of Safety are considered to be adequate for the proposed pond geometry;
- The pond base soils are susceptible to disturbance by heavy construction equipment which could affect trafficability during construction, especially during wet weather or where seepage is encountered;
- Cut side slopes of the ponds should be inspected by the geotechnical engineer during construction. Where erodible seams (e.g., sand or silt seams) are encountered, some form of blanketing, flattening of the slope angles or the like may be required. The need for and the design of any blanketing or other remedial measures should be determined during construction by the geotechnical engineer;
- The ponds should be equipped with an emergency spillway or similar structure(s) designed to eliminate the possibility of over-topping of the berms;
- Where pipes enter or exit the pond, they should be provided with a concrete collar and be backfilled with a relatively impermeable material (e.g., clayey silt or silty clay) to minimize preferential flow through the pipe bedding and backfill and possible loss of ground. Pipes entering or exiting the pond should be sized and designed to allow for cleaning. The exposed end of the riser portion should be provided with a protective wire mesh or the like to prevent unauthorized access (e.g., by children); and
- Regular inspection by the geotechnical engineer should be carried out during the pond construction. The final pond side slopes should be sodded or otherwise treated to reduce erosion. Maintenance will be required over the first several years until the vegetative mat has taken root.

Further comments on the design and construction of the ponds, including the requirements for a pond liner to be constructed, will be provided once the design details are finalized. Additional boreholes and / or test pits may be required in order to finalize the design of the ponds and provide sufficient geotechnical engineering recommendations for the design and construction of the proposed ponds.

6.0 OBSTRUCTIONS

The soils at this site are glacially derived and as such should be expected to contain cobbles and boulders, which could affect excavation for basements and services. The contractor should be made aware of the potential presence of cobbles and/or boulders within the overburden soils. As noted previously in this report, the presence of cobbles and boulders has been inferred from observations during borehole drilling. The borehole drilling method, without coring of boulders and the random distribution of boulders, does not permit measurement of the size of the cobbles and boulders nor an estimate to be made of the quantity (overall volume) of these materials. Should this information be required during the design and tender processes, further investigation would be required to determine the percentage and dimensions of the cobbles and boulders.

7.0 INSPECTION AND TESTING

During construction, full-time observation should be carried out during engineered fill and site servicing backfill placement, and sufficient foundation inspections, subgrade inspections and in-situ materials testing should be carried out to confirm that the conditions exposed are consistent with those encountered in the boreholes and to monitor conformance to the pertinent project specifications.

8.0 CLOSURE

We trust that this preliminary report provides enough preliminary geotechnical engineering information to proceed with the detailed design of the proposed development. If you have any questions regarding the contents of this report or require additional information, please do not hesitate to contact this office.

Signature Page

WSP Canada Inc.

Chad Davis
Team Lead, Ground Engineering

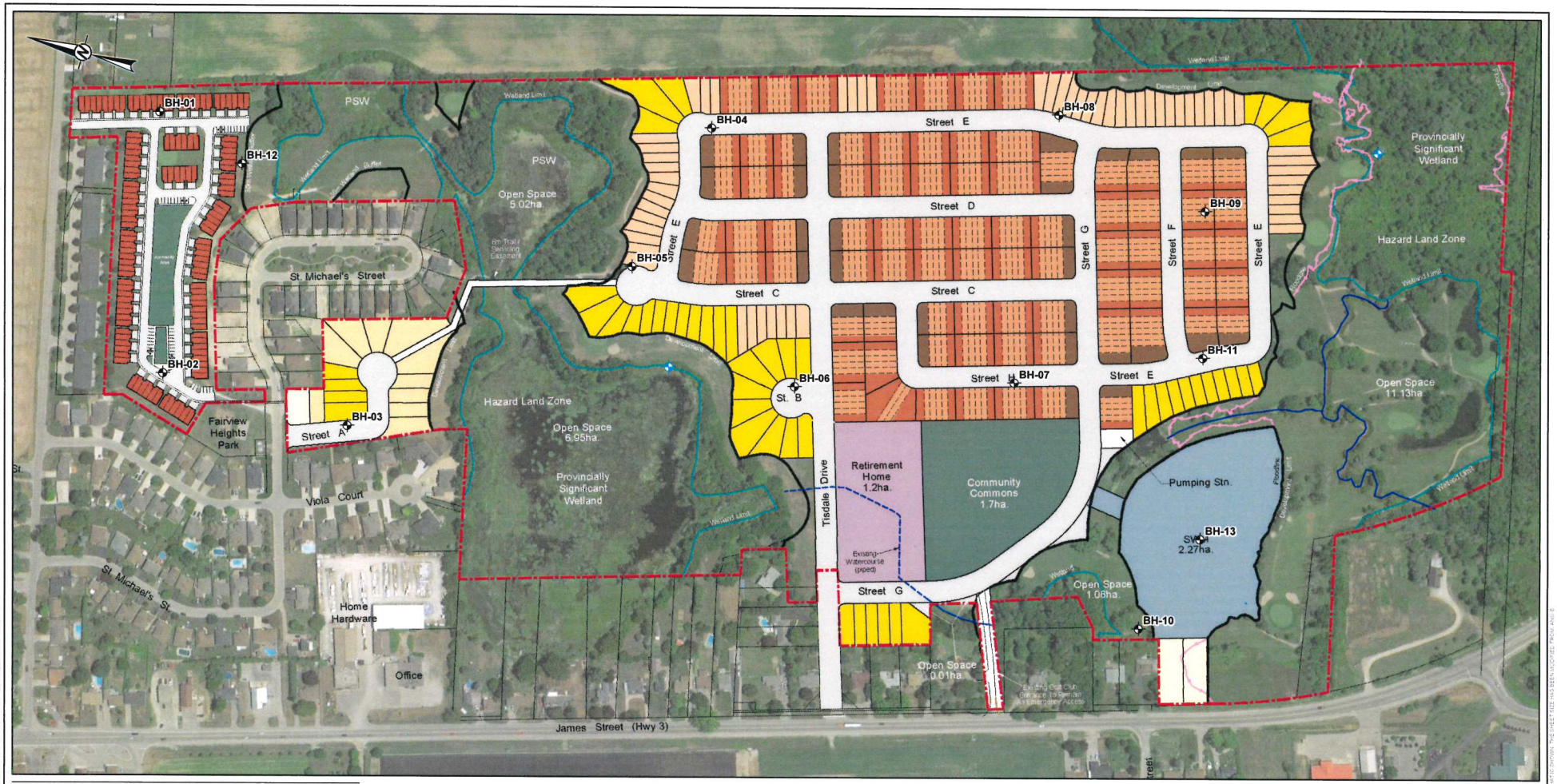
Dan Babcock, P.Eng.
Lead Geotechnical Engineer, Team Lead

MK/JET/DB/CD/sm/ll

https://golderassociates.sharepoint.com/sites/152973/project files/6 deliverables/reports/prelim geotech/final/rev3/21494891(1000)-r-rev3-preliminary geotechnical report - delhi golf club 13mar2023.docx

FIGURES

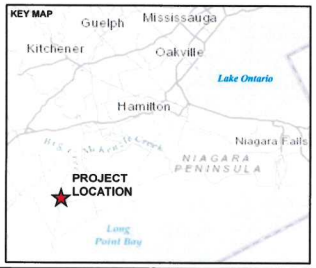
Figure 1 - Borehole Location Plan



LEGEND

- BOREHOLE LOCATION
- MONITORING WELL LOCATION

KEY MAP



DRAFT

0 100 200

1:3,500 METRES

NOTE(S)

REFERENCE(S)
1. SITE PLAN PROVIDED BY THE CLIENT MARCH 2023
2. PROJECTION:TRANSVERSE MERCATOR NAD1983 UTM ZONE 17

CLIENT: GERANIUM

PROJECT: DELHI GOLF CLUB

CONSULTANT: wsp

YYYY-MM-DD	2023-03-09
DESIGNED	SO
PREPARED	SO
REVIEWED	
APPROVED	

TITLE: **BOREHOLE LOCATION PLAN**

PROJECT NO.	CONTROL	REV.	FIGURE
21494891	0001	A	1

APPENDIX A

Important Information and Limitations of This Report

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

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

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

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

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

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

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

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

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

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

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

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

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

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

APPENDIX B

Method of Soil Classification
Abbreviations and Terms Used On Record of Boreholes
List of Symbols
Record of Boreholes BH 21-2 to 21-13

METHOD OF SOIL CLASSIFICATION

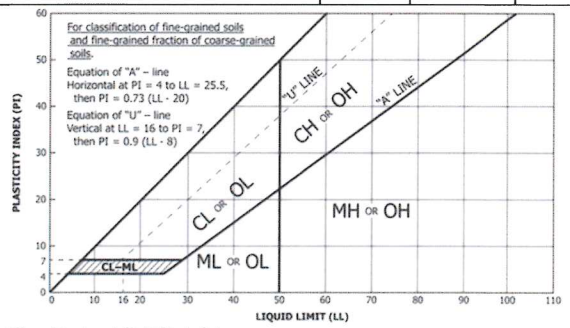
The WSP Canada Soil Classification[1] System is based on the Unified Soil Classification System (USCS) (after ASTM D2487)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content [6,9]	USCS Group Symbol [3,5,7]	Primary Group Name [2]
INORGANIC (Organic Content <30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Clean Gravels with <5% fines [3] (by mass)	Well Graded	≥4 (and)	≥1 to ≤3	≤30%	GW	Well-graded GRAVEL [4,6]
				Poorly Graded	<4 (and/or)	<1 or >3		GP	Poorly graded GRAVEL [4,6]
			Gravels with >12% fines [3] (by mass)	Below A Line	n/a			GM	SILTY GRAVEL [4,6]
				Above A Line	n/a			GC	CLAYEY GRAVEL [4,5,6]
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Clean Sands with <5% fines [7] (by mass)	Well Graded	≥6 (and)	≥1 to ≤3		SW	Well-graded SAND [6,8]
				Poorly Graded	<6 (and/or)	<1 or >3		SP	Poorly graded SAND [6,8]
			Sands with >12% fines [7] (by mass)	Below A Line	n/a			SM	SILTY SAND [6,8]
				Above A Line	n/a			SC	CLAYEY SAND [5,6,8]

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators: Dilatancy	Dry Strength	Shine Test	Thread Diameter (mm)	Toughness (of 3 mm thread)	Organic Content [B,H]	USCS Group Symbol [A]	Primary Group Name [A]
INORGANIC (Organic Content <30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Nonplastic or PI and LL plot **below A-Line** on Plasticity Chart below) [C]	Liquid Limit <50 [D]	Rapid	None to Low	Dull to None	3 to >6	Low/can't roll 3 mm	<15%	ML	SILT [H]
				None to Slow	Low to Medium	Dull to Slight	3 to 6	Low	15% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50 [D]	None to V.Slow	Low to Medium	Slight	3 to 6	Low to Medium	<15%	MH	ELASTIC SILT [H]
				None	Medium to High	Dull to Slight	1 to 3	Low to Medium	15% to <30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot **above A-Line** on Plasticity Chart below) [A]	Liquid Limit <50 [D]	None to Medium Slow	Medium to High	Slight to Shiny	1 to 3	Medium	<15%	CL	LEAN CLAY [A,E,F,G,H]
				None to V.Slow	Medium to High	Slight to Shiny	1 to 3	Medium	15% to <30%	OL	ORGANIC CLAY [E,F,G]
			Liquid Limit ≥50 [D]	None	High to V.High	Shiny	<1	High	<15%	CH	FAT CLAY [E,F,G,H]
				None	High	Shiny	<1 to 1	High	15% to <30%	OH	ORGANIC CLAY [E,F,G]
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures	Relatively lightweight, possibly spongy. Some water may squeeze from sample. Some shrinkage may occur on air drying. Sand fraction may be visible. Low to high dilatancy. Thread weak near plastic limit. Low to medium dry strength.						30% to <75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat	Lightweight, spongy. Much water squeezes from sample. Shrinks considerably on air drying (i.e., very high water content). Plant structure identiable to altered.						75% to 100%		PEAT

Coarse-Grained Soil Note(s):

1. Based on the material passing the 75 mm sieve.
2. If field sample contains or drilling observations indicate cobbles or boulders or both, add, "with cobbles" or "with cobbles and boulders". Include notes on the depth(s) encountered, and sizes if possible.
3. Gravels with 5% to 12% fines require dual symbols:
   (GW-GM) Well-graded GRAVEL with silt,
   (GW-GC) Well-graded GRAVEL with clay,
   (GP-GM) Poorly graded GRAVEL with silt,
   (GP-GC) Poorly graded GRAVEL with clay.
4. If soil contains ≥15% sand, add "with sand" to Group Name.
5. If fines classify as CL-ML, use dual symbol (GC-GM) or (SC-SM) for Group Symbol.
6. If the soil has an organic content (OC) 15%≤OC<30% the prefix "Organic" should be added before the Group Name. If the soil has an organic content 3%≤OC<15% add "with organic fines" to Group Name. If the soil contains >0% to ≤3% organics, the descriptor "trace organics" may be added.
7. Sands with 5% to 12% fines require dual symbols:
   (SW-SM) Well-graded SAND with silt,
   (SW-SC) Well-graded SAND with clay,
   (SP-SM) Poorly graded SAND with silt,
   (SP-SC) Poorly graded SAND with clay.
8. If soil contains ≥15% gravel, add "with gravel" to Group Name.



Fine-Grained Soil Note(s):

- **A.** If Atterberg limits plot above the A-line but in the 'hatched' area on the plasticity chart, soil is a (CL-ML) SILTY CLAY.
- **B.** If the soil contains >0% to ≤3% organics, the descriptor "trace organics" may be added.
- **C.** If fine-grained materials are nonplastic (i.e., a plastic limit (PL) cannot be measured), soil is a (ML) SILT.
- **D.** If soil has a liquid limit (LL) >30% to <50%, the term 'medium plasticity' may be included in the description, but the Group Name/Symbol is not changed.
- **E.** If soil contains 15% to <30% +No.200, add "with sand" or "with gravel".
- **F.** If soil contains ≥30% +No.200 mainly sand, add "Sandy" to Group Name.
- **G.** If soil contains ≥30% +No.200 mainly gravel, add "Gravelly" to Group Name.
- **H.** If the soil has an organic content (OC) 3%≤OC<15% add "with organic fines" to Group Name.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

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

GRADATIONAL COMPONENT TERMS

% (by mass)	Term
≤ 5	Use "trace"
> 5 to ≤ 12	Use "few"
> 12 to <30	Use "little"
≥ 30 to <50	Use "some"
≥ 50	Use "mostly"

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

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

Dynamic Cone Penetration Resistance (DCPT); Nd:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven, pushed tube sampler, or geoprobe macro-core – note size
DS	Denison type sample
FS	Foil Sample
GS	Grab Sample
MC	Modified California Samples – note sample diameter and hammer weight
MS	Modified Shelby (for frozen soil)
RC	Rock core
SC	Soil core
SS	Split-spoon sampler (50 mm OD); larger sizes use MC
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

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

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

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

1. SPT 'N' in general accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
2. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

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

COHESIVE SOILS

Consistency

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

1. SPT 'N' in general accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

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

LIST OF SYMBOLS

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

I. GENERAL

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

PROJECT: 21494891

LOCATION: N 4743379.45; E 542372.04

RECORD OF BOREHOLE: 21-1

SHEET 1 OF 1

BORING DATE: December 15, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected (100 200 300 400) / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ ND = Not Detected (100 200 300 400)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		238.56							GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Auger	TOPSOIL (680 mm)		0.00	1	SS	2	ND			
				237.88							
		(CL) SILTY CLAY, some sand; brown-grey; cohesive, w>PL, firm		0.68	2A	SS	5	ND			
				237.65							
1		(ML) CLAYEY SILT, some sand; brown; cohesive, w<PL, very soft to firm		0.91	2B			ND			
								ND			
					3	SS	2	ND			
2											
				236.35							
		(ML) Sandy SILT, some clay, trace gravel; brown; non-cohesive, moist, compact to very dense		2.21	4	SS	24	ND			
3					5A	SS					
				235.21		SS	56	ND			
		(SM) SILTY SAND, some gravel, trace clay; brown; cohesive, moist, compact to very dense		3.35	5B			ND			
								ND			
4					6	SS	93	ND		MH	
5					7	SS	77	ND			
6											▽ December 15, 2021
					8	SS	17	ND			
				231.85							
7		END OF BOREHOLE		6.71							
		NOTE:									
		1. Groundwater measured at 6.10 m below ground surface upon completion of drilling.									
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: JD

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 1/31/23

PROJECT: 21494891

LOCATION: N 4742381.52; E 542147.79

RECORD OF BOREHOLE: 21-10

SHEET 1 OF 2

BORING DATE: December 21, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected; 100 200 300 400) / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected; 100 200 300 400)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		227.72						GR SA SI CL
0	Power Auger; 108 mm I.D. Hollow Stem Auger	TOPSOIL (200 mm)		0.00 / 227.52	1A			ND		
		(ML) CLAYEY SILT, some sand; brown; cohesive, w~PL, soft		0.20 / 227.04	1B	SS	3	ND		
1		(SM) SILTY SAND, trace clay and gravel, slight plasticity; brown; non-cohesive, moist to wet, compact		0.68	2A / 2B	SS	8			
2					3	SS	16			MH
3					4	SS	16			
					5	SS	28			Bentonite
4		(CL) SILTY CLAY to CLAYEY SILT, some sand, trace gravel; grey; cohesive, w>PL, firm to stiff		223.99 / 3.73	6	SS	8			
5					7	SS	9			MH
6					8	SS	11			
7										Sand
8					9	SS	13			Screen
9										
					10	SS	3			
		END OF BOREHOLE		217.97 / 9.75						
10		*CONTINUED NEXT PAGE*								

DEPTH SCALE

1 : 50

LOGGED: JD

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 1/31/23

PROJECT: 21494891

LOCATION: N 4742381.52; E 542147.79

RECORD OF BOREHOLE: 21-10

BORING DATE: December 21, 2021

DRILL RIG: D70

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected; 100 200 300 400) / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected; 100 200 300 400)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
10		*— CONTINUED FROM PREVIOUS PAGE —*									GR SA SI CL
		NOTE: 1. Water levels measured in monitoring well: Date Depth (m) Elev. (m) 21-Dec-21 5.2 222.5 22-Dec-21 -0.2 227.6 14-Jan-22 -0.2 227.6 02-May-22 -0.2 227.6									
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

LOGGED: JD

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 1/31/23

PROJECT: 21494891

LOCATION: N 4742390.79; E 542406.70

RECORD OF BOREHOLE: 21-11

SHEET 1 OF 2

BORING DATE: December 2, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		228.72					GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Auger	TOPSOIL (150 mm)		0.00	1A				Concrete
		(SP) SAND, some silt; brown; non-cohesive, wet, very loose		0.15	1B	SS	2		May 2, 2022
				228.04					
1		(ML) Sandy SILT; brown; non-cohesive, moist to wet, compact		0.68	2	SS	11		
					3	SS	16		
2				226.52					
		(ML) SILT; brown to grey; cohesive w>PL, stiff to firm		2.20	4	SS	10		
3					5	SS	5		
									Bentonite
4					6	SS	6	MH	
				224.22					
		(ML) Sandy SILT to CLAYEY SILT; grey; cohesive, w>PL, firm		4.50	7	SS	5		
5									
6					8	SS	5		
7				221.56					
		(SP) SAND, some clay and gravel; brown; non-cohesive, wet, very loose		7.16	9A			MH	Sand
8				220.72		SS	2		
		(ML) Sandy SILT; grey; cohesive, w>PL, firm		8.00	9B				Screen
				220.03					
9		(CL) SILTY CLAY; grey; cohesive, w>PL, firm		8.69	10	SS	5		
				218.97					
10		END OF BOREHOLE		9.75					
		CONTINUED NEXT PAGE							

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: 20 40 60 80 — nat V. + Q - ● — rem V. ⊕ U - ○

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10 20 30 40

GRAIN SIZE DISTRIBUTION (%)

DEPTH SCALE

1 : 50

LOGGED: MC

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ_GAL-MIS.GDT 1/31/23

PROJECT: 21494891

LOCATION: N 4742390.79; E 542406.70

RECORD OF BOREHOLE: 21-11

SHEET 2 OF 2

BORING DATE: December 2, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (20 40 60 80) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
10		*— CONTINUED FROM PREVIOUS PAGE —*									
		NOTE: 1. Water levels measured in monitoring well: Date — Depth (m) — Elev. (m) 02-Dec-21 — 3.0 — 225.7 14-Dec-21 — 0.3 — 228.4 22-Dec-21 — 0.4 — 228.3 14-Jan-22 — 0.5 — 228.3 02-May-22 — 0.2 — 228.5									
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

LOGGED: MC

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 1/31/23

PROJECT: 21494891

LOCATION: N 4742389.29; E 542406.70

RECORD OF BOREHOLE: 21-11B

SHEET 1 OF 1

BORING DATE: December 2, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (20 40 60 80) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		0.00							GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Auger										Concrete
1											May 2, 2022
2											Bentonite
3											Sand
4											Screen
5		END OF BOREHOLE		4.42							
6		NOTE:									
7		1. Water levels measured in monitoring well:									
8		Date / Depth (m) / Elev. (m) 02-Dec-21 / 3.0 / 225.7 14-Dec-21 / 0.5 / 228.2 22-Dec-21 / 0.8 / 228.0 14-Jan-22 / 0.9 / 227.9 02-May-22 / 0.5 / 228.2									
9											
10											

DEPTH SCALE

1 : 50

LOGGED: MC

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 1/31/23

PROJECT: 21494891

LOCATION: N 4743293.71; E 542345.65

RECORD OF BOREHOLE: 21-12

SHEET 1 OF 1

BORING DATE: December 16, 2021

DATUM: Geodetic

DRILL RIG: GT8

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected; 100 200 300 400) / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected; 100 200 300 400)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		236.73						GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Augers	TOPSOIL (230 mm)		0.00 / 236.50	1A			ND		Concrete; Sand
		(SM) SILTY SAND, some clay; orange-brown; non-cohesive, moist to wet, very loose to loose		0.23	1B	SS	5	ND		
1					2	SS	0	ND		Bentonite
		(CL-ML) Sandy SILTY CLAY to CLAYEY SILT; brown; cohesive, w>PL, very soft		235.28 / 1.45	3		0	ND	W	
2		(SM) SILTY SAND, some clay; brown; non-cohesive, moist, compact		234.52 / 2.21	4	SS	18	ND		May 2, 2022
3		(ML) CLAYEY SILT and SAND; brown; cohesive, w<PL, hard		233.76 / 2.97	5	SS	45	ND	H	
		(SM) SILTY SAND; brown; non-cohesive, moist to wet, compact to dense		233.00 / 3.73	6	SS	35	ND		Sand
4					7	SS	18	ND		
5										Screen
		(ML) Sandy SILT, some clay; brown; cohesive, w>PL, very stiff		231.13 / 5.60	8	SS	16	ND		
6				230.02						
		END OD BOREHOLE		6.71						
7										
8										
9										
10										

NOTES:

1. Groundwater measured at 2.13 m below ground surface upon completion of drilling.

2. Water levels measured in monitoring well:

Date	Depth (m)	Elev. (m)
16-Dec-21	2.1	234.6
22-Dec-21	2.2	234.5
14-Jan-22	2.3	234.5
02-May-22	2.2	234.5

DEPTH SCALE

1 : 50

LOGGED: JD

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 1/31/23

PROJECT: 21494891

LOCATION: N 4742348.68; E 542243.38

RECORD OF BOREHOLE: 21-13

SHEET 1 OF 1

BORING DATE: December 3, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		229.34							GR SA SI CL
0		TOPSOIL (230 mm)		0.00	1A						
				229.11							
		(SM) SILTY SAND; brown; non-cohesive, moist, loose		0.23	1B	SS	3				
				228.66							
1		(ML) Sandy CLAYEY SILT; brown; cohesive, w<PL to w>PL, soft to stiff		0.68	2	SS	4		W		
2					3	SS	14				
					4	SS	10				▽ December 3, 20221
3	Power Auger 108 mm I.D. Hollow Stem Auger			226.37							
		(SM) SILTY SAND; brown; non-cohesive, wet, loose		2.97	5	SS	5		W		
				225.61							
4		(CL) Sandy SILT, some clay, trace gravel; grey; cohesive, w>PL, firm to stiff		3.73	6	SS	5				
5					7	SS	10				
6					8	SS	6		■○		
				222.63							
7		END OF BOREHOLE		6.71							
		NOTE:									
		1. Groundwater measured at 2.60 m. below ground surface upon completion of drilling.									
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: MC

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 1/31/23

PROJECT: 21494891

LOCATION: N 4743312.99; E 542139.04

RECORD OF BOREHOLE: 21-2

SHEET 1 OF 1

BORING DATE: December 16, 2021

DATUM: Geodetic

DRILL RIG: GT8

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected) / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected)	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		238.78							GR SA SI CL
0	Power Auger; 108 mm I.D. Hollow Stem Auger	TOPSOIL (200 mm)		0.00 / 238.58	1A			ND			Concrete; Sand
		(SM) SILTY SAND, contains cobbles; orange-brown; non-cohesive, moist, loose to dense		0.20	1B	SS	4	ND			
1					2	SS	27	ND			
2					3	SS	31	ND			
				236.34	4A	SS	42	ND			Bentonite
		(SM) SILTY SAND, some gravel, trace clay; brown (TILL); non-cohesive, moist, dense		2.44	4B			ND		MH	
3				235.81							
		(SM) SILTY SAND, some gravel; brown; non-cohesive, moist, very dense		2.97	5A	SS		ND			
				235.43		SS	63				
		(SM) SILTY SAND, some clay; brown; non-cohesive, moist, dense		3.35	5B			ND			
4					6	SS	36	ND			
				234.28							Sand
		(ML) Sandy CLAYEY SILT, contains cobbles; brown; cohesive, w<PL, stiff		4.50							May 2, 2022 ▽
5					7	SS	13	ND			
											Screen
6				232.58	8	SS	50				
		END OF BOREHOLE		6.20				ND			
7		NOTES: 1. Groundwater measured at 6.10 m below ground surface upon completion of drilling. 2. Auger refusal at 6.20 m. 3. Water levels measured in monitoring well:									
8		Date / Depth (m) / Elev. (m): 16-Dec-21 / 6.1 / 232.7; 22-Dec-21 / 4.8 / 233.9; 14-Jan-22 / 4.8 / 233.9; 02-May-22 / 4.7 / 234.0									
9											
10											

DEPTH SCALE

1 : 50

LOGGED: JD

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 1/31/23

PROJECT: 21494891

LOCATION: N 4743136.09; E 542136.97

RECORD OF BOREHOLE: 21-3

SHEET 1 OF 1

BORING DATE: December 15, 2021

DATUM: Geodetic

DRILL RIG: GT8

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected (100 200 300 400) / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ ND = Not Detected (100 200 300 400)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		237.31							GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Auger	TOPSOIL (250 mm)		0.00 / 237.06	1A	SS	3	ND			Concrete; Sand
		(SM) SILTY SAND; orange-brown; non-cohesive, moist, very loose		0.25 / 236.63	1B			ND			
1		(ML) CLAYEY SILT, some sand; brown; cohesive, w>PL, firm		0.68 / 236.24	2A	SS	5	ND			
		(SM) SILTY SAND; brown; non-cohesive, moist, loose		1.07 / 235.86	2B			ND			
2		(ML) Sandy SILT, some clay, slight plasticity; brown; non-cohesive, moist, loose to dense		1.45	3	SS	7	ND			Bentonite
					4	SS	26	ND		MH	
3					5	SS	29	ND			May 2, 2022
4					6	SS	45	ND			Sand
5					7	SS	35	ND			Screen
6					8	SS	52	ND		MH	
				230.60							
7		END OF BOREHOLE		6.71							
8		NOTES:									
9		1. Groundwater measured at 6.10 m below ground surface upon completion of drilling.									
10		2. Water levels measured in monitoring well:									

Date	Depth (m)	Elev. (m)
15-Dec-21	Dry	-
22-Dec-21	3.1	234.2
14-Jan-22	3.4	234.0
02-May-22	3.5	233.8

DEPTH SCALE

1 : 50

LOGGED: JD

CHECKED: MWK

S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 1/31/23

GTA-BHS 005

PROJECT: 21494891

LOCATION: N 4742884.02; E 542492.94

RECORD OF BOREHOLE: 21-4

SHEET 1 OF 1

BORING DATE: December 3, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		238.86							GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Auger	TOPSOIL (150 mm)		0.00	1A						
		(SP) CLAYEY SAND, trace organics; brown; cohesive, w~PL, soft		0.15	1B	SS	2				
				238.18							
1		(ML) CLAYEY SILT, some sand and gravel; brown; cohesive, w~PL, firm to stiff		0.68	2	SS	6				
2					3	SS	14		W		
				236.65							
		(SP/GP) SAND and GRAVEL, some clay, cobbles/boulders; brown; non-cohesive, moist, compact		2.21	4	SS	26				
				235.89							
3		(CI) SILTY CLAY, some sand and gravel; brown (TILL); cohesive, w<PL, very stiff to hard		2.97	5	SS	24		O		
4					6A						
				234.75		SS	41				
		(SM) SILTY SAND, trace gravel; brown; non-cohesive, moist, dense		4.11	6B						
				234.36							
		(ML) Sandy SILT, some clay and gravel; brown; cohesive, w<PL, very dense		4.50	7	SS	46		O		
5											▽ December 15, 2021
				233.26							
		(SP) SAND, some silt, trace gravel; brown; non-cohesive, moist, dense		5.60							
6					8	SS	38				
				232.15							
		END OD BOREHOLE		6.71							
7		NOTE:									
		1. Groundwater measured at 5.33 m below ground surface upon completion of drilling.									
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: JD

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 1/31/23

PROJECT: 21494891

LOCATION: N 4742921.12; E 542349.29

RECORD OF BOREHOLE: 21-5

SHEET 1 OF 1

BORING DATE: December 3, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		239.92					GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Auger	TOPSOIL (250 mm)		0.00	1A				
				239.67					
		(SP) SAND, trace organics; brown; non-cohesive, moist, very loose		0.25	1B	SS	3		
				239.24					
		(SP) SAND, some silt; brown to light brown; non-cohesive, moist, very loose		0.68	2	SS	2		
1									
					3	SS	2		
2									Bentonite
				237.71					
		(SP) SAND; brown; non-cohesive, moist, compact		2.21	4	SS	22		
3									
				236.72	5A				
		(ML) SILT, some sand; brown; non-cohesive, moist, very stiff		3.20	5B	SS	17		
		(SP) SILTY SAND to SAND, some silt, trace clay; brown; non-cohesive, moist to wet, compact		3.35					
4					6	SS	15	MH	Sand
5					7	SS	21		Screen
6									May 2, 2022
					8	SS	21		
				233.21					
7		END OF BOREHOLE		6.71					
		NOTE:							
		1. Water levels measured in monitoring well:							
8		Date Depth (m) Elev. (m) 03-Dec-21 5.8 234.1 14-Dec-21 Dry - 22-Dec-21 Dry - 14-Jan-22 Dry - 02-May-22 6.0 233.9							
9									
10									

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: 20 40 60 80 — nat V. + Q - ● — rem V. ⊕ U - ○

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10 20 30 40

GRAIN SIZE DISTRIBUTION (%)

DEPTH SCALE

1 : 50

LOGGED: MC

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI GOLF CLUB\02 DATA\GINT\DELHI GOLF CLUB GEO-TECH.GPJ GAL-MIS.GDT 1/31/23

PROJECT: 21494891

LOCATION: N 4742746.92; E 542281.29

RECORD OF BOREHOLE: 21-6

SHEET 1 OF 1

BORING DATE: December 15, 2021

DATUM: Geodetic

DRILL RIG: GT8

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected) 100 200 300 400 / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected) 100 200 300 400	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp W Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		238.55						GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Auger	TOPSOIL (200 mm)		0.00 238.35	1A			ND		
		(ML) Sandy CLAYEY SILT to CLAYEY SILT , some sand; brown; cohesive, w~PL to w>PL, soft to hard		0.20	1B	SS	3	ND		
1					2	SS	5			
					3A					
2					3B	SS	46			
		(ML) Sandy SILT, some clay and gravel; (TILL); non-cohesive, moist, dense to very dense		236.34 2.21	4	SS	31			
3					5	SS	50		MH	
		(ML) CLAYEY SILT, some sand and gravel; brown (TILL); cohesive, w<PL, hard		234.82 3.73	6	SS	36			
4				234.05						
		(SM) SILTY SAND, trace gravel; brown to grey; non-cohesive, moist, very dense		4.50	7	SS	83			
5										
6				232.38	8	SS	50			
		END OF BOREHOLE NOTE: 1. Auger refusal at 6.17 m on probable boulder.		6.17						
7										
8										
9										
10										

DEPTH SCALE

1 : 50

LOGGED: MC

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 1/31/23

PROJECT: 21494891

LOCATION: N 4742552.19; E 542338.33

RECORD OF BOREHOLE: 21-7

SHEET 1 OF 1

BORING DATE: December 1, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected (100 200 300 400) / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ ND = Not Detected (100 200 300 400)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		231.55							GR SA SI CL
0		TOPSOIL (200 mm)		0.00 231.35	1A			ND			Concrete
		(SM) SILTY SAND; brown; non-cohesive, moist, very loose to compact		0.20	1B	SS	2	ND			
1					2	SS	1				May 2, 2022
				229.95	3A						
		(SP) SAND, some gravel and silt to (SM) SILTY SAND; brown; non-cohesive, moist to wet, compact to dense		1.60	3B	SS	15				Bentonite
2		- CLAYEY SILT pockets			4A	SS	13				
					4B						
3	Power Auger 108 mm I.D. Hollow Stem Auger				5	SS	14				
4					6A	SS	13			MH	
					6B						Sand
					7A						
5					7B	SS	17				
											Screen
6					8	SS	30				
				224.84							
7		END OF BOREHOLE		6.71							
		NOTE:									
		1. Water levels measured in monitoring well:									
8		Date Depth (m) Elev. (m) 01-Dec-21 3.0 228.6 14-Dec-21 0.9 230.7 22-Dec-21 1.3 230.2 14-Jan-22 1.3 230.2 02-May-22 1.1 230.4									
9											
10											

DEPTH SCALE

1 : 50

LOGGED: MC

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 1/31/23

PROJECT: 21494891

LOCATION: N 4742578.17; E 542590.19

RECORD OF BOREHOLE: 21-8

SHEET 1 OF 1

BORING DATE: December 3, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		232.77					GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Auger	(ML) Sandy SILT and organics; brown; cohesive, w~PL, firm		0.00	1	SS	3		
				231.86	2A	SS	6		
1		(CL) SILTY CLAY, some sand; brown; cohesive, w~PL, firm		0.91	2B				May 2, 2022
				231.32					
		(ML) Sandy SILT, trace gravel; brown; non-cohesive, wet, compact		1.45	3	SS	10		
2				230.56					Bentonite
		(SP) SAND, trace silt and gravel; brown; non-cohesive, wet, compact to dense		2.21	4	SS	28		
3					5A	SS	25	MH	
				229.34	5B				
		(SP/GP) SAND and GRAVEL, some silt; brown; non-cohesive, wet, dense		3.43					
				229.04					
		(ML) SILT, some sand; grey; cohesive w>PL, very stiff		3.73	6	SS	22		
4				228.27					Sand
		(ML) CLAYEY SILT; grey; cohesive, w>PL, very stiff to stiff		4.50	7	SS	17		
5									Screen
6					8	SS	13		
				226.06					
		END OF BOREHOLE		6.71					
7		NOTE:							
		1. Water levels measured in monitoring well:							
8		Date / Depth (m) / Elev. (m) 03-Dec-21 / 2.3 / 230.4 14-Dec-21 / 0.6 / 232.2 22-Dec-21 / 0.7 / 232.1 14-Jan-22 / 0.6 / 232.2 02-May-22 / 0.8 / 232.0							
9									
10									

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: 20 40 60 80 — nat V. + Q - ● — rem V. ⊕ U - ○

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10 20 30 40

GRAIN SIZE DISTRIBUTION (%)

DEPTH SCALE

1 : 50

LOGGED: MC

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI GOLF CLUB\02 DATA\GINT\DELHI GOLF CLUB GEO-TECH.GPJ GAL-MIS.GDT 1/31/23

PROJECT: 21494891

LOCATION: N 4742424.81; E 542539.11

RECORD OF BOREHOLE: 21-9

SHEET 1 OF 1

BORING DATE: December 2, 2021

DATUM: Geodetic

DRILL RIG: D70

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		229.82					GR SA SI CL
0	Power Auger 108 mm I.D. Hollow Stem Auger	TOPSOIL (300 mm)		0.00 / 229.52	1A	SS	5		
		(SP) SILTY SAND; brown; non-cohesive, moist, loose		0.30 / 229.14	1B				
1		(SP) SAND, some silt; brown; non-cohesive, moist, loose		0.68 / 228.37	2	SS	9		May 2, 2022
		(ML) Sandy SILT; brown; non-cohesive, wet, compact		1.45 / 227.61	3	SS	18		Bentonite
2		(ML) SILT, some sand, trace gravel, trace clay; brown to grey; cohesive, w>PL, stiff to very stiff to firm		2.21	4	SS	14		
3					5	SS	15	MH	
4					6	SS	10		Sand
5					7	SS	10		Screen
6					8	SS	7		
				223.11					
7		END OF BOREHOLE		6.71					
8		NOTE:							
9		1. Water levels measured in monitoring well:							
10		Date / Depth (m) / Elev. (m) 02-Dec-21 / 4.6 / 225.2 14-Dec-21 / 1.1 / 228.7 22-Dec-21 / 1.2 / 228.7 14-Jan-22 / 1.1 / 228.7 02-May-22 / 1.0 / 228.8							

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ●; rem V. ⊕ U - ○; 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp W Wl; 10 20 30 40

GRAIN SIZE DISTRIBUTION (%)

DEPTH SCALE

1 : 50

LOGGED: MC

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\DELHI_GOLF_CLUB\02_DATA\GINT\DELHI_GOLF_CLUB_GEO-TECH.GPJ GAL-MIS.GDT 1/31/23

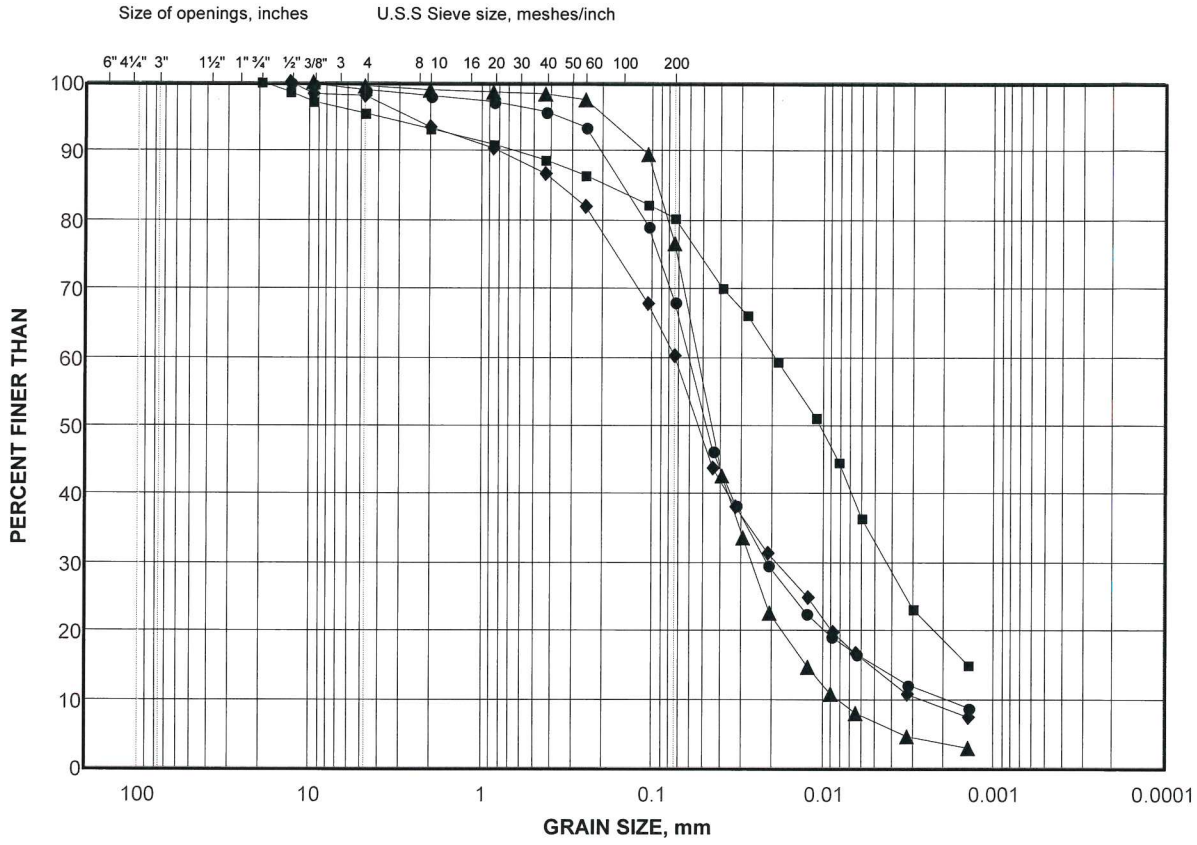
APPENDIX C

Laboratory Test Results

GRAIN SIZE DISTRIBUTION

(CL-ML) SILTY CLAY-CLAYEY SILT to (ML) SILT

FIGURE C1



LEGEND

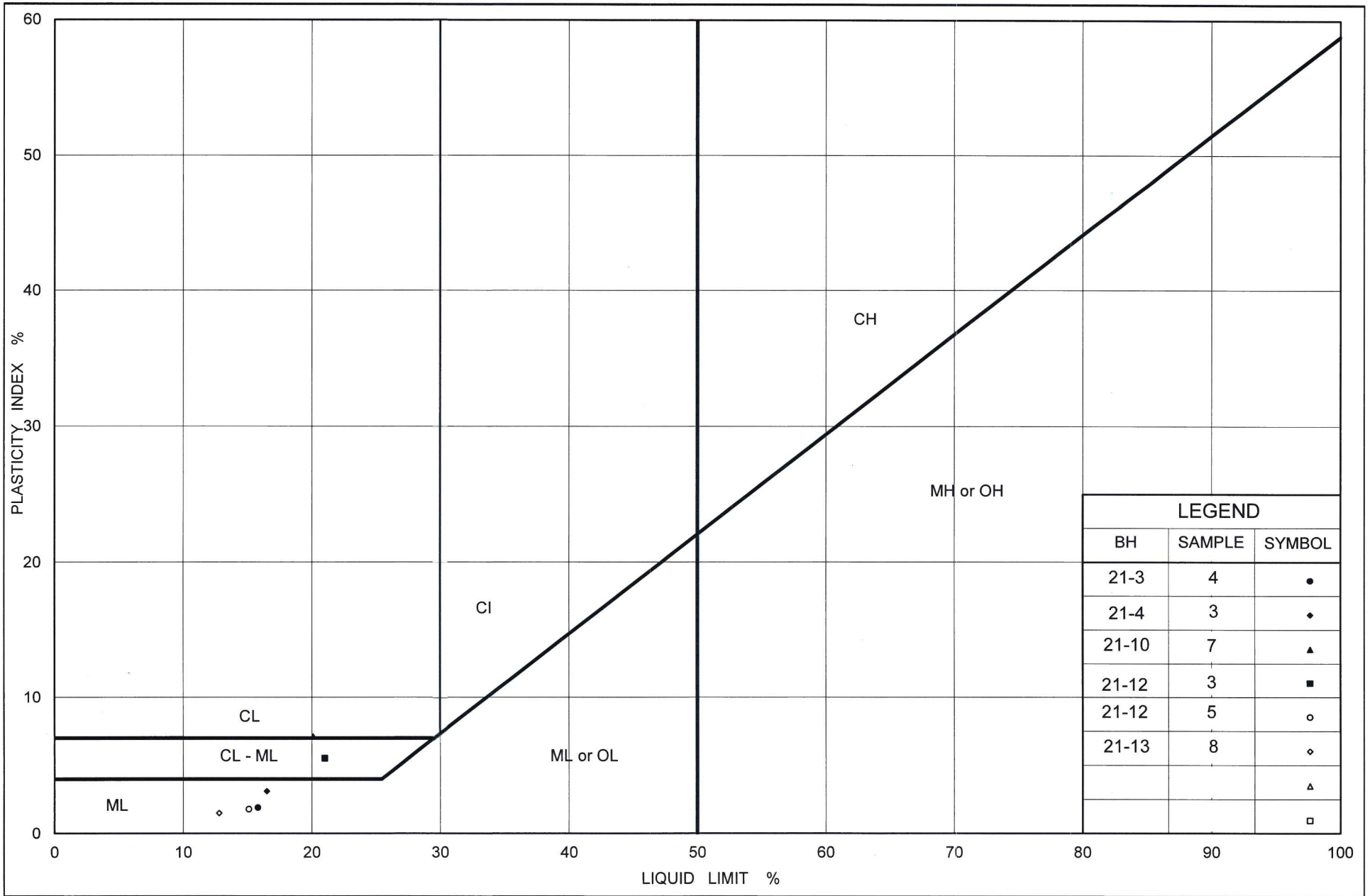
SYMBOL	Borehole	SAMPLE	DEPTH(m)
●	21-3	4	2.29 - 2.90
■	21-10	7	4.57 - 5.18
◆	21-13	8	6.10 - 6.71
▲	21-3	8	6.10 - 6.71

Project Number: 21494891 (1000)

Checked By:

WSP Canada Inc

Date: 29-Mar-22



PLASTICITY CHART

(ML) SILT to CLAYEY SILT to (CL-ML) SILTY CLAY-CLAYEY SILT

Figure No. C2

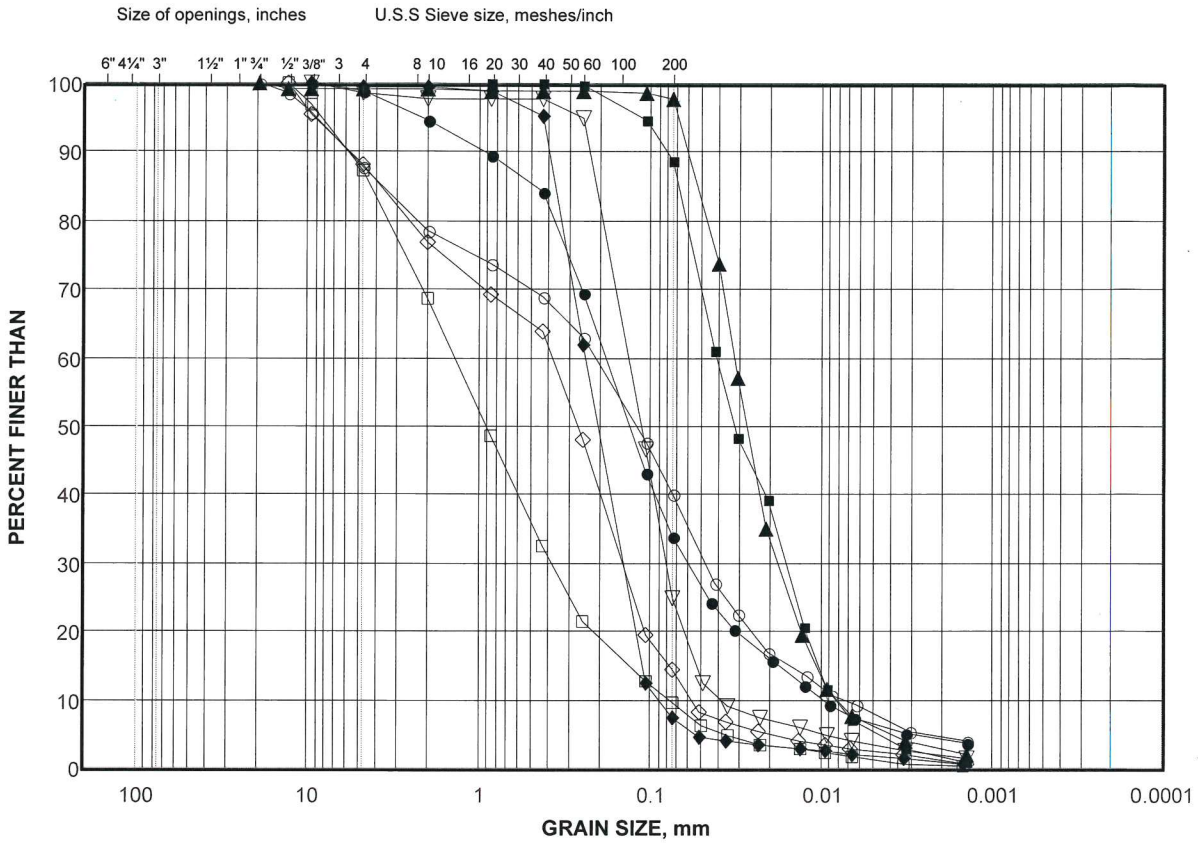
Project No. 21494891 (1000)

Checked By:

GRAIN SIZE DISTRIBUTION

(ML) SILT TO (SM) silty SAND to (SP) SAND

FIGURE C3



LEGEND

SYMBOL	Borehole	SAMPLE	DEPTH(m)
●	21-10	3	1.52 - 2.13
■	21-9	5	3.05 - 3.66
◆	21-8	5A	3.05 - 3.66
▲	21-11	6	3.81 - 4.42
▽	21-5	6	3.81 - 4.42
○	21-1	6	3.81 - 4.42
□	21-7	6A	3.81 - 4.42
△	21-11	9A	7.62 - 8.23

Project Number: 21494891

Checked By: _____

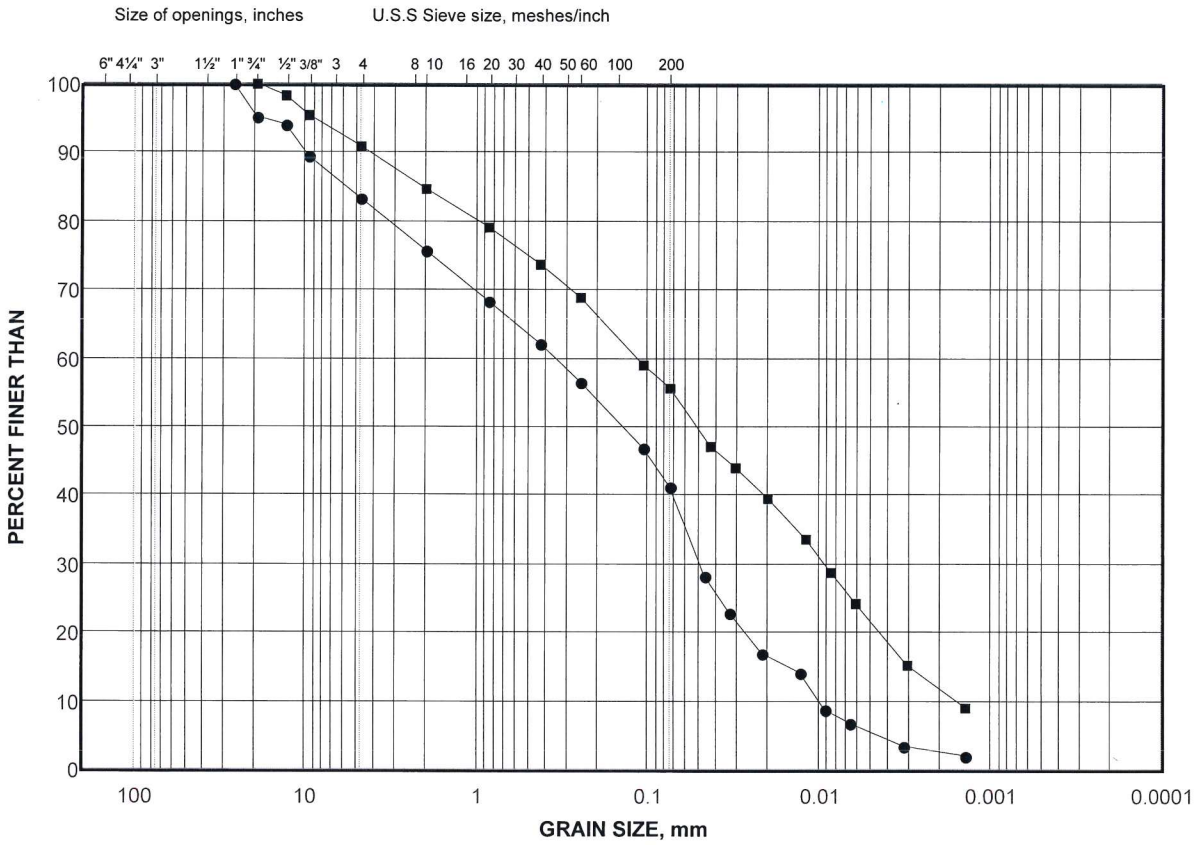
WSP Canada Inc

Date: 29-Mar-22

GRAIN SIZE DISTRIBUTION

(ML) Sandy SILT TILL

FIGURE C4



LEGEND

SYMBOL	Borehole	SAMPLE	DEPTH(m)
●	21-2	4B	2.29 - 2.90
■	21-6	5	3.05 - 3.66

Project Number: 21494891 (1000)

Checked By:

WSP Canada Inc

Date: 29-Mar-22

wsp.com

BEACON
ENVIRONMENTAL

GUIDING SOLUTIONS IN THE
NATURAL ENVIRONMENT

Environmental Impact Study
Delhi Golf and Country Club
Norfolk County

Prepared For:

Delhi Development Inc.

Prepared By:

Beacon Environmental Limited

Date: *Project:*

March 2023 **221361**

Table of Contents

page

1. Introduction 1
2. Methodology 1
   - 2.1 Background Review 1
   - 2.2 Scope of Work 3
   - 2.3 Field Investigations 3
3. Policy Framework 5
   - 3.1 Federal *Fisheries Act* (1985) 5
   - 3.2 Provincial Policy Statement (2020) 6
   - 3.3 *Endangered Species Act* (2007) 7
   - 3.4 Norfolk County Official Plan (2022) 8
   - 3.5 Long Point Region Conservation Authority Regulations (2006) and Policies (2017) 10
     - 3.5.1 Development, Interference with Wetlands and Alterations to Shorelines and Watercourses (Ontario Regulation 178/06) 10
     - 3.5.2 Policies for the Administration of the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation 10
4. Existing Conditions 11
   - 4.1 Aquatic Resources 11
     - 4.1.1 Fish Community Sampling 17
   - 4.2 Terrestrial Resources 18
     - 4.2.1 Vegetation Communities 18
     - 4.2.2 Flora 23
     - 4.2.3 Breeding Birds 25
     - 4.2.4 Amphibian Call Surveys 26
     - 4.2.5 Turtle Basking Surveys 27
     - 4.2.6 Other Wildlife 28
   - 4.3 Endangered or Threatened Species 29
   - 4.4 Hazard Limits 32
5. Significant Wildlife Habitat 32
6. Summary of Natural Features 35
7. Proposed Redevelopment 36
   - 7.1 Site Servicing 36
     - 7.1.1 Stormwater Management 37
       - *7.1.1.1 Quality and Quantity Control* 37
     - 7.1.2 Sanitary Servicing 38
     - 7.1.3 Water Servicing 38
   - 7.2 Grading 38
   - 7.3 Dewatering 38
   - 7.4 Floodplain Modification 39
   - 7.5 Naturalized Channel Design 39

8. Potential Impacts and Mitigation 39
8.1 Impact Assessment 39
8.2 Recommended Mitigation Measures 42
9. Policy Conformity 47
9.1 *Fisheries Act* 47
9.2 Provincial Policy Statement 48
9.3 County of Norfolk Official Plan 48
9.4 LPRCA Regulations and Policies 49
9.5 *Endangered Species Act* and *Species at Risk Act* 49
10. Summary 49
11. Cited References 51

Figures

Figure 1. Site Location ..... after page 2
Figure 2. Existing Conditions ..... after page 12
Figure 3. Natural Heritage Feature and Heritage Limits ..... after page 32

Tables

Table 1. Field Survey Dates 3
Table 2. Fish Community Sampling Results (August 16, 2022) 18
Table 3. List of Regionally Rare and Uncommon Species (2022) 24
Table 4. Breeding Amphibian Survey Results (2022) 26
Table 5. Turtle Basking Survey Results (2022) 27
Table 6. Endangered or Threatened Species 29
Table 7. Summary of Natural Heritage Features and Hazards (2022) 35

Appendices

Appendix A. LPRCA Correspondence – Terms of Reference
Appendix B. Norfolk County OP Mapping
Appendix C. Norfolk County OP Mapping
Appendix D. Vascular Plant List
Appendix E. Breeding Bird List

Report Versions Issued

Version	Date	Revisions
1.	February 2023	
2.	March 2022	Revised Development Plan

1. Introduction

Beacon Environmental Limited (Beacon) has been retained by Delhi Development Inc. to prepare an Environmental Impact Study (EIS) for the proposed redevelopment of the Delhi Golf and Country Club, located at 905 James Street and 76 Wilson Ave, Delhi, Norfolk County (hereafter referred to as the "subject property"; **Figure 1**). The proposed redevelopment is residential in nature and includes a retirement home and community commons. The subject property totals an area of approximately 55 ha (137 acres) and is currently operating as an active golf course facility at the time of report preparation.

Currently these lands are located outside of, but immediately adjacent to, the Delhi Urban Area boundary (Schedule A, Norfolk County Official Plan) and are designated as part of a Rural Area. These lands may be planned for urban uses following an Urban Area boundary expansion as part of a municipal comprehensive review following allocation from the County. The development applications that are required to facilitate the redevelopment of the subject property include an Official Plan Amendment (for an urban settlement area boundary expansion and redesignation of the lands), a Zoning By-law Amendment, and Draft Plan of Subdivision and Condominium applications. For the purposes of this assessment, we have assumed that the subject property will be included within the Urban Area boundary and the corresponding land designation will allow for urban development. This assumption, however, is subject to approval of the aforementioned development applications.

Much of the subject property is anthropogenic in nature in association with the golf course, however, several natural features are present and include a watercourse, woodlands, ponds, and Provincially Significant Wetlands (PSW). The wetlands and watercourse are both regulated by the Long Point Region Conservation Authority (LPRCA) under Ontario Regulation (O. Reg) 178/06. The relevant natural heritage policies in the former Township of Delhi (now, Norfolk County), as well as any applicable LPRCA regulations, have been identified and interpreted with respect to the subject property to ensure policy conformity.

The purpose of this report is to identify and determine the potential impact of the proposed redevelopment on the natural heritage system. This report provides a description of the physical and ecological characteristics of the subject property, their functions, significance and sensitivity.

2. Methodology

The study was completed through a review of background documents and seasonally appropriate field investigations conducted by Beacon ecologists throughout 2021 and 2022. The methodology applied for information reviewed and surveys undertaken to identify natural heritage features and assess ecological functions is summarized in the following subsections.

2.1 Background Review

Background documents and supporting technical documents containing information relevant to the biophysical features of the subject property were gathered and reviewed. This included the following sources:

- Provincial Policy Statement (PPS; 2020);
- Norfolk County Official Plan (2022);
- Ministry of Natural Resources and Forestry (MNRF) information;
- *Endangered Species Act* (ESA; 2007);
- Natural Heritage Information Centre (NHIC) Data via the Make-A-Map application;
- Databases of the Ontario Breeding Bird Atlas (OBBA) project;
- Ontario Reptile and Amphibian Atlas (ORAA);
- SAR range maps (https://www.ontario.ca/environment-and-energy/species-risk-ontario-list);
- High Resolution aerial photography of the property; and
- Natural and physical feature layers from Land Information Ontario (LIO).

Other sources of information, such as aerial photography and topographic maps, were consulted prior to commencing field assessments.

Supporting documents prepared by other specialists on the consulting team were reviewed and relevant findings have been incorporated in this EIS where appropriate.

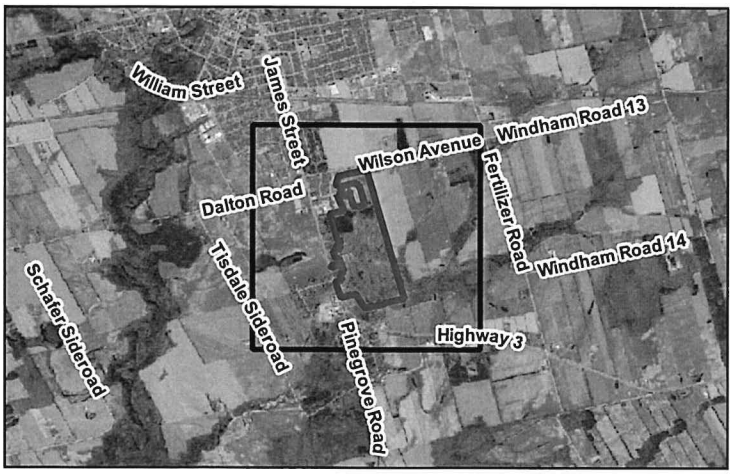
Desktop Species at Risk Assessment

In preparation for on-site investigations Beacon conducted a desktop Species at Risk assessment and the following information sources were reviewed as part of the desktop screening:

- Provincially Tracked Species Layer (1 km grid) from LIO;
- ORAA;
- OBBA;
- NHIC Data via the Make-A-Map application;
- Species at risk (SAR) range maps https://www.ontario.ca/environment-and-energy/species-risk-ontario-list;
- High Resolution aerial photography of the property; and
- Natural heritage and physical feature layers from LIO, including wetlands (provincially significant and un-evaluated wetlands), watercourses with thermal regime, as well as other geospatial layers.

The information sources referenced above were reviewed in a Geographic Information System (GIS) mapping environment that Beacon uses to assess the likelihood that species at risk and other significant natural heritage features and functions are present in an area of interest. This system allows Beacon to combine the most current information provided by MNRF through the LIO portal with GIS layers from provincial floral and faunal atlases. All relevant layers can then be overlaid on the most recent high resolution ortho-imagery. The screening process helps identify areas that can then be targeted (for example, potential habitat) during field assessment to maximize the efficiency and effectiveness of on-site investigations.

During field study, staff assessed the potential for protected species of flora and fauna to occur on the subject property based on habitat presence, quantity and quality.



Site Location	Figure 1
Delhi Golf and Country Club	
BEACON ENVIRONMENTAL	Project: 221361 Last Revised: December 2022
Client: Delhi Development Inc.	Prepared by: BD Checked by: CS
N 1:12,000	Inset Map: 1:70,000
Contains information licensed under the Open Government License–Ontario Orthoimagery Baselayer: 2010 (FBS)	

C:\ODB\OneDrive - Beacon Environmental\GeoSpatial\Geo Projects\2021\221361 Delhi G and CC\Q Project Files\2021-08-04 - Delhi G and CC - 221361.qgz

2.2 Scope of Work

The natural heritage scope of work was provided to LPRCA staff and was agreed to via e-mail on June 21, 2022 (**Appendix A**). The terms of reference were provided to Norfolk County staff on June 22, 2022 and then re-issued on October 12, 2022 due to staffing adjustments. A response had not been received at the time of report preparation.

2.3 Field Investigations

Beacon undertook a reconnaissance level field investigations in October and November 2021 in order to review the natural features present on the property and to scope the requirements for the EIS. Beacon staff subsequently developed a comprehensive field program and conducted in seasonal field investigations to gain an understanding of the natural features and functions of subject property. The methods for each survey are described below with dates provided in **Table 1**.

Table 1. Field Survey Dates

Task	Survey Date
Breeding Bird Surveys	June 10 and 27, 2022
Vegetation Communities and Flora Inventory	October 22, 2021 and July 27, 2022
Amphibian Call Surveys	April 12, May 29, June 14, 2022
Aquatic Habitat Assessment	November 10, 2021 and August 16, 2022
Fish Community Sampling	August 16, 2022
Turtle Basking Surveys	May 13, June 10, 15 and 27, 2022

Breeding Birds

Breeding birds were surveyed during the morning hours on days with low to moderate winds (0-3 Beaufort Scale), no precipitation, and temperatures within 5 ^{o}C of seasonal average. The breeding bird community was surveyed using a roving type survey, in which all parts of the study area were walked to within 50 m and all birds heard or observed and showing some inclination toward breeding were recorded as breeding species. All birds heard and seen were recorded in the location observed on an aerial photograph of the site.

Vegetation Communities and Flora

Detailed field investigations were undertaken to document the vegetation on the subject property. Vegetation communities were mapped and described according to the Ecological Land Classification (ELC) system for southern Ontario (Lee *et al.*, 1998), which involved delineating vegetation communities on an aerial photograph of the property and recording pertinent information concerning the structure and composition of the vegetation in each community. A list of plant species observed on the property was compiled concurrently.

Additionally, a search for Butternut (*Juglans cinerea*) trees was conducted during the vegetation community survey.

Amphibian Call Surveys

Three evening visits were made to the subject property to survey for breeding amphibians. Survey locations were placed in proximity to wetland habitat that may support breeding amphibians. The surveys were conducted as per the protocol outlined in the Great Lakes Marsh Monitoring Program. Surveys consisted of auditory surveys undertaken during the prime breeding period to record calling males that are present, spread throughout the breeding season in an attempt to include the short temporal peak for each species of interest. The surveys involved visiting the site after dusk when minimum night-time air temperatures of at least 5°C during the first visit, 10°C during the second visit and 17°C during the third visit. Calling amphibians, if present, were identified to species and chorus activity was assigned a code from the following options:

- No calls;
- Individuals of one species can be counted, calls not simultaneous;
- Some calls of one species simultaneous, numbers can be reliably estimated and shown in brackets; or
- Full chorus, calls continuous and overlapping.

Turtle Basking Surveys

Turtle surveys were conducted between mid-morning and mid-afternoon on sunny days with low wind and temperatures suitable for basking. Each waterbody was surveyed from a vantage point allowing viewing of potential basking sites depending on the current conditions; multiple viewing points were used for ponds too large to effectively survey from a single vantage point. Numbers of individuals of each turtle species at each location were recorded.

Aquatic Habitat Assessment and Fish Community Sampling

Aquatic habitat assessments on Stoney Creek, tributaries and existing ponds were undertaken, to identify and assess watercourse and pond characteristics that provide habitat, as outlined in the federal *Fisheries Act*. The habitat assessment details the characteristics and major physical attributes of the waterbodies. The habitat assessment considers a variety of details including both flow characteristics and land influences, such as the following:

- Surrounding land use – classifies potential pollution sources and adjacent land use that may affect the water body;
- Riparian zone and canopy cover – a healthy riparian zone consists of vegetation characterized by trees, shrubs, grasses and herbaceous plants. These plants help buffer the water body from runoff, provide shade and create habitat for fish and insects;
- Stream banks – characteristics assessed include signs of erosion and bank scouring, undercut banks, evidence of the normal water mark and high water mark which indicate the water level fluctuation;
- In-stream characteristics – details include substrate type (i.e. ,silt, gravel, cobble), aquatic vegetation, small and large woody debris. All of these in-stream characteristics provide habitat and cover for fish species and benthic macroinvertebrates, which are an important food source for fish;
- Stream morphology – this includes the wetted width of the active channel and average wetted depth as well as a description of the stream morphology:

  - Runs - typically deep, fast moving water with little to no turbulence;
  - Riffles – shallow, fast moving water typically running over rocks. Riffles provide areas of high oxygenated waters;
  - Flats – low flowing water with a smooth un-agitated surface; and
  - Pools – deep pockets of slow moving water that provide ideal refuge habitat for fish;
- General water characteristics – water colour and clarity, presence and description of algae, and description of flow; and
- Stream physical conditions - which were inspected and documented with photographs.

Sampling of the aquatic community with Stoney Creek and Delhi Golf Estates Municipal Drain was completed using a backpack electrofisher to determine presence or absence and species composition and abundance.

Incidental Wildlife

Wildlife observed outside of the targeted studies noted previously were recorded and may include reptiles, amphibians, mammals or invertebrates.

Tree Inventory

A tree inventory and preservation plan was completed by Beacon and has been submitted under a separate cover. Relevant findings have been included in this report, the Arborist Report (Beacon 2023) should be referenced for full details.

3. Policy Framework

This section contains a summary of key environmental policies and regulations that will need to be addressed by the proposed redevelopment. The following sections summarize key environmental legislation policies and regulations that will apply to the subject property within the context of the proposed redevelopment application should the lands be brought into the Delhi Urban Area Boundary.

3.1 Federal *Fisheries Act* (1985)

All fish habitat (direct and indirect) is protected under the Federal *Fisheries Act* (1985). In Ontario, the federal department of Fisheries and Oceans Canada (DFO) manages fish habitat and the Ontario Ministry of Natural Resources and Forestry (MNRF) manages fisheries.

Fish and fish habitat are protected under the federal *Fisheries Act,* which was last amended on August 28, 2019, and is administered by the Fish and Fish Habitat Protection Program within Fisheries and Oceans Canada (DFO). The protection provisions of the *Fisheries Act* apply to all fish and fish habitat throughout Canada and the Act sets out authorities for the regulation of works, undertakings or activities that risk harming fish and fish habitat. Specifically, the protection provisions include two core prohibitions. One is against persons carrying on works, undertakings or activities that result in the "death of fish by means other than fishing" (subsection 34.4[1]), and the other is "harmful alteration, disruption

or destruction of fish habitat" (subsection 35[1]; also referred to as "HADD"). The protection provisions are applied in conjunction with other applicable federal laws and regulations related to aquatic ecosystems, including the federal *Species at Risk Act* (SARA).

Fish habitat is defined in subsection 2(1) of the *Fisheries Act* to include all waters frequented by fish and any other areas upon which fish depend directly or indirectly to carry out their life processes. The types of areas that can directly or indirectly support life processes include, but are not limited to, spawning grounds and nursery, rearing, food supply and migration areas.

Proponents are responsible for planning and implementing works, undertakings or activities in a manner that avoids harmful impacts, specifically the death of fish and HADD. Where proponents believe that their work, undertaking or activity will result in harmful impacts to fish and fish habitat, DFO will work with proponents to assess the risk of their proposed work, undertaking or activity resulting in the death of fish or HADD of fish habitat and provide advice and guidance on how to comply with the *Fisheries Act*.

Development activities taking place in or near water may affect fisheries by adversely affecting fish or fish habitat. DFO recommends that proponents of these activities should:

- Understand the types of impacts their projects are likely to cause;
- Take measures to avoid and mitigate impacts to the extent possible; and
- Request authorization from the Minister and abide by the conditions of any such authorization, when it is not possible to avoid and mitigate impacts of projects that are likely to cause serious harm to fish.

Stoney Creek and the Delhi Golf Estates Municipal Drain traverse the subject property and support fish habitat. As such, the *Fisheries Act* (1985) is a key piece of legislation relevant to any development that has the potential for the death of fish and the harmful alteration, disruption or destruction of fish habitat.

3.2 Provincial Policy Statement (2020)

Natural Heritage Policy 2.1 of the PPS (MMAH 2020) provides direction to regional and local municipalities regarding planning policies for the protection and management of natural heritage features and resources for applications pursuant to the *Planning Act*. The PPS defines natural heritage features and provides planning policies for each. The key text from the PPS that applies to the study area is reproduced below. The study is situated in Ecoregion 7E.

2.1.4 Development and site alteration shall not be permitted in:
- *a) significant wetlands in Ecoregions 5E, 6E and 7E; and*
- *b) significant coastal wetlands.*

2.1.5 Development and site alteration shall not be permitted in:
- *a) significant wetlands in the Canadian Shield north of Ecoregions 5E, 6E and 7E;*
- *b) significant woodlands in Ecoregions 6E and 7E (excluding islands in Lake Huron and the St. Marys River);*
- *c) significant valleylands in Ecoregions 6E and 7E (excluding islands in Lake Huron and the St. Marys River);*
- *d) significant wildlife habitat;*

e) *significant areas of natural and scientific interest; and coastal wetlands in Ecoregions 5E, 6E and 7E that are not subject to policy 2.1.4(b)*

Unless it has been demonstrated that there will be no negative impacts on the natural features or their ecological functions.

2.1.6 Development and site alteration shall not be permitted in fish habitat except in accordance with provincial and federal requirements.

2.1.7 Development and site alteration shall not be permitted in habitat of endangered species and threatened species, except in accordance with provincial and federal requirements.

Of these features, PSWs and significant ANSIs are identified directly by the MNRF. Woodlands are identified using MNRF criteria, and other significant features may be identified using MNRF criteria or municipal criteria that meet the same standard. In Ontario, Fisheries and Oceans Canada (DFO) manages fish habitat and the MNRF manages fisheries. Habitat of endangered and threatened species is mainly governed by the provincial ESA (refer to **Section 2.6**).

Furthermore, development and site alteration shall not be permitted on "adjacent lands" to the natural heritage features/areas (i.e., within 120 m) addressed in policies 2.1.4, 2.1.5 and 2.1.6:

Unless the ecological function of the adjacent lands has been evaluated and it has been demonstrated [through an EIS] that there will be no negative impacts on the natural features or on their ecological functions.

Adjacent lands are defined in the PPS as:

Those lands contiguous to a specific natural heritage feature or area where it is likely that development or site alteration would have a negative impact on the feature or area.

3.3 *Endangered Species Act* (2007)

Ontario's ESA came into effect on June 30, 2008 and replaced the former 1971 Act. The ESA protects species listed as endangered and threatened by the Committee on the Status of Species at Risk in Ontario (COSSARO). Under the 2008 ESA over 200 species in Ontario are identified as extirpated, endangered, threatened, or of special concern.

The purpose of the ESA is:

- To identify species at risk based on the best available scientific information, including information obtained from community knowledge and aboriginal traditional knowledge;
- To protect species that are at risk and their habitats, and to promote the recovery of species that are at risk; and
- To promote stewardship activities to assist in the protection and recovery of species that is at risk.

Endangered or threatened species and their habitats receive protection under the regulations of the ESA. Specifically, Section 9 of the ESA prohibits the killing, harming, harassing, possession, collection,

buying and selling of extirpated, endangered, and threatened species on the Species at Risk in Ontario (SARO) List; and Section 10 prohibits the damage or destruction of protected habitat of species listed as extirpated, endangered or threatened on the SARO List, unless authorization in accordance with the requirements of the Act is provided by the Ministry of Environment, Conservation and Parks (MECP).

Authorization from MECP is required under the ESA for any works proposed within the habitat of a threatened or endangered species. Searches for these species require seasonal field work and, in some cases, even if the species are found to be present, certain exemptions or a permit process may be available.

3.4 Norfolk County Official Plan (2022)

The Norfolk Official Plan (OP) contains policies for the protection of natural features within a Natural Heritage System.

It is the policy of this Plan to conserve Natural Heritage Features and functions and protect such features and areas from incompatible development, wherever possible.

The Official Plan separates land-based environmental considerations into three categories:

- Provincially Significant Features, as described in Section 3.5.1 (Provincially Significant Features), and Section 7.4 (Provincially Significant Wetlands Designation);
- Natural Heritage Features, as described in Section 3.5.2 (Natural Heritage Features), and identified on Schedule "C" to this Plan; and
- Hazard Lands, as designated and described in Section 7.3 (Hazard Lands Designation) and designated on Schedule "B" to this Plan.

Delineation of the Natural Heritage is based on data provided the Natural Areas Inventory, Long Point Conservation Authority, the Grand River Conservation Authority and the Ministry of Natural Resources and Forestry. Feature limits can be confirmed through the completion of an EIS.

The following key natural heritage policies stated in Section 3.5.1 apply within Norfolk County:

1. *Development and site alteration shall not be permitted in a Provincially Significant Feature unless in accordance with provincial and federal requirements.*
2. *Development and site alteration shall not be permitted on lands adjacent to the natural heritage features and areas, unless the ecological function of the adjacent land has been evaluated and it has been demonstrated that there will be no negative impacts on the natural features or on their ecological functions that cannot be adequately mitigated. The extent of adjacent land shall be defined as indicated in Table 1 .*

Further, Section *3.5.2 b)* states that:

> *Development or site alteration proposed in, or adjacent to, a Natural Heritage Feature(s), whether illustrated on Schedule "C" or only described in Table 2, shall be subject to the completion of an Environmental Impact Study, in accordance with Section 9.7.1 (Environmental Impact Study) of this Plan. Development or site alteration in, or adjacent to, such features shall not be permitted unless it has been demonstrated that there will*

be no negative impacts on the natural features or on their ecological functions that cannot be adequately mitigated.

As it applies to the subject property, development and site alteration on adjacent lands which trigger the need for an EIS are defined as follows:

- PSWs – within 120 m;
- Locally Significant Wetlands – within 120 m;
- Woodlands- within 10 m;
- Significant Wildlife Habitat – within 50 m;
- Habitat of Threatened and Endangered Species – within 100 m;
- Fish Habitat- within 30 m of high water mark; and
- Watercourses- within 15 m of top of bank.

Development will only be permitted on adjacent lands if an EIS is prepared to demonstrate no negative impacts on the ecological or hydrological functions of the feature.

Development shall not be permitted in areas of habitat of endangered species and/or threatened species, except in accordance with applicable provincial and federal requirements.

The subject property has various land use designations under the Norfolk County OP (Schedule B-17, **Appendix B**). Two large shallow ponds and associated marsh and swamp areas in the north central portion of the subject property, as well as the swamp areas associated with Stoney Creek along the southern edge of the subject property have been designated as PSW (Schedule B-17). These areas and adjacent lands form part of the County's Natural Heritage System because of the PSW designation (Schedule C-4, **Appendix C**). The County's OP states that development and site alteration shall not be permitted within Provincially Significant features. No development or site alteration is permitted on lands adjacent (within 120 m) to the natural heritage features and areas, unless the ecological function of the adjacent lands has been evaluated and it has been demonstrated that there will no negative impacts on the natural heritage feature or on the ecological functions that cannot be adequately mitigated, as discussed in Section 3.5.1 in the Norfolk OP (2022).

Lands adjacent to the PSWs have been identified as Hazard Lands due to their tendency for flood conditions (Schedule B-17). No development or site alteration is permitted within Hazard Lands, as outlined in Sections 7.3 and 7.4 in the Norfolk OP (2022). Hazard Lands are areas that pose inherent environmental hazards such as flood susceptibility, instability and other conditions that under severe occasions, pose a risk to loss of life, property damage and social disruption. Hazard Lands are also regulated by the Long Point Region Conservation Authority (LPRCA).

Where components of the Natural Heritage Features are held in private ownership, nothing in the Plan requires that these lands be free and available for public use, and the identification of land will not oblige the County, or other public agencies to purchase the land.

3.5 Long Point Region Conservation Authority Regulations (2006) and Policies (2017)

3.5.1 Development, Interference with Wetlands and Alterations to Shorelines and Watercourses (Ontario Regulation 178/06)

LPRCA is authorized under Section 28 of the *Conservation Authorities Act* to regulate development and site alteration within hazard lands and lands located adjacent to hazard lands should proposed development have adverse effect on those natural features. Hazard lands include areas subject to flooding, erosion, dynamic beaches and within wetlands and watercourses.

The subject property contains significant wetlands, watercourses and lands subject to flooding. A permit for development or site alteration within or adjacent to each of these natural heritage features is required from LPRCA. Proposed development and site alteration on lands adjacent to the hazard lands, specifically the floodplain, may also be required from LPRCA should it be shown land use changes cause adverse impacts on the hazard lands or be adequately mitigated.

3.5.2 Policies for the Administration of the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation

The *Conservation Authorities Act* has empowered conservation authorities such that:

- They can prohibit or regulate development in river and stream valleys, wetlands, shoreline and hazardous lands (flood plain, steep slopes); and
- They can prohibit or regulate the straightening, changing, diverting or interfering in any way with the existing channel of a river, creek, stream, watercourse or for changing or interfering in anyway with a wetland (Section3.1, LPRCA, Regulation 178/06).

The Riverine Hazard Area is defined by the 100-year flood level. Any development being proposed within a Riverine Hazard Area plus 15 m (50 feet) defines the Regulation Area for which a permit must be acquired from LPRCA (Section 8.1, LPRCA, Regulation 178/06).

Riverine Erosion Hazard Area is defined where slopes are steep and intrinsically unstable or where slopes are stable but there is unreasonable risk that they have the potential to become unstable when development is constructed too close to the top-of-bank. In latter of these cases, the Riverine Erosion Hazard is defined by using a Stable Slope Angle which a based on a stable slope gradient determined from a geotechnical study or engineering assessment (Section 8.2, LPRCA, Regulation 178/06).

Wetlands moderate water flow by collecting surface water from the land and then slowly releasing it. Wetlands collect and improve water quality, providing fish and wildlife habitat, and providing recreational opportunities. The areas surrounding wetland where development could interfere with the hydraulic function of the wetland are called "areas of interference". These areas include lands that are 120 m (394 feet) from the boundaries of a provincially significant wetland and 30 m (100 feet) from a non-provincially significant wetland (Section 8.6, LPRCA, Regulation 178/06).

Section 8.1.30 Prohibited Uses within the Riverine Flooding Hazard Notwithstanding state in Sections 8.1.2-8.1.29, development will not be permitted within the Riverine Flooding Hazard as specified in Section 7.2 - General Policies, or where the use is:

- A new campground or the expansion of an existing campground;
- Underground parking associated with any use; and
- Flood protection works and bank stabilization works to allow for future/proposed development.

Further Section 8.1.31 states that:

> *Development, excluding non-habitable accessory buildings or structures associated with an existing use, will not be permitted within 15 metres (49.2 feet) of either bank of the watercourse with the exception of works permitted under the provisions of Section 9.*

LPRCA Policy 9.1.7 Conservation Projects states,

> *Stream rehabilitation works, small impoundments and realignments which restore or enhance watercourse morphology or aquatic health and habitat may be permitted in accordance with the policies in Sections 7.1.2-7.1.3 – General Policies, and provided that:*
>
> *a) the hydrologic and ecological benefits of the project are demonstrated to the satisfaction of the LPRCA,*
> *b) stream bank stability is enhanced,*
> *c) significant natural features and hydrologic and ecological functions are restored and enhanced using best management practices including site and/or infrastructure design and appropriate remedial measures,*
> d) *natural channel design principles are followed to the extent possible, and maintenance requirements are minimize.*

The completion of an EIS can be completed at a landscape scale, watershed or subwatershed study level and sets the width of setbacks and offers guidance for the investigation, establishment and maintenance of buffers.

4. Existing Conditions

The total subject property totals an area of approximately 55 ha (137 acres) and is generally situated south of the populated community of Delhi (**Figure 2**). The subject property is currently used as an active golf course. Residential units are present to the west of the property along James Street, St. Michael's Street and Wilson Avenue, and a combination of agriculture, woodlands and wetlands are situated to the east.

The results of the field studies are visually depicted on **Figure 2** and are described in greater detail below within the sections of respective disciplines.

4.1 Aquatic Resources

Aquatic habitat assessments of Stoney Creek and its tributaries, including the Delhi Golf Estates Municipal Drain, as well as existing online ponds were completed.

Stoney Creek

Stoney Creek flows from the east side of the property boundary to the west side. Surrounding land use and riparian vegetation varied, manicured grasses was dominant at about 70% of the reach and forest and scrubland each comprising of 15% within the subject property boundary (**Photograph 1**). Stream banks had evidence of erosion and scour, typical for a meandering stream. Outside meander bends had undercut banks present averaging around 0.30 m deep. In-stream substrate was predominantly sand with some gravel. Small woody debris was present in approximately 15% of the reach with very minimal large woody debris. Channel morphology was predominantly runs with deeper pool pockets present at meander bends. Channel width was uniform throughout, averaging approximately 4.0 m across, and 0.75 m depth on average.

There is a substantial existing watercourse crossing of Stoney Creek composed of four concrete pipes surrounded by flagstone.

Photograph 1. Section B of Stoney Creek Had Evidence of Scour and Undercutting Present on Both Banks. Note Watercourse Crossing (red arrow) (August 16, 2022)

Delhi Golf Estates Municipal Drain

The Delhi Golf Estates Municipal Drain is a tributary to Stoney Creek and was divided into three reaches, A1, A2 and the online pond to the confluence with Stoney Creek. Each of these reaches are described below.

Legend

- Subject Property
- Ecological Communities (Beacon 2022)
- Watercourse (Beacon 2022)
- Ponded Section (Beacon 2022)
- Piped Feature (Beacon 2022)
- Drainage Ditch (Beacon 2022)
- Floodline (R.J. Burnside 2022)
- Reach Breaks (Beacon 2022)
- Provincially Significant Wetland (MNRF 2022)
- Wetlands (Beacon 2022)
- Butternut
- American Chestnut
- Northern Pin Oak
- Kentucky Coffee-Tree
- Pignut Hickory
- Amphibian Survey Locations

UnitID	Code	Wetland Communities
1	MAS2	Mineral Shallow Marsh
12	MAS2/SWT2	Mineral Shallow Marsh/Mineral Thicket Swamp
5	SWD3-3	Swamp Maple Mineral Deciduous Swamp
8	SWT3-4	Buttonbush Organic Thicket Swamp
		Aquatic Communities
2	SA	Shallow Water
		Forest Communities
3	FOD2-2	Dry - Fresh Oak - Hickory Deciduous Forest
11	FOD3-1	Dry - Fresh Aspen Deciduous Forest
4	FOD8-1	Fresh - Moist Poplar Deciduous Forest
7	FOM	Mixed Forest
		Cultural Communities
10	CUP3	Coniferous Plantations
9	CUT1	Mineral Cultural Thicket
6	CUW1	Mineral Cultural Woodland
		Other Communities
14	ANT	Anthropogenic
13	HE	Hedgerow

Existing Conditions

Figure 2

Delhi Golf and Country Club

BEACON ENVIRONMENTAL

Project: 221361
Last Revised: December 2022

Client: Delhi Development Inc.

Prepared by: BD
Checked by: CS

N

1:4,500

0 100 200 m

Contains information licensed under the Open Government License–Ontario Orthoimagery Baselayer: FBS Haldimand Norfolk Region (2010)

C:\ODB\OneDrive - Beacon Environmental\GeoSpatial\Geo Projects\2021\221361 Delhi G and CC\Q Project Files\2021-08-04 - Delhi G and CC - 221361.qgz

Reach A1

Reach A1 flows south from the northern PSW through an enclosed tile drain system. A1 ends once the water resurfaces from the pipe and becomes a channelized feature (i.e., reach A2) (**Photograph 2**).

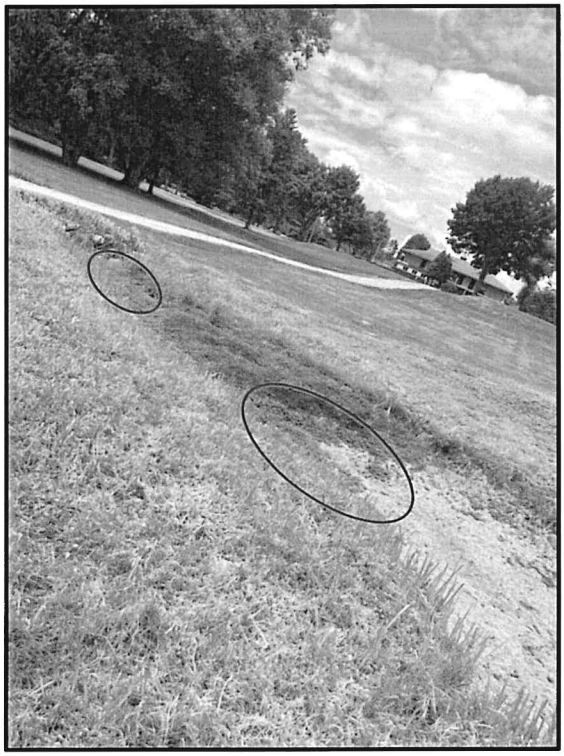
Photograph 2. Outflow of A1 from PVC Pipe, into Channelized Watercourse (A2) (November 10, 2021)

Reach A2

A2 continues south into a woodland/wetland and then re-enters the golf course lands via an underground drainage system that is not visible. It continues to flow for approximately 100 m until it outlets into the pond (i.e., Reach A3).

A2 had very little to no evidence of erosion or bank scouring. Substrate type was predominately gravel and sand. Small and large woody debris was very low to nonexistent in the channel. In-stream vegetation was significant as it exits the woodland. Grasses, soft stem sedges, and cattails were present (**Photograph 3**). Vegetation changes slightly upstream of the pond, where watercress was observed (**Photograph 4**). Wetted width varied from 0.5 m to 1 m, and water depth was low averaging 0.12 m. Stream morphology throughout A2 was approximately 90% flat, 7% pools and 3% riffles.

Photograph 3. Significant Instream Vegetation Present in Channel as A2 Flows out of the Woodland (November 10, 2021)



Photograph 4. A2 Upstream of the Pond, Watercress Presence Outlined in Red (August 16, 2022)

Reach A3 - Online Pond

The online pond surrounding land use was predominately manicured lawn with sparse canopy cover or riparian vegetation. The pond was predominately silt bottom with an abundance of aquatic vegetation and fish present. In 2022 at the time of fish surveys pond levels were very low (**Photograph 5**) and the pond outlet acted as a seasonal fish barrier. The lower section of the pond was very shallow, with an abundance of aquatic vegetation (e.g., cattails, grasses, aquatic macrophytes, and duct weed). The online pond outlets into a short channel at the confluence with Stoney Creek by three PVC pipes which are also a seasonal fish barrier (**Photograph 6**).

Photograph 5. Pond Conditions Include Little to no Riparian Vegetation, High Water Mark Visible, Abundance of Pond Vegetation (August 16, 2022)

Photograph 6. Outlet of Pond into Stoney Creek by three PVC Pipes, Creates a Seasonal Fish Barrier (November 10, 2021)

Feature B

Feature B was a small channel which connected the eastern wetland to the southern wetland across a small section of golf course in the southeast corner of the subject property. Riparian vegetation was predominantly grasses with some wetland plants present (**Photograph 7**). Stream banks had a minor slope with minimal erosion. Substrate was silt dominate with moderate presence of small woody debris, and aquatic vegetation present.

Photograph 7. Feature B, Located Within the Golf Course Lands (November 10, 2021)

Feature C

Feature C is a narrow flow path connecting the Mineral Shallow Marsh along Highway 3 to the deciduous swamp in the southern portion of the subject property. It flows along the property boundary and is a result of grade differential, creating a narrow ditch between the two wetland areas.

Existing Golf Course Ponds

There are three anthropogenic ponds located within the subject property, two of which are isolated south of Stoney Creek, and one is online to the Delhi Golf Estates Municipal Drain (**Figure 2**). These ponds have been created as part of the golf course development and act as water features, irrigation ponds and stormwater management ponds for the golf course. Man-made ponds located in urban environments, especially golf course ponds, often have fish species present. Specific fish sampling was not completed for the ponds; however, a visual assessment was carried out to document any fish. Fish were observed in all the golf course ponds. Given the location of the ponds within an active golf course and adjacent to a residential area they provide marginal fish habitat for common, warmwater species.

4.1.1 Fish Community Sampling

Fish community sampling was completed on August 16, 2022. Sampling was completed throughout Stoney Creek and the Delhi Golf Estates Municipal Drain to the extent possible. A total of ten species were captured, eight species in Stoney Creek and four species were captured in Tannery Creek (**Table 2**). Majority of the fish captured in Stoney Creek are classified as "coolwater" thermal regime, with the

exception of Brown Trout (coldwater) and Bluegill (warmwater). Majority of the fish captured in the open portions of the Delhi Golf Estates Municipal Drain were warmwater species apart from Central Mudminnow which is a coolwater species. As the municipal drain is composed of online pond features, this warmwater fish assemblage is expected. No SAR were observed or captured; however, Lake Chubsucker (*Erimyzon sucetta*) a fish species protected under the ESA and SARA has been identified by DFO has having the potential to occur in Stoney Creek and the municipal drain (refer to **Section 4.3**)

Table 2. Fish Community Sampling Results (August 16, 2022)

Common Name	Scientific Name	Survey Location		Thermal Regime and Spawning Season*
		Stoney Creek	Municipal Drain	
White Sucker	*Catostomus commersonii*	X		Coolwater April-June
Mottled Sculpin	*Cottus bairdii*	X		Coolwater April-May
Central Mudminnow	*Umbra limi*	X	X	Coolwater April-May
Brook Stickleback	*Culaea inconstans*	X		Coolwater May-July
Brown Trout	*Salmo trutta*	X		Coldwater October to November
Bluegill	*Lepomis macrochirus*	X	X	Warmwater June-August
Creek Chub	*Semotilus atromaculatus*	X		Coolwater May-June
Nothern Pike	*Esox lucius*	X		Coolwater March -May
Fathead Minnow	*Pimephales promelas*		X	Warmwater May-August
Largemouth Bass	*Micropterus salmoides*		X	Warmwater May-June

4.2 Terrestrial Resources

4.2.1 Vegetation Communities

Vegetation communities were mapped and described according to the ELC system for southern Ontario (Lee *et al.*, 1998), which involved delineating vegetation communities on an aerial photograph of the property and recording pertinent information concerning the structure and composition of the vegetation in each community. Vegetation communities on the subject property are illustrated on **Figure 2**.

ELC Unit 1: Cattail Mineral Shallow Marsh (MAS2-1)

This small wetland unit is located on the west side of the property. It is dominated by Narrow-leaved Cattail (Typha angustifolia), in association with Wooly Sedge (*Carex pellita*), Swamp Milkweed (*Asclepias incarnata*), and Purple Loosestrife (*Lythrum salicaria*).

ELC Unit 2: Shallow Aquatic (SA)

This classification applies to two natural kettle ponds (units 2a and 2b) located at the north end of the property which are mapped as PSW, as well as several small ponds that were dug for the golf course (units 2c, 2d, 2e, and 2f). See **Photograph 8**.

Units 2a and 2b are dominated American Water-lily (*Nymphaea odorata*), Lesser Duckweed (*Lemna minor*), and pondweeds (*Potomogeton* spp.). Emergent vegetation includes Reed Canary Grass (*Phalaris arundinacea*), Broad-leaved Cattail (*Typha latifolia*), and sedges (*Carex* spp.), among others. The ponds are fringed by willows (*Salix* spp.) and Winterberry (*Ilex verticillata*).

There are four small golf course ponds (Units 2c, 2d, 2e and 2f) at the south end of the property that are man-made and have naturalized over time which support submerged and floating-leaved aquatic vegetation including Stonewort algae (*Chara* spp.), Coon's Tail (*Ceratophyllum demersum*), American water-weed (*Elodea canadensis*), and Lesser Duckweed. Emergent vegetation along the pond margins includes Narrow-leaved Cattail, Broad-leaved Cattail, Spikerush (*Eleocharis erythrypoda*), sedges (*Carex* spp.), and Rice Cutgrass (*Leerisa oryzoides*), among others. Units 2c and 2d are online to the Delhi Golf Estates Municipal Drain.

Photograph 8. View of Unit 2f, the SA pond in the South, Along with a MAS2-1 Border (July 27, 2022)

ELC Unit 3: Dry-Fresh Oak-Hickory Deciduous Forest (FOD2-2)

This community is dominated by mature Red Oak (*Quercus rubra*) and White Oak (*Quercus alba*) in association with Bitternut Hickory (*Carya cordiformis*), Shagbark Hickory (*Carya ovata*), Sugar Maple (*Acer saccharum*), and Red Maple (*Acer rubrum*). The understory consists of Witch-hazel (*Hamamelis virginiana*), Gray Dogwood (*Cornus racemosa*), Bush Honeysuckle (*Diervilla lonicera*), and Alternate-leaved Dogwood (*Cornus alternifolia*). Dominant ground covers are Enchanter's Nightshade (*Circaea*

lutetiana), Thicket Creeper, False Solomon's Seal (*Mainthemum racemosum*), Pennsylvania Sedge (*Carex pensylvanica*), and White Trillium (*Trillium grandiflora*).

ELC Unit 4: Fresh-Moist Poplar Deciduous Forest (FOD8-1)

This community consist of young to mid-aged Trembling Aspen (*Populus tremuloides*) in association with Manitoba Maple (*Acer negundo*), Green Ash (*Fraxinus pennsylvanica*), and Black Walnut (*Juglans nigra*). Dominant ground covers include Thicket Creeper, Enchanter's Nightshade, Jewelweed (*Impatiens capensis*), and avens (*Geum* spp.).

ELC Unit 5: Swamp Maple Mineral Deciduous Swamp (SWD3-3)

This community is dominated by mid-aged to mature Freeman's Maple (*Acer x freemanii*), in association with Yellow Birch (*Betula alleghaniensis*), Basswood (*Tilia americana*), and Green Ash (*Fraxinus pennsylvanica*). The understory consists of Gray Dogwood, Green Ash, Spicebush (*Lindera benzoin*), Multilfora Rose (*Rosa multiflora*), and Black Currant (*Ribes americanum*). Dominant ground covers area Jewelweed, ferns (*Onoclea sensibilis, Matteucia struthiopteris*), sedges (*Carex* spp.) and Skunk Cabbage (*Symplocarpus foetidus*). See **Photograph 9**.

Photograph 9. SWD3-3 Community (July 27, 2022)

ELC Unit 6: Mineral Cultural Woodland (CUW1)

Cultural woodlands on the subject property are characterize by an open canopy of mid-aged Black Walnut and Trembling Aspen (*Populus tremuloides*). The understory consists of a dense layer of Gray Dogwood, Tatarian Honeysuckle (*Lonicera tatarica*), and Black Raspberry (*Rubus occidentalis*), and Riverbank Grape (*Vitis riparia*). Dominant ground covers are Enchanter's Nightshade (*Circaea canadensis*), White avens (*Geum canadense*), Tall Goldenrod (*Solidago altissima*), Thicket Creeper, and Garlic Mustard (*Alliaria petiolata*).

ELC Unit 7: Fresh-Moist Mixed Forest (FOM)

This community is located along the western edge of the subject property. The canopy consists of mix of Norway Maple (*Acer platanoides*), Eastern Hemlock (*Tsuga canadensis*), Black Cherry (*Prunus serotina*), White Birch (*Betula papyrifera*), European Larch (*Larix decidua*), and Bitternut Hickory (*Carya cordiformis*). The understory consists of Choke Cherry (*Prunus virginiana*), Wild Black Currant, and Green Ash (*Fraxinus pennsylvanica*). Dominant species in the ground layer include Thicket Creeper (*Parthenocissus vitacea*), Enchanter's Nightshade (*Circaea canadensis*), Wild Strawberry (*Fragaria virginiana*), and Garlic Mustard.

ELC Unit 8: Buttonbush Organic Thicket Swamp (SWT3-4)

This community is dominated by Buttonbush (*Cephalanthus occidentalis*) and willows. Dominant groundcovers include Reed Canary Grass, Frogbit, Bur-reed, and Water Smartweed (*Persicara amphibium*).

ELC Unit 9: Mineral Cultural Thicket (CUT1)

This small thicket community is dominated by Staghorn Sumac (*Rhus typhina*).

ELC Unit 10: Coniferous Plantation (CUP3)

This community consist of mid-aged planted Norway Spruce (*Picea abies*) with an understorey of White Ash (*Fraxinus americana*) and Choke Cherry. Dominant ground covers include Lily of the Valley (*Convallaria majalis*), Enchanter's Nightshade, False Solomon's Seal, and Thicket Creeper.

ELC Unit 11: Dry-Fresh Poplar Deciduous Forest (FOD3-1)

This community is located along the eastern property lines. The canopy is dominated by young to mid-aged Trembling Aspen. Dominant ground covers are Yellow Trout-Lily (*Erythronium americanum*), Pennsylvania Sedge (*Carex pensylvanica*), May-Apple (*Podophyllum peltatum*), and False Solomon's Seal (*Maianthemum racemosum*).

ELC Unit 12: Mineral Shallow Marsh/Mineral Thicket Swamp (MAS2/SWT2)

This community is a mix of thicket swamp and shallow marsh dominated by willows (*Salix petiolaris, S. inerior, S. eriocephala*), Reed Canary Grass (*Phalaris arundinacea*), Bulblet-bearing Water Hemlock (*Cicuta bulbifera*), Frogbit (*Limnobium laevigatum*), and Bur-reed (*Sparganium eurycarpum*). See **Photograph 10**.

Photograph 10. Portion of Unit 12 Dominated by Reed Canary Grass and Forbs (July 27, 2022)

Unit 13: Hedgerow (HE)

A hedgerow located along the eastern property line consist of mid-aged to mature Red Oak, Bitternut Hickory, Black Cherry, and Black Walnut.

Unit 14: Anthropogenic (ANT)

Areas classified as anthropogenic include the existing golf course and associated buildings and parking area. Patches of trees have been planted throughout the golf course lands and included a combination of deciduous and coniferous species. See **Photograph 11**.

Photograph 11. Sample of Anthropogenic Portion of the Delhi Golf Course – Unit 14 (July 27, 2022)

4.2.2 Flora

A total of 184 species of vascular plants was identified on the subject property. A plant list is provided in **Appendix D.** Of the 184 species documented, 151 (83%) are native to Ontario and 30 (17%) are non-native. Of the 151 native species, 150 are ranked S5 or S4 by NHIC, indicating that they are secure (S5) or apparently secure (S4) in Ontario. Once species, Butternut (*Juglans cinerea*) is ranked S2? (Imperilled) and is also designated an Endangered species in Ontario. A suspected American Chestnut (*Castanea dentata*) tree was identified as well, which is a provincially endangered species and S1S2. A Kentucky Coffee-tree (*Gymnocladus dioicus*) was noted along the property edge, which is a provincially threatened species under the ESA, and is designated S2. Pignut Hickory (*Carya glabra*) and Northern Pin Oak (*Quercus ellipsoidalis*) were also presented and are S3. The approximate locations of all the aforementioned tree species are illustrated in **Figure 2**.

Fifteen species identified on the subject property are considered uncommon in Norfolk County and three species are considered rare according to Oldham (2017). A list of regionally rare and uncommon species is provided in **Table 3**, with a sample image of an uncommon observation species below in **Photograph 12**.

The majority of these rare and uncommon species are situated outside of the development footprint and are associated with the woodland and wetland units that are being retained and buffered. The following species may be within the removal area and will be explored for the suitability of transplantation as the project progresses: Common Evening-primrose, Annual Fleabane and Highbush Cranberry.

Table 3. List of Regionally Rare and Uncommon Species (2022)

Plant Species	Common Name	Status in Haldimand - Norfolk County
Dryopteris cristata	Crested Wood Fern	Rare
Oenothera biennis	Common Evening-primrose	Rare
Actaea rubra	Red Baneberry	Uncommon
Carex hystericina	Porcupine Sedge	Uncommon
Carex radiata	Eastern Star Sedge	Uncommon
Cornus racemosa	Grey Dogwood	Uncommon
Erigeron annuus	Annual Fleabane	Uncommon
Galium boreale	Northern Bedstraw	Uncommon
Gymnocladus dioicus	Kentucky Coffee-tree	Rare
Juncus articulatus	Jointed Rush	Uncommon
Persicaria hydropiperoides	False Waterpepper	Uncommon
Platanus occidentalis	Sycamore	Uncommon
Salix amygdaloides	Peach-leaved Willow	Uncommon
Scirpus microcarpus	Red-tinged Bulrush	Uncommon
Spirodela polyrhiza	Great Duckweed	Uncommon
Triosteum aurantiacum	Orange-fruit Horse-gentian	Uncommon
Veronica americana	American Speedwell	Uncommon
Viburnum opulus ssp. trilobum	Highbush Cranberry	Uncommon
Wolffia columbiana	Columbia Watermeal	Uncommon

Photograph 12. One of the Uncommon Plants in Norfolk County – Orange-fruited Horse Gentian (July 27, 2022)

4.2.3 Breeding Birds

A total of 36 breeding bird species were recorded on or adjacent to the property during the 2022 breeding season (**Appendix E**); six additional species were observed foraging or flying over but not breeding on the subject property. Avian observations were distributed throughout the property, with higher concentrations in the more heavily wooded portions.

The most abundant species were common birds that are frequently found in disturbed urban and urbanizing environments with landscape plantings. The following species were recorded with more than ten singing males or territories: American Robin (*Turdus migratorius*), Warbling Vireo (*Vireo gilivus*), Chipping Sparrow (*Spizella passerina*), Song Sparrow (*Melospiza melodia*) and Red-winged Blackbird (*Agelaius phoeniceus*). Other generalist species found across the anthropogenic- areas in lower numbers included Blue Jay (*Cyanocitta cristata*), European Starling (*Sturnus vulgaris*), Northern Cardinal (*Cardinalis cardinalis*), Brown-headed Cowbird (*Molothrus ater*), and Baltimore Oriole (*Icterus galbula*).

A variety of wetland habitats both adjacent to the larger ponds and on the southern boundary of the subject property provide habitat for some marsh species. In addition to the numerous Red-winged Blackbirds, other species recorded in these areas included: Mallard (*Anas platyrhynchos*), Green Heron (*Butorides virescens*), Belted Kingfisher (*Ceryle alcyon*), Tree Swallow (*Tachycineta bicolor*), Gray Catbird (*Dumetella carolinensis*), Yellow Warbler (*Setophaga petechia*), Common Yellowthroat (*Geothlyphis trichas*), and Swamp Sparrow (*Melospiza georgiana*).

Narrow areas of woodland along the pond, and larger areas of swamp and forest areas on the southeast portion of the subject property, provided habitat for woodland species including Red-bellied Woodpecker (*Melanerpes carolinus*), Downy Woodpecker (*Dryobates pubescens*), Eastern Wood-Pewee (*Contopus virens*), Great Crested Flycatcher (*Myiarchus crinitus*), and Black-capped Chickadee (*Poecile atricapillus*). Other species observed within the same communities but outside the property boundaries included: Yellow-billed Cuckoo (*Coccyzus americanus*), White-breasted Nuthatch (*Sitta carolinensis*), Red-eyed Vireo (*Vireo olivaceus*), American Redstart (*Setophaga ruticilla*), and Rose-breasted Grosbeak (*Pheucticus ludovicianus*). The territories of these individuals are primarily off-property, although since these communities encroach slightly onto the subject property portions of the territories are also expected to encroach slightly.

Area-sensitive birds are those that require larger tracts of suitable habitat in which to breed or are those that have a higher breeding success in larger areas of suitable habitat. Two such species were recorded: White-breasted Nuthatch and American Redstart. As noted, single territories were observed outside the property boundaries, and while these territories likely encroach into the subject property the majority lies outside the property bounds.

No species ranked S1 through S3 (Critically Imperiled through Vulnerable) by the province were recorded, nor were any species regulated under the ESA recorded as breeding. One provincially threatened species, Barn Swallow (*Hirundo rustica*), was recorded foraging over the subject property, however no structures suitable for nesting were present on the property. One additional species listed as special concern was observed, Eastern Wood-Pewee, with one territory located in the cultural woodland bordering the eastern pond and another two located to the south and east of the subject property in the adjacent woodlands. This species is ranked as special concern due to a declining trend across its range but remains common in a variety of woodland and forest edge habitats in both intact and fragmented features. Species of special concern are not regulated under the ESA.

4.2.4 Amphibian Call Surveys

Numerous areas of suitable amphibian habitat were identified and were surveyed during the 2022 breeding season. The survey stations were placed in proximity to the identified suitable habitat, the locations of which are shown on **Figure 2.**

The amphibian surveys documented rich and abundant vocalizations of the following species:

- Green Frog (*Lithobates clamitans*);
- Gray Treefrog (*Hyla versicolor*);
- Western Chorus Frog (*Pseudacris triseriata*);
- Wood Frog (*Lithobates sylvatica*);
- Spring Peeper (*Pseudacris crucifer*);
- Northern Leopard Frog (*Lithobates pipiens*); and
- American Bullfrog (*Lithobates catesbeianus*).

In addition to this, a number of American Toads (*Anaxyrus americana*) were visually encountered on the subject property during other unrelated fieldwork, despite these species not recorded during the auditory surveys. The documented species include amphibians that overwinter both terrestrially and aquatically. Aquatic overwintering requires sufficiently deep and permanent water bodies to sustain these animals in the substrate below, whereas terrestrially overwintering species can do so in leaf litter or under debris on the forest floor.

The results are presented below in **Table 4** and includes the call code notation along with number of individuals in brackets.

Table 4. Breeding Amphibian Survey Results (2022)

Stations	Visit 1 *April 12*	Visit 2 *May 21*	Visit 3 *June 14*
A1	Chorus Frog - 3; Wood Frog - 3; Spring Peeper - 3	Gray Treefrog – 2(5); Spring Peeper – 1(1)	Green Frog – 2(4); Gray Treefrog – 1(1)
A2	Chorus Frog - 3; Wood Frog - 3; Spring Peeper - 3	Green Frog – 2(3); Spring Peeper – 1(4)	Bullfrog – 3; Green Frog – 2(15)
A3	Chorus Frog - 3; Wood Frog - 3; Spring Peeper - 3	Leopard Frog – 1(1); Green Frog – 1(2); Gray Treefrog – 1(1); Spring Peeper – 1(1)	Bullfrog – 3 Green Frog - 3
A4	Leopard Frog – 2(2)	Green Frog – 1(2); Gray Treefrog – 1(1); Spring Peeper – 1(1)	Bullfrog 1(1); Green Frog – 2(6)
A5	Wood Frog – 1(1)	Green Frog - 2(10)	Bullfrog – 2(4); Green Frog – 2(13)
A6	-	Green Frog – 1(2); Spring Peeper – 1(1)	Bullfrog – 1(1); Green Frog – 2(7)
7	Chorus Frog - 3; Wood Frog - 3; Spring Peeper - 3	Spring Peeper – 1(1); Green Frog – 1(2)	Green Frog 2(10)

Stations	Visit 1 *April 12*	Visit 2 *May 21*	Visit 3 *June 14*
8	Spring Peeper – 1(2)	Spring Peeper – 2(2); Green Frog – 1(1)	Green Frog – 2(3)

4.2.5 Turtle Basking Surveys

Three of the six ponds surveyed were identified as occupied turtle habitat during the 2022 breeding season. Two common species of turtles were observed: Midland Painted Turtle (*Chrysemys picta marginata*) and Common Snapping Turtle (*Chelydra serpentina*). Other individuals of these species were recorded elsewhere on the property during unrelated fieldwork to suggest these animals are widespread on the property and disperse throughout the landscape for various aspects of their life cycles. Turtles of different ages were noted as well (juveniles to mature) and suggests these animals are breeding and persistent on the golf course.

The results are presented below in **Table 5** and include the species and number of individuals observed each visit.

Table 5. Turtle Basking Survey Results (2022)

ELC Unit	Visit 1 *May 13*	Visit 2 *June 10*	Visit 3 *June 15*	Visit 4 *June 27*
2c/2d	5 Midland Painted Turtles	1 Midland Painted Turtles	5 Midland Painted Turtles	1 Midland Painted Turtles
2e	-	-	-	-
2f	-	-	-	-
2b	2 Midland Painted Turtles	20 Midland Painted Turtle; and 3 Common Snapping Turtle	4 Midland Painted Turtles	15 Midland Painted Turtles; and 1 Common Snapping Turtle
2a/8	4 Midland Painted Turtles	8 Midland Painted Turtle; and 2 Common Snapping Turtle	5 Midland Painted Turtles; and 1 Common Snapping Turtles	12 Midland Painted Turtle
12	-	-	-	-

Other turtle observations were made outside of the targeted basking surveys and should be included in the discussion on turtle habitat on the subject property. A number of Midland Painted Turtles (adults and juveniles) were observed basking and foraging in ELC communities 2e, 2f and 12, despite these animals not being observed during the targeted surveys. See **Photograph 13**.

Photograph 13. A Number of Midland Painted Turtles Basking in ELC Unit 2e (July 27, 2022)

4.2.6 Other Wildlife

Any wildlife species observed on the subject property during field investigations not considered within the preceding sections of this report were recorded as incidental observations.

Mammal species documented from the property included Eastern Cottontail (*Sylvilagus flordinaus*), Red Squirrel (*Tamiasciurus hudsonicus*) and Gray Squirrel (*Sciurus carolinensis).* A Muskrat (*Ondatra zibethicus*) lodge was also present in the south, and two juvenile individuals of this species were noted. Extensive evidence of both Eastern Coyote (*Canis* X *latrans*) and White-tailed Deer (*Odocoileus virginianus*) was also observed. Numerous bats were observed during evening fieldwork on the subject property however, the species composition remains unclear in the absence of acoustic monitoring.

Other common mammal species that are likely present on and adjacent to the subject property though were not directly observed include Raccoon (*Proycon lotor*), Striped Skunk (*Mephitis mephitis*) and Red Fox (*Vulpes vulpes*).

Staff found a number of owl pellets in the northern portion of the subject property, however, owls were not detected during breeding surveys, which is expected as they breed earlier than most other birds and are active in the evening.

One snake species was observed on the subject property, Eastern Gartersnake (*Thamnophis sirtalis sirtalis*).

4.3 Endangered or Threatened Species

As described in the preceding sections, Beacon staff conducted both desktop and on-site investigations to assess whether any endangered or threatened species were likely to occur on or adjacent to the subject property. **Table 6** provides Beacon's assessment based on the results of field investigations combined with knowledge of the habitat preferences and natural history of the species being considered.

Table 6. Endangered or Threatened Species

Species	Status on SARO List	Were Species and/or Habitat Documented during on-site Assessment?
Vascular Plants (Dicots)		
Butternut, *Juglans cinerea*	END	**Yes,** a targeted search for Butternut trees (*Juglans cinerea*) was conducted. This species is a provincially and nationally endangered tree species that, while still relatively common in southern Ontario, has been listed because the population has been declining due to the presence of a Butternut Canker disease. Specimens located are depicted on **Figure 2**. Details on the Butternut Health Assessment (BHA) are provided below.
Kentucky Coffee-tree, *Gymnocladus dioicus*	THR	**Yes**, one tree was found and is depicted on **Figure 2**. Given the single tree's location along an existing roadway in association with an off-site homestead, this tree is assumed to be planted and therefore not subject to the ESA.
American Water-willow, *Justicia americana*	THR	Staff compiled a botanical inventory and did not encounter this species.
Eastern Flowering Dogwood, *Cornus florida*	END	Staff compiled a botanical inventory and did not encounter this species.
American Chestnut, *Castanea dentata*	END	**Yes**, an American Chestnut tree was encountered in the extreme northeastern portion of the subject property and is depicted on **Figure 2**. Beacon is currently exploring the possibility for hybridity/genetic testing for this species to ensure identification.
Reptiles and Amphibians		
Blanding's Turtle, *Emydoidea blandingii*	END	**Potential**, wetlands within and adjacent to the subject property are Blanding's Turtle habitat. Species was not observed in these wetlands during four basking surveys conducted in 2022.
Gray Ratsnake, *Pantherophis spiloides*	END	**No,** although Gray Ratsnake historically occurred in this area, the northern boundary of the current distribution of the species is a minimum of eight km to the south of the subject property making the likelihood of occurrence very low.
Spotted Turtle, *Clemmys guttata*	END	**No,** although wetlands on the subject property have the physical characteristics necessary to function as habitat for Spotted Turtle, the surrounding landscape and known distribution of the species in this part of Ontario makes the likelihood of occurrence very low.
Eastern Foxsnake, *Pantheropphis gloydi*	END	**Potential,** the wetlands and hedgerows on the subject property are habitat for Eastern Foxsnake and it is possible that a population of the species would persist in the area given the contiguous patch of habitat provided by the PSW at the southern end of the property.
Eastern Hog-nosed Snake, *Heterodon platirhinos*	THR	**Potential,** areas of the property have the potential to function as habitat for the species and it is possible that a population of the species would persist in the area given the contiguous patch of habitat provided by the PSW at the southern end of the property.
Birds		

Species	Status on SARO List	Were Species and/or Habitat Documented during on-site Assessment?
Bank Swallow, *Riparia riparia*	THR	**No**, suitable habitat is absent on the subject property as vertical exposed banks (suitable habitat) are not present at this location. Breeding bird surveys did not record any foraging birds of this species.
Barn Swallow, *Hirundo rustica*	THR	**No**, a comprehensive habitat assessment was undertaken for this species and no nests were identified. A foraging bird was noted during the breeding bird survey however was not breeding on site. These birds construct conspicuous mud-based nests on the exterior of structures.
Chimney Swift, *Chaetura pelagica*	THR	**No,** a suitable vertical column is absent on the property and no Chimney Swift were noted during breeding bird surveys.
Bobolink, *Dolichonyx oryzivorus*	THR	**No**, this species was not recorded during breeding bird surveys as it requires extensive meadow habitat which is absent.
Eastern Meadowlark, *Sturnella magna*	THR	**No**, Eastern Meadowlark were not present on the property during breeding bird surveys as this species requires extensive meadow habitat.
Cerulean Warbler, *Setophaga cerulea*	THR	**No,** there is no suitable habitat and Cerulean Warblers were absent on the property and in the vicinity during breeding bird surveys.
Louisiana Waterthrush, *Parkesia motacilla*	THR	**No,** these birds were not detected during breeding bird surveys.
Acadian Flycatcher, *Empidonax virescens*	END	**No**, Acadian Flycatchers were absent on the property during breeding bird surveys.
Aquatic Species		
Lake Chubsucker, *Erimyzon sucetta*	THR	**Potential**, the watercourses on the subject property underwent electrofishing and no Lake Chubsuckers were encountered. However, it is possible this species exists within the Shallow Aquatic communities on the subject property.
Mammals		
Little Brown Myotis, *Myotis lucifugus* Northern Myotis, *Myotis septentrionalis* Eastern Small-footed Myotis, *Myotis leibii* Tri-colored Bat, *Perimyotis subflavus*	END	**Potential**, suitable habitat for endangered bats is present in the treed communities on the subject property, based on the provincial habitat guidelines (FOD2-2, FOD3-1, FOD8-1, FOM, SWD3-3 and potentially the CUW1). Targeted surveys have not been undertaken at this time, however numerous bats were observed in the evenings on site during unrelated fieldwork. Consultation with MECP will be required to determine the necessary steps to ensure conformity with the ESA as the project proceeds. Snag surveys will likely be required at a minimum, however Beacon will confirm this prior to proceeding with additional works.

Key: SARO Species at Risk in Ontario List EN: Endangered; THR Threatened; ORAA Ontario Reptile and Amphibian Atlas; NHIC Natural Heritage Information Centre

Butternut

This tree species is protected under the provincial ESA and associated Exemption Regulation 242/08 section 23.7. Documented occurrences are shown on **Figure 2**. The species can be damaged or removed if the criteria under the Regulation are achieved (i.e., removal of ten or fewer Category 2 trees), or if the criteria are not achieved then an Overall Benefit Permit (or the new compensation permit process) is required under the ESA. Compensation for the removal of trees is required, which typically involves planting, tending and monitoring of replacement Butternut trees and associated companion

trees, alternatively monetary compensation can be made through the Species at Risk Conservation Fund.

When found, the species is assessed with a Butternut Health Assessment (BHA) by a qualified Butternut Health Assessor as either:

- Category 1 – Non-retainable (no protection is given);
- Category 2 – Retainable;
- Category 3 – Potentially Archivable (may be useful in determining sources of resistance to Butternut canker); or
- Cultivated – Having been planted or actively in a cultivated/residential location.

Furthermore, as per section 23.7 (4) of Regulation 242/08, any Category 1 Butternut trees may be killed, harmed, or taken without further process or documentation (unless the results of an MNRF examination of the trees indicate that the activity is not eligible for the regulation). On this basis, only Category 2 and Category 3 trees are protected by the ESA.

One Butternut tree was present on the subject property and is shown on **Figure 3**, along with an 18 m root harm protection zone. This tree underwent a BHA and was determined to be retainable (Category 2). Root Harm Prevention Zones are established in the regulation (830/21) and an 18 m protection zone is to be applied on Butternuts that are between 30-50 cm DBH.

Kentucky Coffee-tree

Given the location of this tree, it is assumed to be planted and therefore not subject to the ESA.

American Chestnut

This tree was encountered in the northeastern portion of the property and species identification will be confirmed through genetic testing. If confirmed to be a non-hybrid American Chestnut, grading modifications will be recommended to the project team in order to ensure this tree remains unharmed through the proposed development. Consultation will take place with the MECP, if deemed necessary, to ensure conformity with the ESA.

Lake Chubsucker

In Ontario, the Lake Chubsucker lives in marshes and lakes with clear, still, warmwater with many aquatic plants. In this regard, there may be suitable habitat, including suitable breeding habitat (i.e., shallow water marshes) in the PSW units at the northern portion of the property. Discussion with MECP and DFO will be undertaken to ensure protection of the species under the ESA and SARA.

Endangered Bats

Potential maternity roosting habitat is present on the subject property in the treed communities noted in **Table 6**. Consultation will take place with the MECP to seek agreement with the next steps of the project and ensure necessary fieldwork takes places to ensure the application is in conformity with the ESA.

Potential fieldwork may include a snag survey, which must take place during the leaf-off condition, and acoustic monitoring may follow depending on the outcome of the snag survey and MECP consultation.

Herpetofauna

Suitable habitat may be present for Blanding's Turtle, Eastern Foxsnake and Eastern Hog-nosed Snake on the subject property. Consultation with the MECP will be required to determine the next steps to ensure the appropriate amount of field data is collected, and to ensure the project remains in conformity with the ESA.

4.4 Hazard Limits

A floodplain is present on the subject property in associated with Stoney Creek in the southern area and is visualized on **Figure 2** and **3**. Floodplain mapping has been obtained by R.J. Burnside (2022).

5. Significant Wildlife Habitat

SWH designation is the responsibility of the planning authority and determination of it on a site by site basis is generally not an appropriate manner in which to determine this constraint given that it is necessary to understand the context of the habitat within the local environment. Very few municipalities have provided their own thresholds for the suggested criteria. As it relates to the subject property, the County has not identified significant wildlife habitat within their jurisdiction.

While the County of Norfolk Official Plan has not identified SWH, the subject property has been assessed for the potential to provide Significant Wildlife Habitat (SWH) in the context of the *Significant Wildlife Habitat Criteria Schedules for Ecoregion 7E* (OMNRF 2015; the "Guideline").

It is noted in the context of this assessment that the guideline specifically states that man-made ponds should not be considered SWH.

The Significant Wildlife Habitat Criteria Schedules for Ecoregion 7E (OMNRF 2015) provide guidance for the SWH designation for the four categories of SWH outlined in the Significant Wildlife Habitat Technical Guide and its Appendices (OMNR 2000).

Regarding these guidelines, the Province notes that:

> *They are advisory only and may be updated as technology or techniques improve. They provide information to assist in understanding the policy. They do not add to or detract from policy. Except as otherwise specified (e.g. where requirements are established by legislation or regulation), they do not represent the only acceptable approaches.*

The PPS defines significant wildlife habitat as follows:

> *Significant: means:*

Legend

- Subject Property
- Ecological Communities (Beacon 2022)
- Proposed Natural Channel (subject to detailed studies)
- Outermost Constraint Line (Natural Heritage)
- American Chestnut
- Northern Pin Oak
- Kentucky Coffee-Tree
- Pignut Hickory
- Butternut
- Butternut + 16 m
- Provincially Significant Wetland (MNRF 2022)
- Wetlands (Beacon 2022)

Drainage Features

- Watercourse (Beacon 2022)
- Ponded Section (Beacon 2022)
- Piped Feature (Beacon 2022)
- Drainage Ditch (Beacon 2022)
- Floodline* (R.J. Burnside 2022)

Buffers

- Wetland + 30 m
- Woodland + 10 m
- Watercourse + 15 m
- Watercourse + 30 m

* Floodline refinements and any necessary setbacks to be determined by others

UnitID	Code	Wetland Communities
1	MAS2	Mineral Shallow Marsh
12	MAS2/SWT2	Mineral Shallow Marsh/Mineral Thicket Swamp
5	SWD3-3	Swamp Maple Mineral Deciduous Swamp
8	SWT3-4	Buttonbush Organic Thicket Swamp
		Aquatic Communities
2	SA	Shallow Water
		Forest Communities
3	FOD2-2	Dry - Fresh Oak - Hickory Deciduous Forest
11	FOD3-1	Dry - Fresh Aspen Deciduous Forest
4	FOD8-1	Fresh - Moist Poplar Deciduous Forest
7	FOM	Mixed Forest
		Cultural Communities
10	CUP3	Coniferous Plantations
9	CUT1	Mineral Cultural Thicket
6	CUW1	Mineral Cultural Woodland
		Other Communities
14	ANT	Anthropogenic
13	HE	Hedgerow

Proposed Development | **Figure 3**

Delhi Golf and Country Club

BEACON ENVIRONMENTAL

Project: 221361
Last Revised: March 2023

Client: Delhi Development Inc.

Prepared by: BD
Checked by: CS

N | 1:4,500 | 0 100 200 m

Contains information licensed under the Open Government License– Ontario Orthoimagery Baselayer: FBS Haldimand Norfolk Region (2010)

C:\ODB\OneDrive - Beacon Environmental\GeoSpatial\Geo Projects\2021\221361 Delhi G and CC\Q Project Files\2021-08-04 - Delhi G and CC - 221361.qgz

d) *In regard to other features and areas, ecologically important in terms of features, functions, representation or amount, and contributing to the quality and diversity of an identifiable geographic area or natural heritage system.*

According to the *Significant Wildlife Habitat Technical Guidelines* (MNRF 2000), there are four broad categories of SWH:

- Seasonal Concentration Areas of Animals;
- Rare Vegetation Communities or Specialized Habitat for Wildlife;
- Habitat for Species of Conservation Concern; and
- Animal Movement Corridors.

Within each of the above general categories, there are multiple types of SWH, each of which are intended to capture a specialized type of habitat that may or may not be captured by other existing feature-based categories (e.g., significant wetlands, significant woodlands).

This analysis distinguishes between the natural areas on the subject property, specifically the PSW and the anthropogenic units that have naturalized to provide various elements of wildlife habitat, namely the constructed golf course ponds (ELC units 2c, 2e and 2f). Constructed habitats such as golf course ponds are not typically considered in the SWH discussion, however, are noted below.

As the confirmation of SWH is the responsibility of the municipality, the identified categories are discussed as potential habitat and candidate/confirmed SWH is not determined.

The following SWH sub-categories have been considered in relation to the subject property and the proposed development.

Bat Maternity Colonies

Potential SWH under this category includes forested and swamp ecosites similar to the MNRF methodology discussed under Section 4.3. Habitat criteria includes mature deciduous or mixed forest stands with high densities (>10/ha) of suitable trees containing cavities (>25cm DBH). Based on this, potential SWH is present in the southern portion of the property, with the bulk of the feature extending off site. Bat maternity colonies SWH cannot be confirmed in the absence of species-specific monitoring.

Turtle Wintering Areas

Generally, these sites are the only known sites in the area. Sites with the highest number of individuals are most significant.

Potential SWH is present under this category, with the presence of five or more basking turtles observed in the PSW ponds (2a & 2b). This indicates the potential for over-wintering Midland Painted Turtles and one or more overwintering Snapping Turtles in the PSW ponds. Golf course ponds (Units 2c/2d) also have high numbers of turtles observed at the basking survey locations to a lesser extent then present in the PSW.

Deer Winter Congregation Areas

Although numerous separate deer tracks were observed throughout the property area, this area is not considered a deer winter congregation area, since it is not considered as such by MNRF (MNRF deer wintering areas on LIO mapping).

Turtle Nesting Areas

As with the turtle wintering areas discussed previously, the numbers of Midland Painted Turtles and Snapping Turtles observed on the subject property exceed the threshold for consideration of candidate SWH in both the golf course ponds and PSW units. It is worth noting that juvenile and mature turtles were observed on site.

Amphibian Breeding Habitat (Woodland)

Amphibian breeding surveys in 2022 revealed the presence of a number amphibians, including the following species noted under this SWH category: Gray Treefrog, Spring Peeper, Western Chorus Frog and Wood Frog. Salamander surveys were not conducted and none were incidentally encountered.

The confirmed SWH definition for the woodland category notes that the presence of a breeding population of one or more of the listed newt/salamander species or two or more of the listed frog species with at least 20 or more individuals or full chorus vocalizations. Potential SWH is present on the subject property based on this.

Amphibian Breeding Habitat (Wetland)

The following amphibian species were noted on the subject property in relation to this SWH category: American Toad, Gray Treefrog, Western Chorus Frog, Northern Leopard Frog, Green Frog and Bullfrog. Salamander surveys were not conducted and none were incidentally encountered. Potential SWH is present on the subject property based on this.

Special Concern and Rare Wildlife Species

A number of specialized habitats are described under this general heading including marsh, open country, and early successional shrublands. The category of special concern and rare wildlife species includes species that are quite rare and have experienced significant population declines in Ontario. This includes S1-S3 and SH wildlife per the NHIC. Three Eastern Wood-Pewee pairs were present as a breeding species on the subject property. This bird species is relatively common and widespread, on this basis and in our professional opinion, the presence of these Eastern Wood-Pewee alone should not confer SWH status. Regardless of this analysis, the habitat occupied by the pewees is being protected.

Summary

In summary, this analysis has considered that there are six potential candidate SWH types on the property: amphibian breeding habitat (wetland and woodland), bat maternity colonies, along with turtle nesting and turtle overwintering areas.

6. Summary of Natural Features

Table 7 provides a summary of the natural heritage features that have been identified and which need to be addressed with respect to potential development impacts. The limits of these features have been confirmed in the field by Beacon Ecologists and are depicted on **Figure 2.**

Table 7. Summary of Natural Heritage Features and Hazards (2022)

Feature	Key Functions and Attributes
Provincially Significant Wetlands	• A Provincially Significant Wetland (PSW) unit is present on the subject property and indicated on **Figure 2**. • Correspondence with the LPRCA confirmed that a site visit and feature staking were not required at this time, and therefore the ELC performed by Beacon serves as the PSW limits. Refinements were made to reflect current conditions on site and resulting in a reduction in the mapped wetland in some areas, as well as increases in others. • The PSW is inclusive of ELC units 2a, 2b, 5b and 12, and extends off site.
Other Wetlands	• Additional wetland units that were not previously indicated as being part of the PSW were present through field surveys as well and are indicated as additional wetland units on **Figure 2**. • Botanical composition and characterization of the identified wetlands is provided under Section 4.2. • Wetland communities include ELC units 8, 5 and 1.
Watercourses & Online Ponds	• Stoney Creek is located in the southern portion of the subject property and has a coolwater thermal regime. • The open portions of the Delhi Golf Estates Municipal Drain represent warmwater thermal regime and consist mainly of an online pond of anthropogenic origin. • Both watercourses provide fish habitat.
Significant Wildlife Habitat	• Potential SWH was identified for the following categories: o Amphibian breeding habitat (wetland); o Amphibian breeding habitat (woodland); o Bat maternity colonies; o Turtle nesting areas; o Turtle wintering areas; • Potential SWH for the above categories is located within the PSW. • The confirmation of SWH is the responsibility of the municipality and therefore no confirmed SWH is discussed. This report notes the difference in treatment of the PSW units and built golf course ponds with respect to SWH.
Threatened and Endangered Species Habitat	Seasonal surveys have confirmed the presence of the following threatened and endangered species on the subject property: • Butternut (END) • American Chestnut (END)

Feature	Key Functions and Attributes
	• Potential suitable habitat for endangered bats has been recorded in the treed communities on the subject property and will be subject to seasonal surveys should removals be proposed. • Potential habitat for the federally endangered and provincially threatened Creek Chub habitat is present in the shallow pond and marsh areas within the PSWs on the subject property. Discussion with MECP and DFO will be undertaken to ensure compliance with the ESA and SARA.
Hazard Lands (i.e., Floodplain and Meander belt)	• A floodplain is present on the subject property in associated with Stoney Creek in the southern area and is visualized on **Figure 2** and **3**. The floodplain has been modified in two areas to optimize the design and development limit of the subject property (R.J. Burnside 2022). • A meander belt assessment is being prepared for the Municipal Drain and will be used to inform the natural channel design.

7. Proposed Redevelopment

The proposed redevelopment will shift the current golf course into primarily residential use (**Figure 3**). The development proposal includes a total of 874 units, comprised of the construction of 120 single family dwelling lots, 129 townhouses, 475 street townhouses and 150 units within a retirement block. The proposal also includes an Open Space Block, a community commons block, a proposed sanitary pumping station, and a stormwater management (SWM) pond for quality and quantity control.

An access road for the proposed subdivision will be provided as an extension to Tisdale Drive, another for the townhome block off Wilson Avenue and another for Street 'A' off St. Michael's Street. An additional access, for emergency purposes will be provided by maintaining the existing driveway into the Golf Course.

The proposed development limit was determined through the analysis of and required setbacks to various features present on the subject property. The features and setbacks are visually depicted on **Figure 3** and are described in Section 8 of this report.

A 6 m trail/servicing easement is proposed in the northern portion of the subject property that connects the northern areas to the proposed redevelopment in the central and southern parts of the site utilizing an existing golf cart pathway (**Figure 3**).

7.1 Site Servicing

A Functional Servicing Report (FSR; 2023a) and a Stormwater Management Report (2023b) was prepared by R. J. Burnside and Associates (Burnside) for the proposed redevelopment. A summary of the site servicing as detailed in these reports in is included below.

7.1.1 Stormwater Management

The post-development drainage scheme generally follows the existing drainage pattern. SWM for the proposed redevelopment will be achieved through using one SWM facility located at the southwest corner of the site along with SWM controls within the condo block on the North Site (portion of the lands north of northern PSW block). The facility is an off-line SWM wet pond, with an outlet to Stoney Creek that will receive most of the drainage from the southern portion of the subject property. There are additional uncontrolled areas that will drain from the subject property, which have been accommodated for by reducing the allowable release rate from SWM facility.

The northern portion of the subject property will drain to the PSW, consistent with existing conditions. The proposed condo block will incorporate its own SWM measures to control post-development flows prior to discharging to the PSW, as outlined in the FSR (Burnside 2023a). The single-family lots have limited opportunity for on-site stormwater control measures, therefore will have a direct storm discharge to the PSW.

Currently the PSW discharges to the existing piped section of the drain runs through the proposed retirement block and proposed residential units before outletting into open channel portion of the drain. Re-alignment of the piped section is proposed, moving the pipe into the ROW, where it will outlet in the same location as the existing condition. The realignment has been sized to convey the same flow as the existing condition to maintain the existing environmental features.

Ultimately, all drainage from the subject property, including the SWM facility, will discharge to Stoney Creek.

Per the SWM Report (Burnside 2023b), the four outfall locations set-up in the pre-development model remained unchanged in the post-development scenario. At detailed design a proposed outlet structure will be designed that replicates this discharge to the best extent possible.

The roof drainage from the individual lots will be directed at the surface to pervious areas to promote infiltration and reduce surface runoff.

7.1.1.1 Quality and Quantity Control

An oil-grit separator and/or surface low impact development (LID) measures are proposed for the northern portion of the subject property to ensure the provision of the 80% TSS removal associated with Level 1 quality control prior to entering the PSW. Further details will be provided at the detailed design stage.

The SWM facility will be sized in accordance with the MECP requirements for the provision of Level 1 Quantity Control.

Extended Detention volume for the SWM facility will be provided to meet the greater of the 40m^3/ha noted in the MECP manual or the equivalent runoff from the 25mm storm event. The extended detention will be released over a minimum 24-hour period.

Most of the uncontrolled areas that do not reach the SWM ponds are rear yards which are considered "clean runoff" sources.

7.1.2 Sanitary Servicing

The northern portion of the subject property will connect and discharge into the existing sanitary sewer system within the St Michael's Street ROW. From there, the sewer flows by gravity into the nearby pumping station where it is pumped to Main Street pumping station and onto the Delhi wastewater treatment plant.

A new sanitary pumping station and forcemain is proposed to service the southern portion of the subject property. A collection of gravity sewers within the southern portion of the subject property will collect flows and direct them to the proposed pumping station and onto the proposed forcemain. The forcemain will connect to Delhi's existing sanitary sewer network. The connection point is examined in further detail in the External Servicing Study by T.Y. Lin (2022). The pumping station and associated linear infrastructure would be assumed by the County after construction.

7.1.3 Water Servicing

The proposed water supply for the proposed subdivision will be delivered by the existing municipal watermain that services the community of Delhi. The water supply requirement is estimated to be 596 m^3/day for the Average Day Flow and 1267 m^3/ Please refer to the External Servicing Study prepared by T.Y. Lin (2022) for more information regarding the existing system and required upgrades. A new watermain connection has been proposed through the servicing easement connecting the northern and southern portions of the site through the existing golf cart path between the PSW units.

7.2 Grading

A conceptual grading design for the subject property has been developed by Burnside and limits of proposed grading are shown on **Figure 3**. Limits of grading have considered the protection of natural features and associated buffer areas, with efforts on minimizing natural feature intrusions where adjustments can be made.

7.3 Dewatering

A preliminary dewatering assessment was carried out at the Site to provide an estimate of pumping rates for construction excavations in proposed municipal servicing, residential basements, and the SWM pond in order to identify the type of water handling permit likely required during construction. Dewatering potential has been assessed on the depths of excavations, types of soils anticipated to be encountered at the foundation levels, and the interpreted seasonally high groundwater levels. Details on the dewatering requirements are included in the Hydrogeological Assessment (WSP 2023).

A preliminary dewatering assessment has estimated that a Permit to Take Water (PTTW) is likely to be needed for construction of the SWM pond and may be required for a combination of other excavation elements if construction is carried out during periods when groundwater is higher (winter and spring).

7.4 Floodplain Modification

The floodplain has been modified in two areas to optimize the design and development limit of the subject property (Burnside 2023a). The online pond, located along the Delhi Golf Estates Municipal Drain, which is anthropogenic in nature, was desirable to remove the land from the floodplain. The other minor adjustment to the floodplain is along James Street at the southern limit of the property; the floodplain has been adjusted to allow an extra lot fronting onto James Street. The adjustments to the floodplain were made possible by the widening and naturalization of the open ditch channel, the larger channel resulted in a volume of cut material that offset the fill volumes for the floodplain adjustments. The development limit has been defined as either 100-Year Flood Line, the regulated limit per LPRCA, the 30 m regulated area for the naturalized channel, or as the 30 m buffer from the PSW within the subject property.

7.5 Naturalized Channel Design

A portion of the Delhi Golf Estates Municipal Drain was altered significantly in the past through the construction of online ponds, likely for the purposes of golf course irrigation. These shallow pond features have resulted in a loss of aquatic habitat quality, thermal impacts, sediment accumulation and the creation of multiple barriers to fish migration. The primary objective of the design is to decommission the existing pond and reinstate a naturalized channel to provide enhanced aquatic habitat conditions within the tributary system. A Geomorphic Assessment has been prepared by Beacon (2023a) under separate cover.

8. Potential Impacts and Mitigation

The following sections present some of the key potential impacts of the proposed redevelopment and identify mitigation opportunities and compensation measures to be utilized to minimize the adverse effects of the project.

8.1 Impact Assessment

Background review and field investigations identified that the subject property consists of a predominantly anthropogenic golf course area with PSW units, woodlands, Stoney Creek and an associated floodplain. These features have been defined and delineated by Beacon and Burnside (**Figure 2**). These constraints to development and their applied setbacks have defined the limits for the proposed development that is proposed and visualized on **Figure 3**.

In order to establish the development limit, a 10 m setback was applied to the wooded areas, a 15 m setback was applied to the municipal drain feature, and a 30 m buffer was added to Stoney Creek and the wetland units on site. The latter includes both the PSW units and additional wetlands that were encountered throughout seasonal field studies. Buffers and setbacks are discussed in greater detail below and depicted on **Figure 3**.

The proposed shift in land use will introduce different pressures to the natural system, as the post-development condition will support a higher density of people with more diverse forms of land use. The current condition is predominantly an open landscape with natural features, although some element of disturbance is present with the current golf course operation. The post-development condition introduces an increase in human habitation and may have a number of impacts that are discussed in the following sections of this report.

Potential adverse effects associated with the proposed development could include the following:

- Direct loss of vegetation and wildlife habitat;
- Encroachment into natural features and buffers;
- Interruptions associated with trail construction and the realignment of Delhi Golf Estates Municipal Drain;
- Changes in hydrology associated with increase in impervious surfaces;
- Soil or sediment compaction and/or mobilization; and
- Anthropogenic disturbance (e.g., noise, light etc.) to the natural system in the post development condition.

Removal of Vegetation and Wildlife Habitat

Vegetation removal to accommodate the proposed redevelopment is proposed throughout the golf course lands where a number of planted trees and tree groupings are present. The anthropogenic condition of the golf course and its botanical composition is discussed under Sections 4.2.1 and 4.2.2 of this report. The proposed redevelopment is almost entirely outside of the natural areas and their associated buffers and therefore the removal of sensitive and uncommon vegetation has largely been avoided.

An Arborist Report was prepared and will be provided under separate cover (Beacon 2023b). A total of 877 individually tagged trees and approximately 260 tallied trees between 1 cm and 19 cm DBH are proposed for removal to accommodate the development, and an additional 80 are proposed for removal due to poor condition.

Beacon staff noted the presence of uncommon, rare and/or protected plant species through the ESA, as discussed under Section 4.2.2 and 4.3 of this report. The location of Butternut, American Chestnut, Northern Pin Oak, Pignut Hickory and Kentucky Coffee-tree are depicted on **Figure 2**, with the Butternut tree and Kentucky Coffee-tree situated outside of the development footprint. The proposed removal of the other species is unclear at this time and will be revisited once an arborist report is available, although efforts will be made for retention.

The shift of the on-line pond into a natural channel design will introduce impacts to the wildlife using the pond currently, in both the short term through construction disruption, and long-term as the habitat offered will change through enhancements. This is discussed in more detail throughout this section.

Reptile and amphibian movement across the existing golf course between the PSWs in the northern and southern parts of the property will be substantially reduced as the land urbanizes, although some movement/migration will still be possible in the short term.

Increase in Impervious Surfaces

The current site condition is predominantly softscape, although some impervious surfaces are present. The proposed redevelopment plan represents an expansion of impervious surfaces in the eastern portion of the property with the bulk of the area outside of the natural features and associated buffers proposed to be impervious. If unmitigated, the land use changes associated with the proposed redevelopment and increase in impervious surfaces will result in an increase in runoff and decrease in infiltration.

Trail within Natural Heritage System

A 6 m trail and servicing easement is proposed through the northern PSW and corresponds with the location of an existing golf cart pathway. This encroachment is visualized in **Figure 3** and totals 0.1 ha of site alteration with the natural system, which includes the PSW, adjacent woodlands and the buffer to these features. The potential impacts of this will be reassessed through detailed design.

Realignment of the Delhi Golf Estates Municipal Drain

The open, online pond section of the municipal drain is proposed for re-alignment in the southern portion of the subject property. The portion of feature that will be re-aligned is currently channelized and located within a golf course area.

In order to facilitate natural channel design and construction of riparian wetlands to provide enhanced aquatic habitat, removal of the existing channel and associated golf course ponds (i.e., ELC communities 2d and 2c) is required. The approximate area of temporary disturbance, inclusive of proposed grading, is 0.6 ha, subject to detailed design.

In addition, the existing piped section of the drain runs through the proposed retirement block and proposed residential units before outletting into open channel portion of the drain. Re-alignment of the piped section is proposed, moving the pipe into the ROW, where it will outlet in the same location as the existing condition.

Soil Mobilization

Construction works such as grading, grubbing and excavation can cause the movement of sediment into the protected natural features.

Anthropogenic Effects on Wildlife Following Development

The effects of noise and light on wildlife are very difficult to quantify. Noise, in particular, may be a reason why landscape-level effects are known to occur within urban matrices even as natural areas are set aside. The effects of these stressors are difficult to identify however remain important to consider in the context of large-scale developments in proximity to natural areas. A certain amount of existing noise and light pollution exists on the subject property based on the proximity of roadways and the existing use in some areas. Despite this, the valley system hosts a number of uncommon plant species and area sensitive bird species. The proximity of new development up against the wetland and woodland edges has the potential to represent an increase in noise and light effects.

As the proposed redevelopment accommodates more human activity than the existing use, it could potentially increase the risk of encroachments into the adjacent natural area such as trail creation and waste dumping. Novel and uncontrolled access into a natural system can result in direct effects on flora and fauna and garbage deposited into the valley. Non-native invasive plant species are also spread in this manner, and overuse can result in physical damage and degradation of the natural system that is being protected from development.

Generally speaking, and without any mitigative measures it can be anticipated that dumping of waste into natural areas, novel vertical buildings and poorly planned lighting could be negative effects on the natural system.

8.2 Recommended Mitigation Measures

The following section identifies mitigation measures to minimize effects of the project and address the impacts discussed in the preceding section.

The proposed redevelopment is situated within an area that has shifted into a predominantly anthropogenic landscape given the golf course usage, which inevitably reduces natural heritage functions of any particular site within that larger landscape area. However, these kinds of landscape level changes cannot be wholly mitigated on a site-by-site basis, and a shift in the natural heritage values towards an urban tolerant system will continue to occur. Despite the recommendation of the numerous mitigation measures in this section, impacts such as a general trend towards urbanization can not be addressed at the site level.

Mitigation by Design

As the KNHF/KHF features and functions of the subject property are largely contained within the adjacent lands and along the eastern edge of the subject property, it is anticipated that the site-specific effects have largely been mitigated by the design of the development plan. The maintenance of a contiguous natural corridor is proposed through this built-up valley corridor. The redevelopment is proposed within in area that has been previously altered and is currently represented by residential use.

Feature Buffers

The following buffers (or minimum vegetation protection zones [MVPZs]) have generally been applied:

- Woodlands 10 m;
- Wetlands 30 m; and
- Stoney Creek 30 m.

The objective of a buffer is to insulate the natural system from the proposed site alteration and the application of these buffers will further remove the natural system from the proposed future site condition.

A 10 m buffer has been applied to the wooded areas on the subject property, which are generally not the outermost constraint driving the development limit. The woodland buffer formulates the natural system boundary in one location, south of the 2b portion of the PSW. This distance will adequately

insulate the woodland along the wetland fringe and provides sufficient distance from the proposed redevelopment. In many jurisdictions a 10 m dripline buffer is added to woodlands when they are being retained in the face of adjacent land use change or land development. Although not explicitly adopted by Ontario municipalities, the guidelines provided through the Carolinian Canada Committee (2003) in their Draft Guidelines for Environmental Impact Statements are often used as a reference. Their generic buffer guidelines, based on the best available science at that time, are 10 m buffers for woodlands measured from the dripline. Although there are some exceptions, the standard woodland buffer in many southern Ontario jurisdictions has become 10 m on dripline.

A 30 m setback has been applied to all the wetlands on the subject property, which includes the PSW units and the additional wetlands that were mapped outside of the PSW. This setback serves as the outermost constraint throughout much of the development perimeter and will serve to protect the attributes and functions of the wetlands.

Typical buffers for the protection of aquatic resources are 15 m for warmwater systems and 30 m for cold water systems unless any particular site-specific conditions indicate that more is required. In this case, a 30 m setback has been applied to Stoney Creek, and a 30 m corridor (i.e., 15 m on either side) has been provided to the municipal drain in which the natural channel design will occur.

Fish and Wildlife Salvage for Pond Removal

The channel realignment involves the removal of an online pond that contains wildlife including reptiles, amphibians and plants. A wildlife salvage and relocation exercise will need to take place to ensure harm is minimized and that the wildlife can continue to persist elsewhere on site and generally in the local landscape. This exercise will be timed appropriately to ensure the likelihood of missing animals is minimized and to ensure critical timing windows in the life cycle are avoided thereby minimizing potential stressors.

Encroachment into Natural Feature and Buffers

Following the application of the aforementioned buffers and setbacks, the total encroachment area associated with the proposed redevelopment is approximately 0.11 ha (**Figure 3**).

A minor intrusion into the wetland and woodland buffer north of ELC unit 2a is proposed, much of which is temporary disturbance associated with outfall grading. This totals 0.01 ha and is outside of the natural feature, confined to the setback.

A second intrusion area is depicted on **Figure 3** as a 6 m trail/servicing easement that spans the ELC unit 2a/2b complex, as well as the adjacent woodland units (ELC 6b). The total encroachment area associated with this is 0.1 ha.

Water Balance and LID Measures

A hydrogeological assessment has been prepared by WSP (2023) for the subject property. A water balance assessment for the proposed redevelopment has estimated a 27.2% deficit in groundwater recharge and a 69% increase in runoff to the SWM pond in the post-development condition without implementing mitigation measures. The addition of 0.25 m of topsoil and disconnecting roof leaders on

single and semi-detached properties to allow rear roof runoff to flow to the rear yards for additional infiltration will reduce the post-development infiltration deficit to 4.8%, creating a near balance with the pre-development condition.

WSP (2023) indicates that the water balance should be reassessed at detail design to refine roof runoff contributions to additional post-development infiltration on rear lawns, specifically to differentiate on a lot-by-lot basis between front and rear-draining lots. The initial assessment has assumed all lots are rear draining, which should be reassessed.

Mitigation measures are recommended to promote on site infiltration. At this time, this includes roof drainage to yards and increased topsoil, however, this may be revised at the detailed design stage. Rear roof runoff from single and semi-detached houses will be directed onto the ground rather than to the SWM pond using disconnected drain spouts for additional infiltration. The excess roof runoff directed to the lawns is then treated as water surplus that will infiltrate and runoff in the same proportion as natural precipitation falling upon the lawns. Secondly, the placement of thicker topsoil (0.25 m to 0.40 m thickness) in landscaped areas will provide additional retention of water.

Opportunities for the incorporation of LID measures will be addressed through detailed design to promote infiltration on the subject property.

Tree Inventory and Protection Plan

There is potential for damage to occur to trees slated for retention during construction if proper precautions and protection measures are not implemented. Trees can be negatively impacted through grade changes, soil compaction, root cutting, and mechanical damage to trunks and branches resulting from the operation of construction equipment.

Details with respect to tree protection including Tree Protection Zones (TPZs) for the site are provided in the Arborist Report prepared by Beacon (2023b). No grading, soil disturbance or surface treatments shall occur within the TPZ. No equipment or materials shall be stored inside the TPZ. If grading or site alteration is required within the TPZs and ISA certified arborist should be consulted. Where trees have been identified for retention, tree protection fencing will be erected and maintained throughout the duration of all construction activity. There shall be no disturbance within the tree protection zone. Further details on this are found within the arborist report and are to be adhered to.

Buffer Planting Plan

A buffer planting plan will be prepared to include additional plantings within the identified buffer areas. The addition of a planted buffer area will convert existing golf course to natural areas and will further bolster the utility of the buffer distance to protect the natural feature from potentially adverse impacts associated with the proposed redevelopment, in addition to increasing overall naturalized cover area.

Species should be selected that are appropriate to the natural system at this location and are native, self-sustaining species.

Should the rare and/or uncommon tree species discussed under Section 4.2.2 be proposed for removal, these species should be included in the planting plan at a minimum of a 1:1 replacement ratio.

Sediment and Erosion Control

The erosion and sediment control plan for the subject property will be developed by Burnside, in accordance with the County and LPRCA guidelines. The plan will be completed at the detailed design stage prior to the undertaking of any grading activity on the subject property.

Erosion and sediment control will be implemented for all construction activities including topsoil stripping, foundation excavation, and stockpiling of material. The following erosion and sediment control measures will be implemented:

- Temporary sediment control fence will be placed around the perimeter of all areas to be disturbed prior to grading. Double row fencing may be appropriate adjacent to natural areas;
- Appropriately designed sediment control ponds will be provided;
- Catch basin (CB) sediment traps will be provided on existing CBs affected by construction as well as newly installed CBs within the new development Site;
- Check dams, etc., for erosion/velocity control will be provided; and
- Gravel mud mats will be provided at all construction access points to minimize off-site tracking of sediment.

All temporary erosion and sediment control measures will be routinely inspected and repaired if required during construction. Temporary controls will not be removed until the serviced areas have been restored and stabilized.

Connection to LID measures will not be completed until the subject property is stabilized with vegetation to minimize sediment accumulation and maintenance issues.

All reasonable measures will be taken to ensure that sediment loading is minimized both during and following construction. Additional details will be provided as part of the detailed design.

Channel Naturalization and Enhancement of Riparian Corridor

A portion of the Delhi Golf Estates Municipal Drain on the subject property was altered significantly in the past through the construction of online ponds, likely for the purposes of golf course irrigation. These shallow pond features have resulted in a loss of aquatic habitat quality, thermal impacts, sediment accumulation and the creation of multiple barriers to fish migration. As such, Beacon is preparing natural channel design drawings. The primary objective of the design is to decommission the existing pond and reinstate a naturalized channel to provide enhanced aquatic habitat conditions within the tributary system.

The piped portion of the drain will be realigned and has been sized to convey the same flow as the existing condition to maintain the existing environmental features. A Geomorphic Assessment has been prepared by Beacon (2023a) under separate cover.

In order to provide a benefit to the natural heritage features and functions on the property, specifically the drainage feature, a number of studies are underway to support the re-alignment of the municipal drain within the subject property. The pond decommissioning, re-alignment of the channel and naturalization of the newly created riparian corridor will create a larger, contiguous natural system that will incorporate enhanced functions as described below.

- Restoration of a more natural channel planform;
- Reinstatement of a functional floodplain and riparian zone;
- Removal of barriers to fish passage;
- Enhancement to aquatic habitat;
- Creation of wetland communities;
- Improved natural heritage feature connectivity; and
- Increased wildlife habitat.

Fisheries Protection

Subject to the detailed design of the channel realignment, the following general mitigation measures are recommended to be adapted for the project to ensure the protection of fish and fish habitat within Stoney Creek and the municipal drain.

- Works will be conducted within the fisheries timing window, as prescribed by MNRF;
- ESC measures will be installed to contain the construction zone and to manage site drainage to prevent erosion and sedimentation to downstream watercourses;
- Installation of ESC measures will occur prior to the start of construction, maintained, and repaired in place until all areas are stabilized;
- Isolation of stockpiled and other excess materials with suitable ESC measures and stored outside the creek corridor;
- During construction, the existing corridor will be isolated via temporary dams and, if deemed necessary, a flow diversion pipe will convey drainage around the work area;
- If installed, the flow diversion pipe will be screened to prevent entrainment or impingement of fish;
- Fish (if present) shall be transferred (using appropriate capture, handling, and release techniques to prevent harm and minimize stress) downstream or away from the construction area. A scientific collectors permit will be obtained MNRF to relocate fish trapped within the isolated work area;
- A qualified environmental professional will safely relocate them to an appropriate location downstream of the isolation area;
- Any work completed outside of the construction window (i.e., between March 15 to July 15 when construction works are generally restricted) will require DFO/MNRF approval, and scheduling of works in inclement weather will be avoided; and
- An Aquatic Biologist will monitor/adjust the in-water mitigation as required. The watercourse will be monitored to observe signs of sedimentation during all phases of the work and take any necessary corrective actions.

Timing of Vegetation Removal

The federal *Migratory Bird Convention Act* (1994) protects the nests, eggs and young of most bird species from harm or destruction. Environment Canada considers the general nesting period of breeding birds in southern Ontario to be between late March and the end of August. This includes times at the beginning and end of the season when only a few species might be nesting. It is recommended that during the peak period of bird nesting (i.e., between mid-April and mid-July), no vegetation clearing or disturbance to nesting bird habitat should occur. Vegetation that may be supportive of breeding birds is not limited to trees, and includes shrubs, grasslands and anthropogenic conditions.

In the "shoulder" seasons of April 1 to April 15, and July 16 to August 31, vegetation clearing could occur, but only after an ecologist with appropriate avian knowledge has surveyed the area to confirm lack of nesting. For any proposed clearing of vegetation within the breeding bird season an ecologist should undertake detailed nest searches immediately prior (within two days) to site alteration to ensure that no active nests are present.

If nesting is found, then vegetation clearing in an area around the nest, the size of which depends on the specific circumstances, has to wait until nesting has concluded. The likelihood of nesting birds being present in the "shoulder" seasons also depends on the habitat type.

From September 1 through to March 31, vegetation clearing can occur without nest surveys, but the need to ensure nest protection still applies (i.e., if an active nest is known to be present it must be protected).

Similar to the timing windows with respect to breeding birds, all tree removals are to occur outside of the active roosting period for bat species to avoid interacting adversely with these animals (April 1 – October 31).

Directional Lighting

To the extent possible given security and safety issues the future configuration of lighting associated with the proposed redevelopment should be downturned and pointed away from the natural system, specifically the wetlands, woodlands and watercourse areas.

Fencing Installation

A fence is to be built to current municipal standards between the subject property and natural feature boundary. Fence installation serves multiple benefits to the natural system including mitigating against rear-year dumping of waste and minimizes the flow of people and their companion animals into natural areas by serving as a physical barrier.

9. Policy Conformity

The natural heritage policy framework with respect to the subject property was detailed under Section 3 of this report.

9.1 *Fisheries Act*

In compliance with Section 35 of the Act, a Request for Review will be required. It is anticipated the proposed channel re-alignment of the Delhi Golf Estates Municipal Drain may be recognized as alteration, disruption of fish habitat and additional measures and guidance by DFO may be required to reduce those impacts.

9.2 Provincial Policy Statement

Policy 2.1 of the PPS provides direction to regional and local municipalities regarding planning policies specifically for the protection and management of natural heritage features and resources.

Section 2.3 of the PPS provides direction to the planning authority with respect to natural heritage features and functions.

Within the PPS, natural heritage features listed and identified on the subject property are:

- Significant wetlands – present;
- Habitat of endangered or threatened species - as discussed in Sections 4.3;
- Fish habitat – present in Stoney Creek; and
- Significant wildlife habitat- Potential SWH present within wetlands and woodlands.

A PSW is present on the subject property and additional wetland units were identified. The wetlands on site were delineated during the 2022 field season and are protected with a 30 m buffer, with a minor encroachment associated with the 6 m trail easement. Fish habitat associated with Stoney Creek (coolwater) will be buffered by a 30 m setback, with the associated tributary/municipal drain (warmwater) receiving a 15 m setback which will undergo a natural channel design and enhancements.

Potential significant wildlife habitat was identified within the PSW units in the northern portion of the property which will be retained and buffered appropriately to retain this wildlife functionality.

Habitat of endangered or threatened species was identified and will be addressed through the ESA below.

9.3 County of Norfolk Official Plan

This EIS has been prepared per the policies of the County to demonstrate no negative impact on the identified natural heritage features. Features were identified to trigger the completion of this report and include a PSW, woodlands, Significant Wildlife Habitat, Habitat of threatened and endangered species, fish habitat and watercourses (Stoney Creek)

Appropriate buffers and setbacks have been applied to the identified features and were utilized to inform the proposed development limits. A 30 m buffer has been applied to wetlands on site, 10 m on woodlands, 30 m on the coolwater Stoney Creek and 15 m on the tributaries of the watercourse (warmwater) which will undergo a channel re-design and naturalization. The buffer and setback configurations provide insulation from the impacts of the proposed development to ensure the form and function remains in the post development condition.

A robust discussion on the proposed mitigation measures is provided in this report to ensure the test of no negative impact is met, per County policy 3.5.2.

9.4 LPRCA Regulations and Policies

LPRCA regulated areas are present on the subject property and therefore a permit will likely be required from the authority to proceed with site alteration.

Beacon consulted with the LPRCA to ensure they were in agreement with the terms of reference provided and confirmed that their team would not be required for a feature staking or site visit.

Ecologically appropriate buffers have been applied to natural features to prevent any negative impacts and to enhance the Natural Heritage System Features and function. A buffer planting plan will be prepared to include additional plantings within the identified buffer areas. The addition of a planted buffer area will convert existing golf course to natural areas and will further bolster the utility of the buffer distance to protect the natural feature from potentially adverse impacts associated with the proposed redevelopment, in addition to increasing overall naturalized cover area.

9.5 *Endangered Species Act* and *Species at Risk Act*

A Butternut tree was identified and is outside of the development footprint. An 18 m setback has been applied based on the DBH of this tree and the habitat regulation, and no site alteration is proposed within that area.

A suspected American Chestnut tree was located and will undergo genetic testing to ensure accurate identification. Following identification, Beacon will consult with the MECP as necessary to ensure no negative impacts and conformity with the ESA.

A Kentucky Coffee-tree was also identified and is situated outside of the proposed redevelopment envelope. This tree is likely planted and therefore not subject to the ESA, however this will be confirmed in consultation with the consulting arborist.

Potential suitable habitat for endangered bat species may be present in the woodland communities on the subject property. Taxa specific studies were not undertaken at this time, and consultation with the MECP will be required to ensure the application proceeds in conformity with the ESA.

Suitable habitat was also flagged for herpetofauna (Blanding's Turtle, Eastern Foxsnake and Eastern Hog-nosed Snake_, and therefore consultation with the MECP will be required to ensure the appropriate fieldwork is undertaken and that the application proceeds in conformity with the ESA.

There may be suitable habitat for Lake Chubsucker in the PSW units at the northern portion of the property. Discussion with MECP and DFO will be undertaken to ensure protection of the species under the ESA and SARA.

10. Summary

Beacon has reviewed the existing natural heritage policies as they pertain to the subject property. A comprehensive, seasonal field program was developed to understand the site conditions, context and function with respect to natural heritage features.

Natural heritage features were identified through Beacon's field program and through consultation with other members of the consulting team and included a PSW, Stoney Creek, wooded areas, fish habitat and habitat for endangered or threatened species. Consultation with the MECP will follow as needed with respect to the need for additional surveys or analysis to address the potential for threatened and endangered species, and if necessary an addendum will be provided to this report.

The proposed redevelopment was described and has provided a collaborative analysis, with consideration for the other disciplines involved including the engineering team, hydrogeologists, geomorphologists and arborists. An impact analysis of the proposed redevelopment was provided and identified impacts including tree removal, an increase in impervious surfaces and habitat intrusions associated with the. To address and offset the identified impacts in Section 8.1, mitigation measures were proposed including LID measures, an edge management plan, wildlife relocations and vegetation removal timing. Many of these are to be refined at the detailed design stage.

Subject to the implementation of the recommended mitigation measures, the proposed redevelopment of the subject property demonstrates compliance and conformity with the relevant policies of the PPS, County, ESA and the regulations of the LPRCA.

Report prepared by:
Beacon Environmental

Chana Steinberg, B.Sc. (Hons)
Ecologist

Report prepared and reviewed by:
Beacon Environmental

Kristi Quinn, B.E.S., Cert. Env. Assessment
Principal, Senior Environmental Planner

11. Cited References

Beacon Environmental. 2023a.
Geomorphic Assessment – Delhi Golf and County Club, Norfolk County. March 2023.

Beacon Environmental. 2023b.
Arborist Report – Delhi Golf and County Club, Norfolk County. February 2023.

Canadian Wildlife Services. 1994.
Migratory Birds Convention Act.

Chapman, Lyman John and Donald F. Putnam. 1984.
The Physiography of Southern Ontario (Third Edition). Ontario Geological Survey Special Volume 2. Ontario Ministry of Natural Resources, Toronto.

Lee, H.T., W.D. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig and S. McMurray. 1998.
Ecological Land Classification for Southern Ontario: First Approximation and Its Application. Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfer Branch. SCSS Field Guide FG-02.

Ministry of Natural Resources and Forestry. 2015.
Technical Definitions and Criteria for Identifying Key Natural Heritage Features and Key Hydrologic Features for the Lake Simcoe Protection Plan. January 20, 2015.

Oldham, M. 2017.
List of the Vascular Plants of Ontario's Carolinian Zone (Ecoregion 7E). March 2017.

Ontario Ministry of Municipal Affairs. 2020.
Provincial Policy Statement. Queen's Printer for Ontario, Toronto.

Ontario Ministry of Natural Resources. 2015.
Significant Wildlife Habitat Criteria Schedules for Ecoregion 7E. January 2015.

Ontario Ministry of Natural Resources. 2007.
Endangered Species Act (S.O. 2007, Chapter 6).

Ontario Ministry of Natural Resources. 2010.
Natural Heritage Reference Manual for Natural Heritage Policies of the Provincial Policy Statement, 2005. Second Edition. Toronto: Queen's Printer for Ontario. 248 pp.

Ontario Regulation 179/06. 2006.
Lake Simcoe Region Conservation Authority: Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses.

R.J. Burnside and Associated Limited. 2023a.
Functional Servicing Report – Delhi Golf and Country Club Redevelopment. March 15, 2023.

R.J. Burnside and Associated Limited. 2023b.

Stormwater Management Report – Delhi Golf and Country Club Redevelopment. March 15, 2023.

Stanfield L., Del Giudice L., Bearss E., and Morodvanschi E. 2014.
Ontario Stream Assessment Protocol Section 4: Module 10: Assessing Headwater Drainage Features.

Toronto and Region Conservation Authority and Credit Valley Conservation. 2014.
Evaluation, Classification and Management of Headwater Drainage Features Guidelines

WSP. 2023.
Hydrogeological Assessment – Delhi Golf and Country Club. March 11, 2023.

BEACON
ENVIRONMENTAL

Appendix A

LPRCA Correspondence

From: Isabel Johnson
To: Kristi Quinn
Cc: Chana Steinberg; Jennifer Catarino
Subject: RE: Environmental Impact Study - Terms of Reference
Date: June 21, 2022 4:17:10 PM

Good afternoon,

Long Point Region Conservation Authority (LPRCA) staff have reviewed the Terms of Reference (ToR) for an Environmental Impact Study for the Delhi Golf Club in Norfolk County. Comments in relation to the study are as follows:

The ToR identified the Environmental Impact Study will be completed to facilitate a proposed residential subdivision at the Delhi Golf Club. It is important to note that LPRCA staff have not received a Planning Application or any supplementary plans for the proposed development. Therefore, the comments below only relate to the information provided in the ToR.

Staff have reviewed Fisheries and Oceans Canada's mapping in regards to the Distribution of Fish Species at Risk. Stoney Creek and the north/south tributary have Species at Risk present, so fish community sampling may be required. Please contact Fisheries and Oceans Canada for further information.

In regards to a site visit to stake the natural features on the property, LPRCA staff do not believe this is necessary at this time. The natural features are well defined and the setbacks will be determined based on the description of proposed development, impact assessment, and mitigation measures determined by the Environmental Impact Study.

You may also reach out to Norfolk County regarding this matter if you haven't done so already. The Terms of Reference will need to be approved by their staff. I have Cc'd Jennifer, a wonderful Planner from the County you may wish to contact.

Best regards,

Isabel Johnson, *Resource Planner*
Long Point Region Conservation Authority
4 Elm Street, Tillsonburg, ON. N4G 0C4
Office:519-842-4242 ext. 229. Email: ijohnson@lprca.on.ca

From: Kristi Quinn <kquinn@beaconenviro.com>
Sent: June 15, 2022 6:59 AM
To: Leigh-Anne Mauthe <lmauthe@lprca.on.ca>; Isabel Johnson <ijohnson@lprca.on.ca>
Cc: Chana Steinberg <csteinberg@beaconenviro.com>
Subject: Environmental Impact Study - Terms of Reference - Delhi (221361)

Good morning Leigh-Anne and Isabel,
Beacon Environmental has been retained to prepare an Environmental Impact Study for the Delhi Golf Club in Norfolk County in support of an expansion of the settlement area boundary. Out team

of ecologists is currently proceeding with seasonal surveys and ask that you kindly review the attached Terms of Reference for the study and provide us with any comments/feedback you may have.

In addition, we would like to set up a time to conduct a site visit to confirm and stake (should you require) the limits of the natural features on the property. This includes wetlands and woodland communities.

I have left a message on your office line and would be happy to discuss further at your convenience.

Regards,

Kristi Quinn, Principal, Senior Environmental Planner
BEACON ENVIRONMENTAL
C) 647.637.7586

BEACON ENVIRONMENTAL

Appendix B

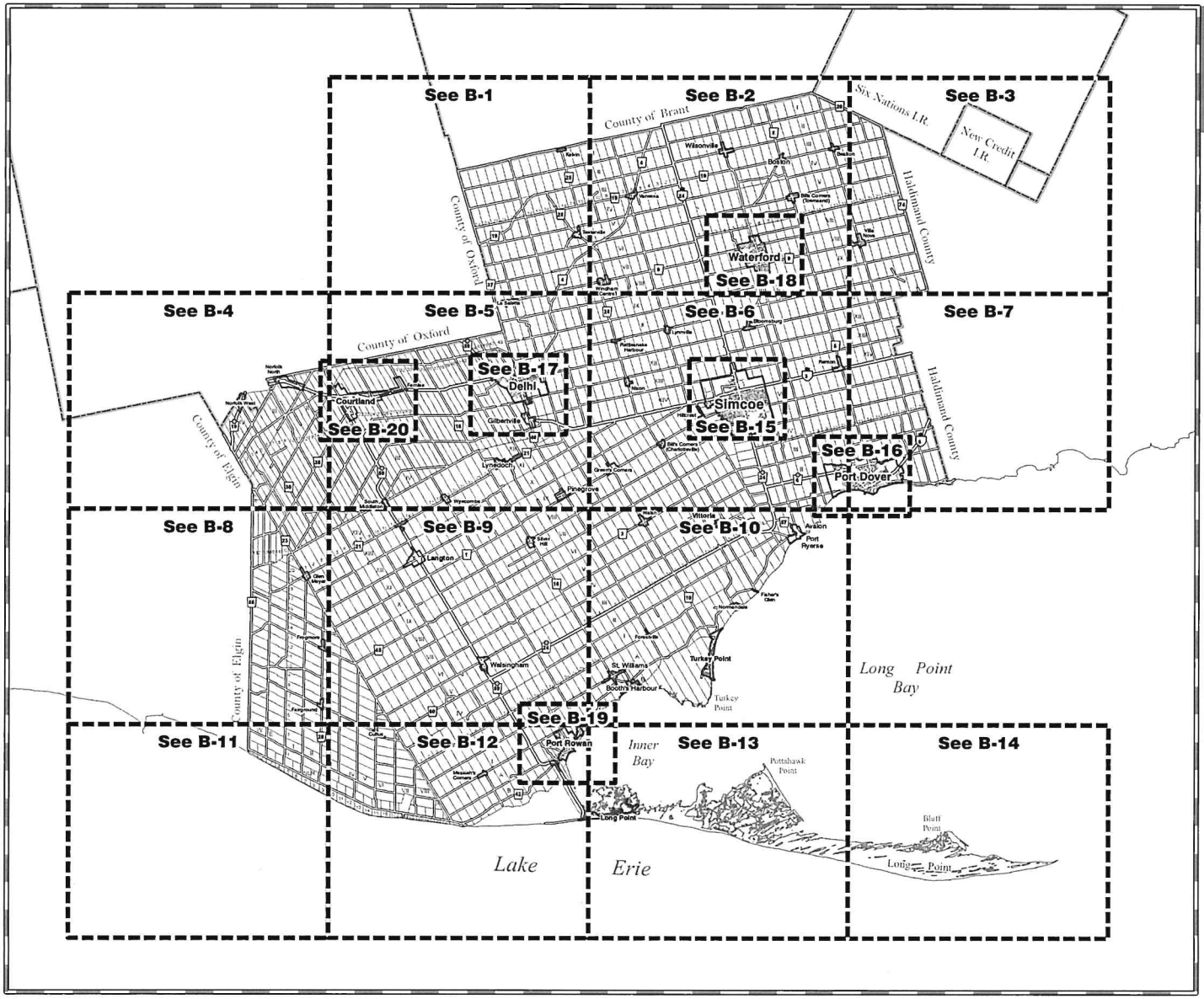
Norfolk County OP Mapping

BEACON
ENVIRONMENTAL

Appendix C

Norfolk County OP Mapping

Norfolk County
OFFICIAL PLAN
Schedule "B"

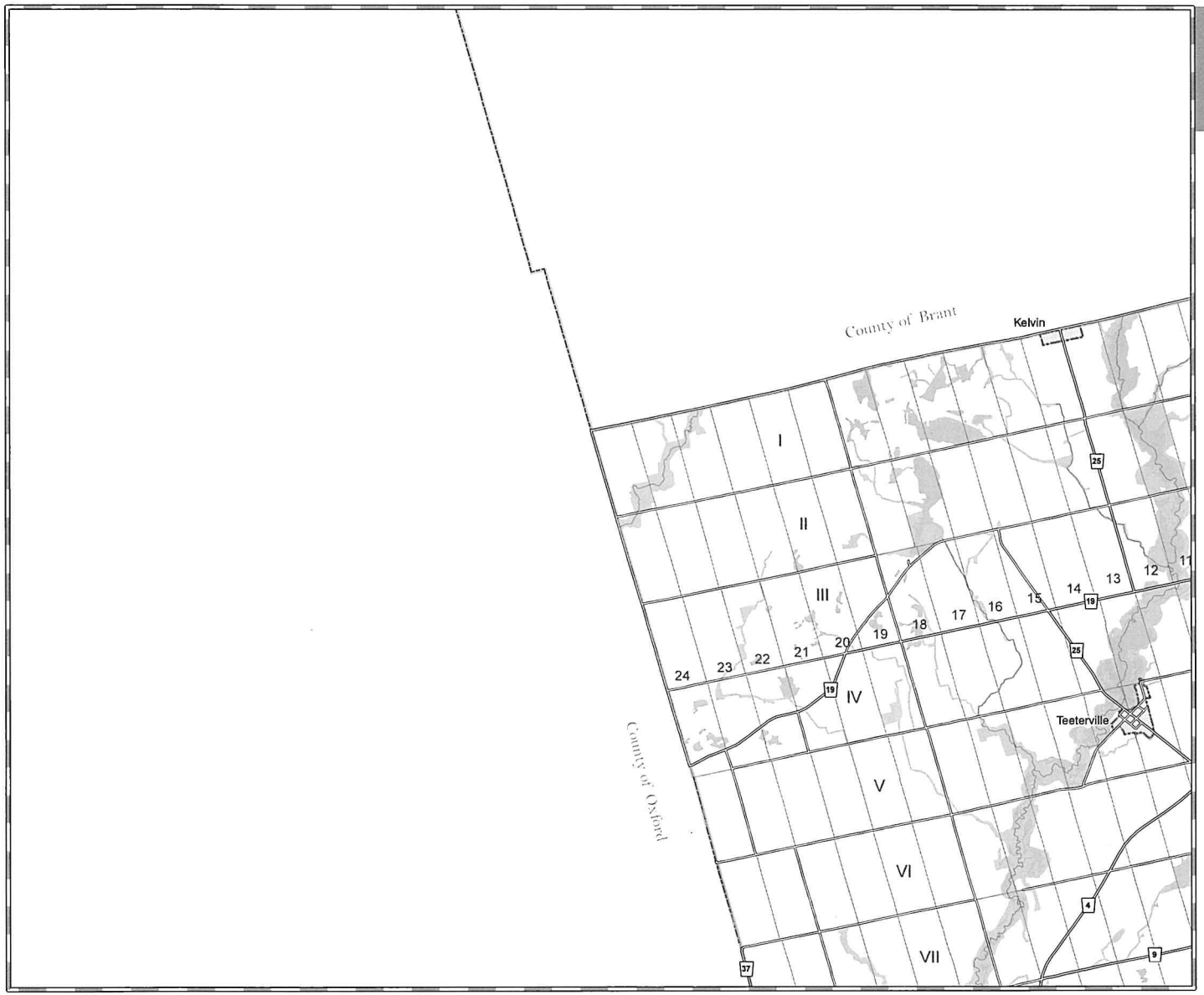


Key Map
Land Use

Revision Date: January 1, 2022

Norfolk County OFFICIAL PLAN

Schedule "B-1"



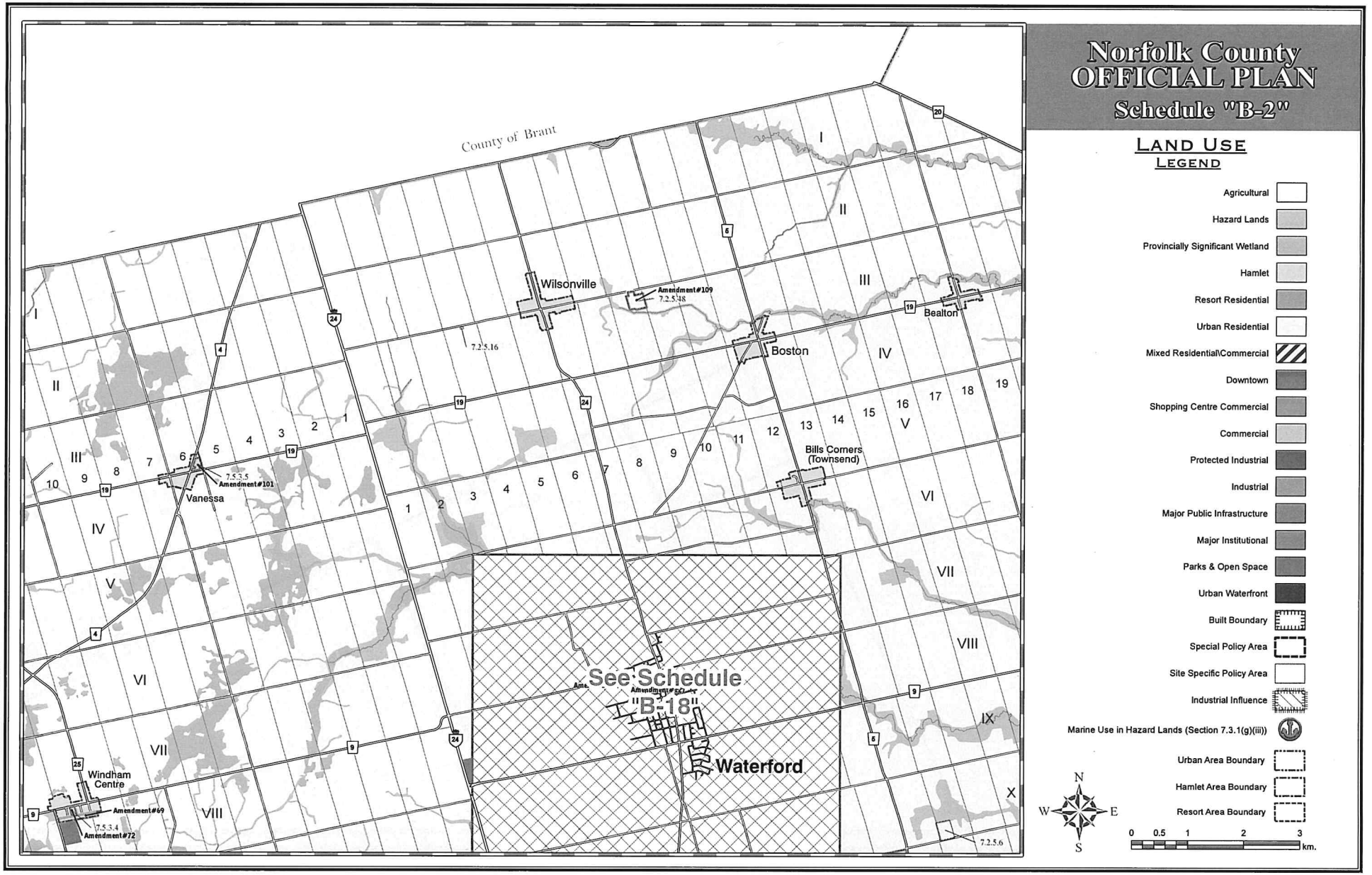
Land Use
Legend

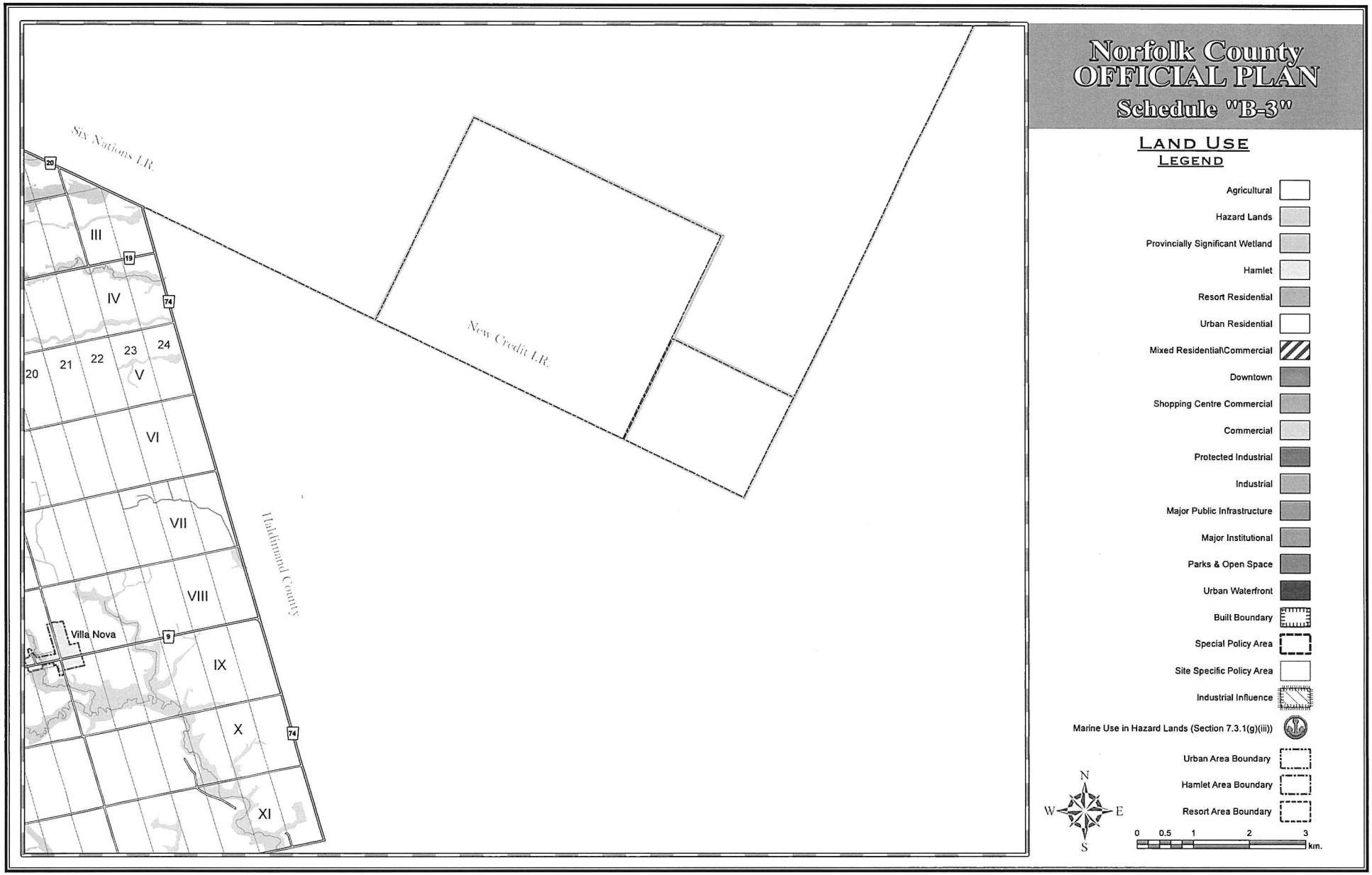
- Agricultural
- Hazard Lands
- Provincially Significant Wetland
- Hamlet
- Resort Residential
- Urban Residential
- Mixed Residential\Commercial
- Downtown
- Shopping Centre Commercial
- Commercial
- Protected Industrial
- Industrial
- Major Public Infrastructure
- Major Institutional
- Parks & Open Space
- Urban Waterfront
- Built Boundary
- Special Policy Area
- Site Specific Policy Area
- Industrial Influence
- Marine Use in Hazard Lands (Section 7.3.1(g)(iii))
- Urban Area Boundary
- Hamlet Area Boundary
- Resort Area Boundary

N
W E
S

0 0.5 1 2 3 km.

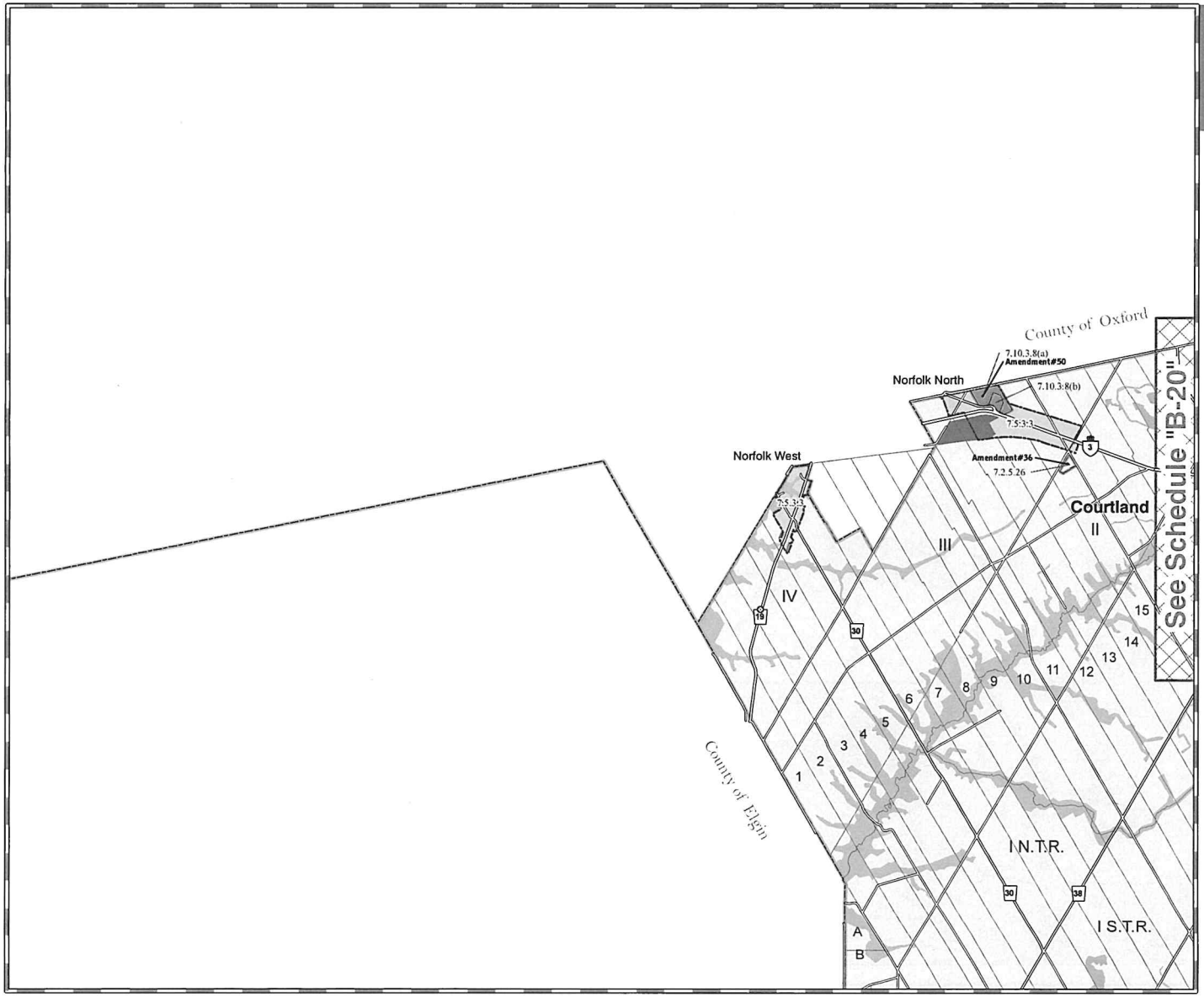
Revision Date: January 1, 2022


Norfolk County
OFFICIAL PLAN
Schedule "B-2"
LAND USE
LEGEND
Agricultural
Hazard Lands
Provincially Significant Wetland
Hamlet
Resort Residential
Urban Residential
Mixed Residential\Commercial
Downtown
Shopping Centre Commercial
Commercial
Protected Industrial
Industrial
Major Public Infrastructure
Major Institutional
Parks & Open Space
Urban Waterfront
Built Boundary
Special Policy Area
Site Specific Policy Area
Industrial Influence
Marine Use in Hazard Lands (Section 7.3.1(g)(iii))
Urban Area Boundary
Hamlet Area Boundary
Resort Area Boundary
0 0.5 1 2 3 km.
N
W
E
S
County of Brant
Wilsonville
Amendment#109
7.2.5.38
7.2.5.16
Boston
Bealton
Vanessa
7.5.3.5
Amendment#101
Bills Corners
(Townsend)
See Schedule
"B-18"
Waterford
Windham
Centre
Amendment#69
7.5.3.4
Amendment#72
7.2.5.6
Revision Date: January 1, 2022


Norfolk County
OFFICIAL PLAN
Schedule "B-3"
LAND USE
LEGEND
Agricultural
Hazard Lands
Provincially Significant Wetland
Hamlet
Resort Residential
Urban Residential
Mixed Residential\Commercial
Downtown
Shopping Centre Commercial
Commercial
Protected Industrial
Industrial
Major Public Infrastructure
Major Institutional
Parks & Open Space
Urban Waterfront
Built Boundary
Special Policy Area
Site Specific Policy Area
Industrial Influence
Marine Use in Hazard Lands (Section 7.3.1(g)(iii))
Urban Area Boundary
Hamlet Area Boundary
Resort Area Boundary
N
W
E
S
0 0.5 1 2 3
km.
Six Nations I.R.
New Credit I.R.
Haldimand County
Villa Nova
III
IV
V
VI
VII
VIII
IX
X
XI
20
21
22
23
24
20
19
74
9
74
Revision Date: January 1, 2022

Norfolk County OFFICIAL PLAN

Schedule "B-4"



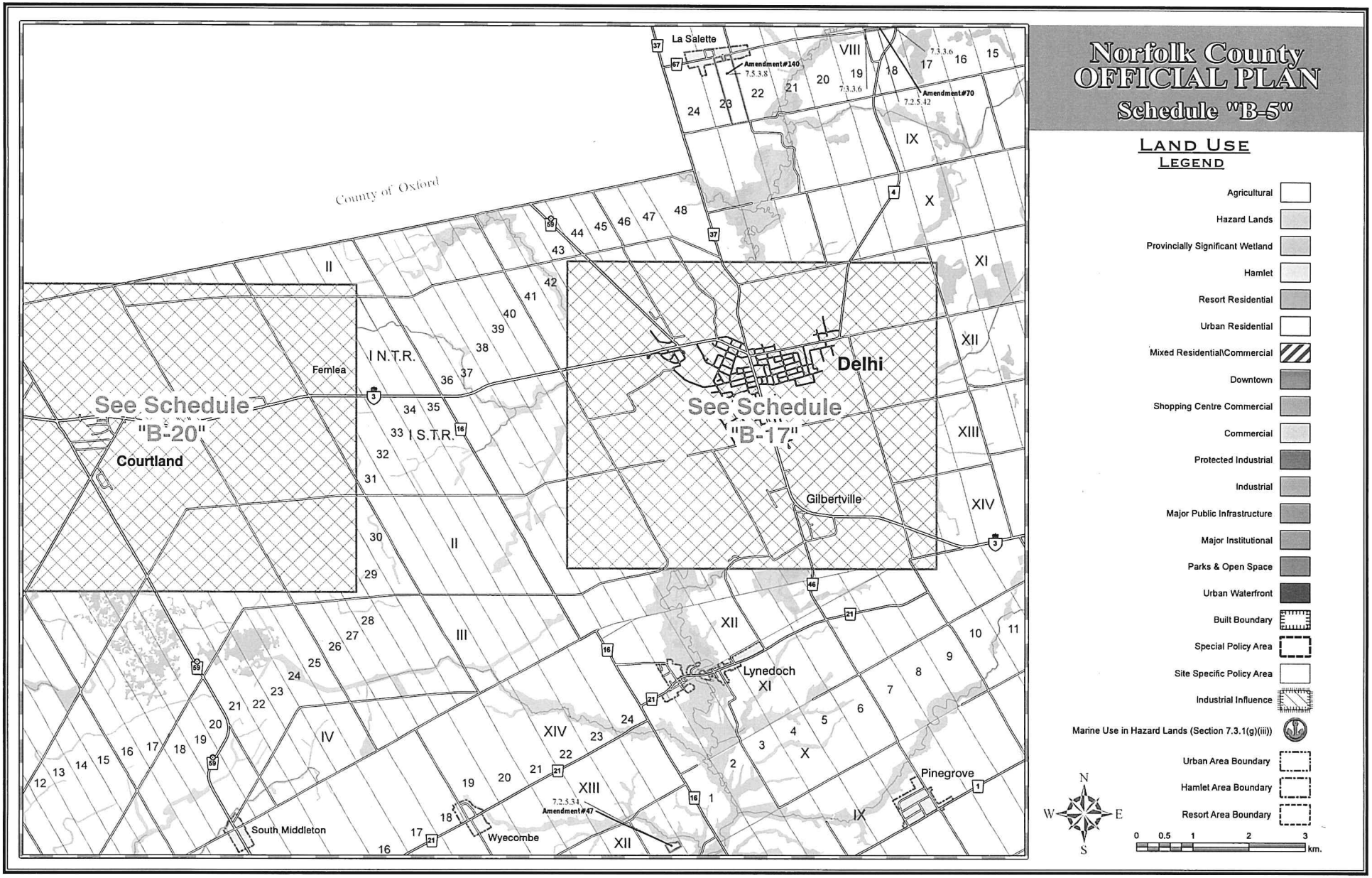
Land Use
Legend

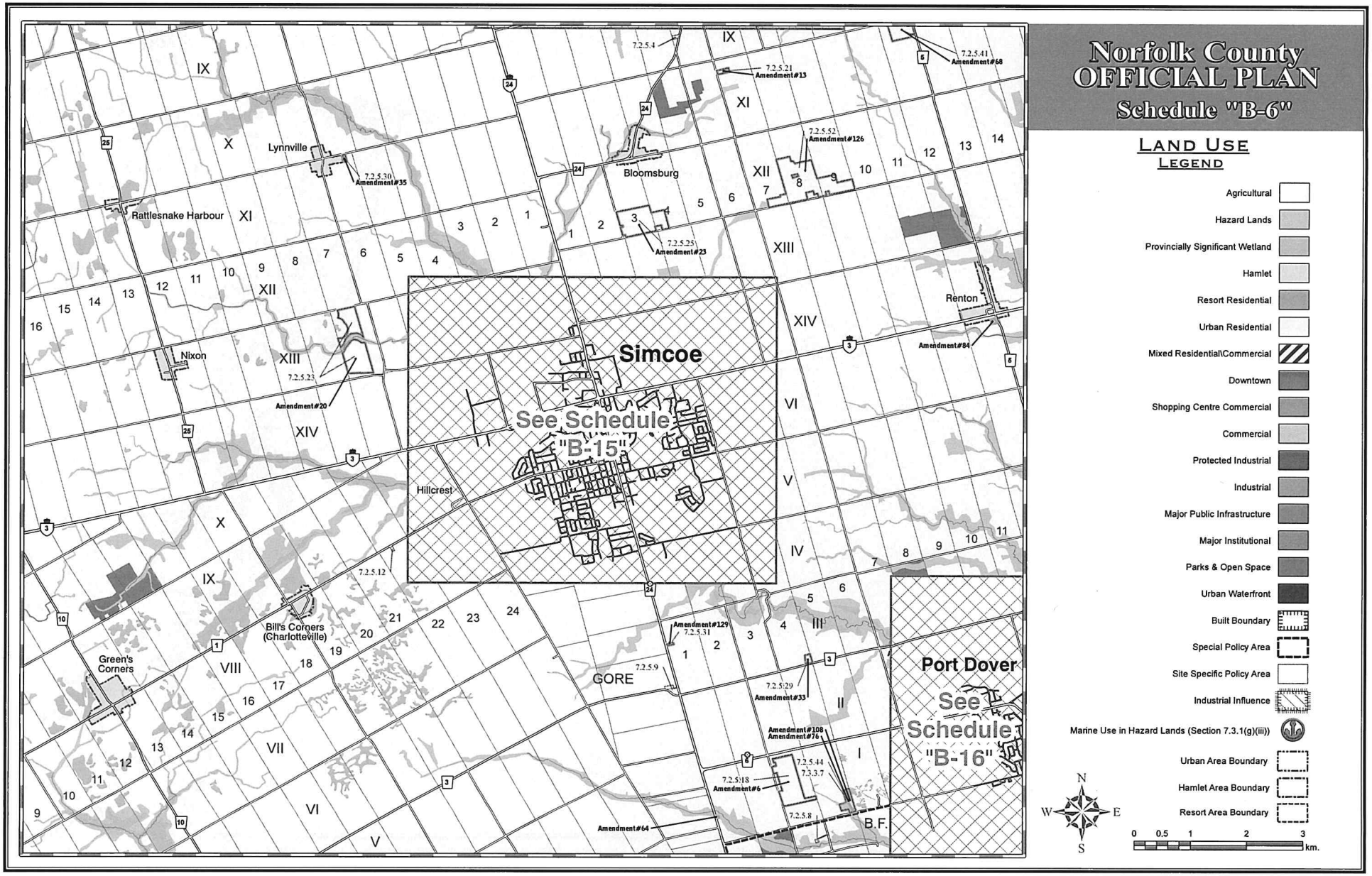
- Agricultural
- Hazard Lands
- Provincially Significant Wetland
- Hamlet
- Resort Residential
- Urban Residential
- Mixed Residential\Commercial
- Downtown
- Shopping Centre Commercial
- Commercial
- Protected Industrial
- Industrial
- Major Public Infrastructure
- Major Institutional
- Parks & Open Space
- Urban Waterfront
- Built Boundary
- Special Policy Area
- Site Specific Policy Area
- Industrial Influence
- Marine Use in Hazard Lands (Section 7.3.1(g)(iii))
- Urban Area Boundary
- Hamlet Area Boundary
- Resort Area Boundary

N W E S

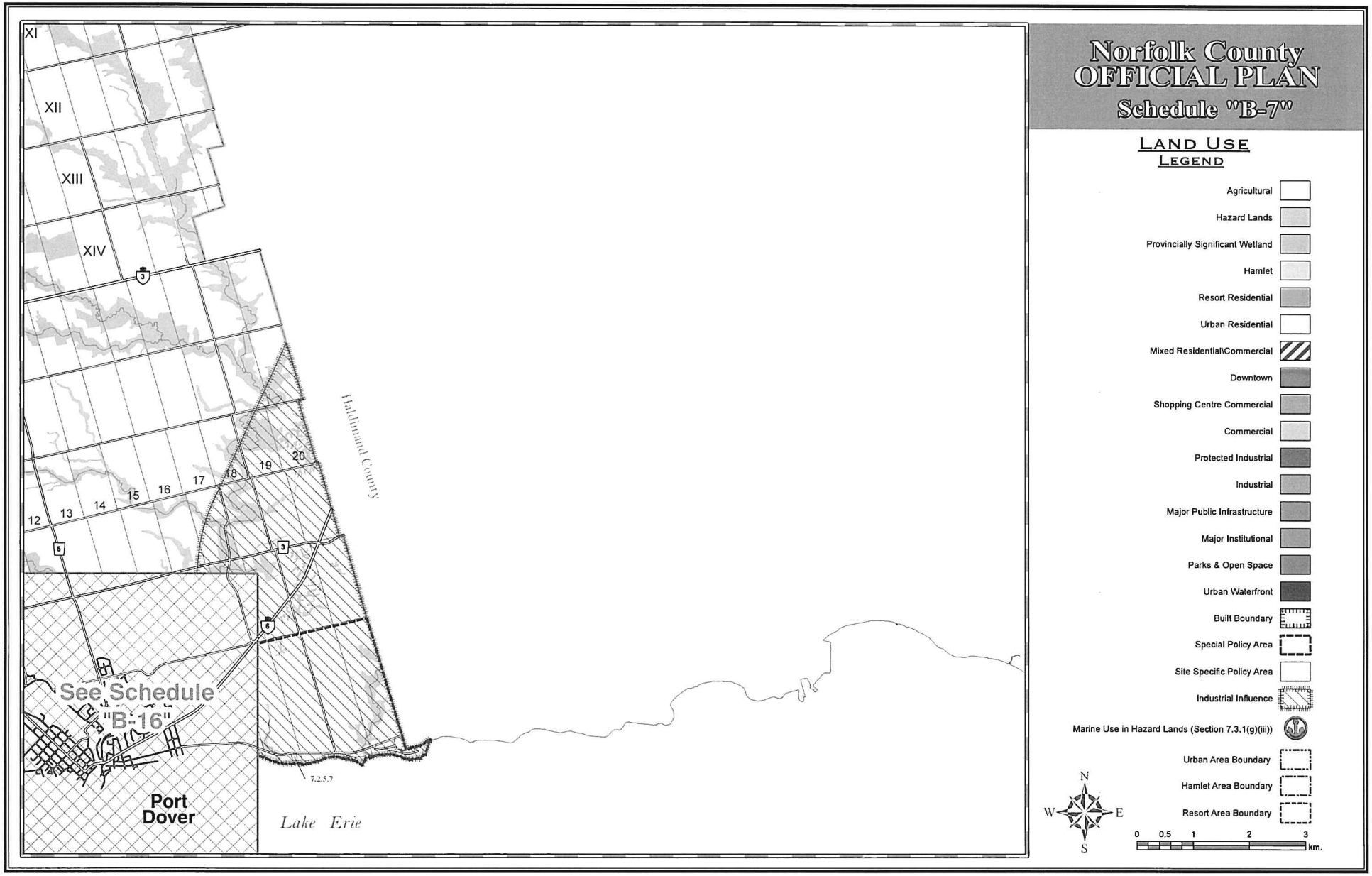
0 0.5 1 2 3 km.

Revision Date: January 1, 2022


Norfolk County
OFFICIAL PLAN
Schedule "B-5"
LAND USE
LEGEND
Agricultural
Hazard Lands
Provincially Significant Wetland
Hamlet
Resort Residential
Urban Residential
Mixed Residential\Commercial
Downtown
Shopping Centre Commercial
Commercial
Protected Industrial
Industrial
Major Public Infrastructure
Major Institutional
Parks & Open Space
Urban Waterfront
Built Boundary
Special Policy Area
Site Specific Policy Area
Industrial Influence
Marine Use in Hazard Lands (Section 7.3.1(g)(iii))
Urban Area Boundary
Hamlet Area Boundary
Resort Area Boundary
0 0.5 1 2 3 km.
N
W E
S
County of Oxford
La Salette
Amendment#140
7.5.3.8
Amendment#70
7.2.5.42
7.3.3.6
Delhi
See Schedule "B-17"
Gilbertville
Fernlea
See Schedule "B-20"
Courtland
I.N.T.R.
I.S.T.R.
Lynedoch
Pinegrove
South Middleton
Wyecombe
7.2.5.34
Amendment#47
Revision Date: January 1, 2022



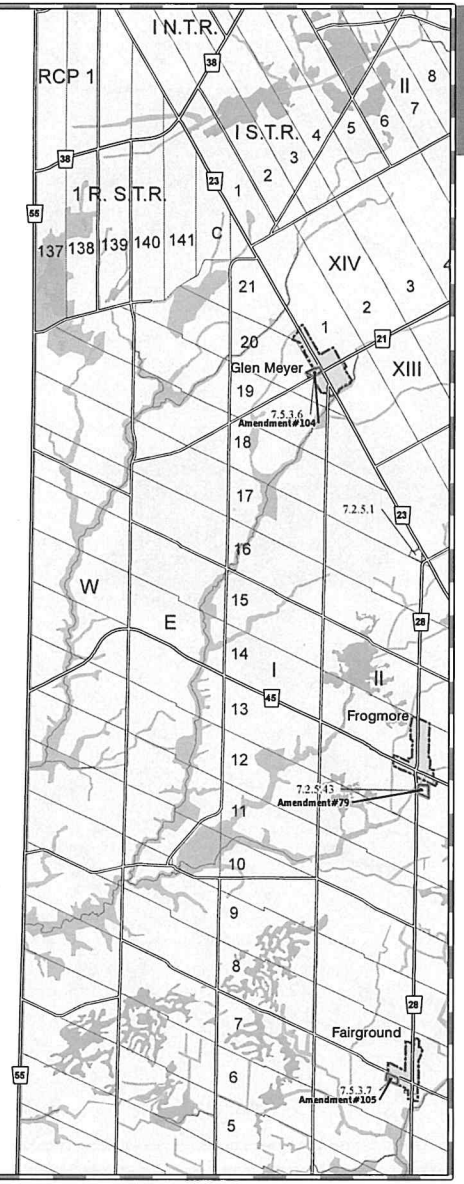
Revision Date: January 1, 2022



Revision Date: January 1, 2022

Norfolk County OFFICIAL PLAN

Schedule "B-8"



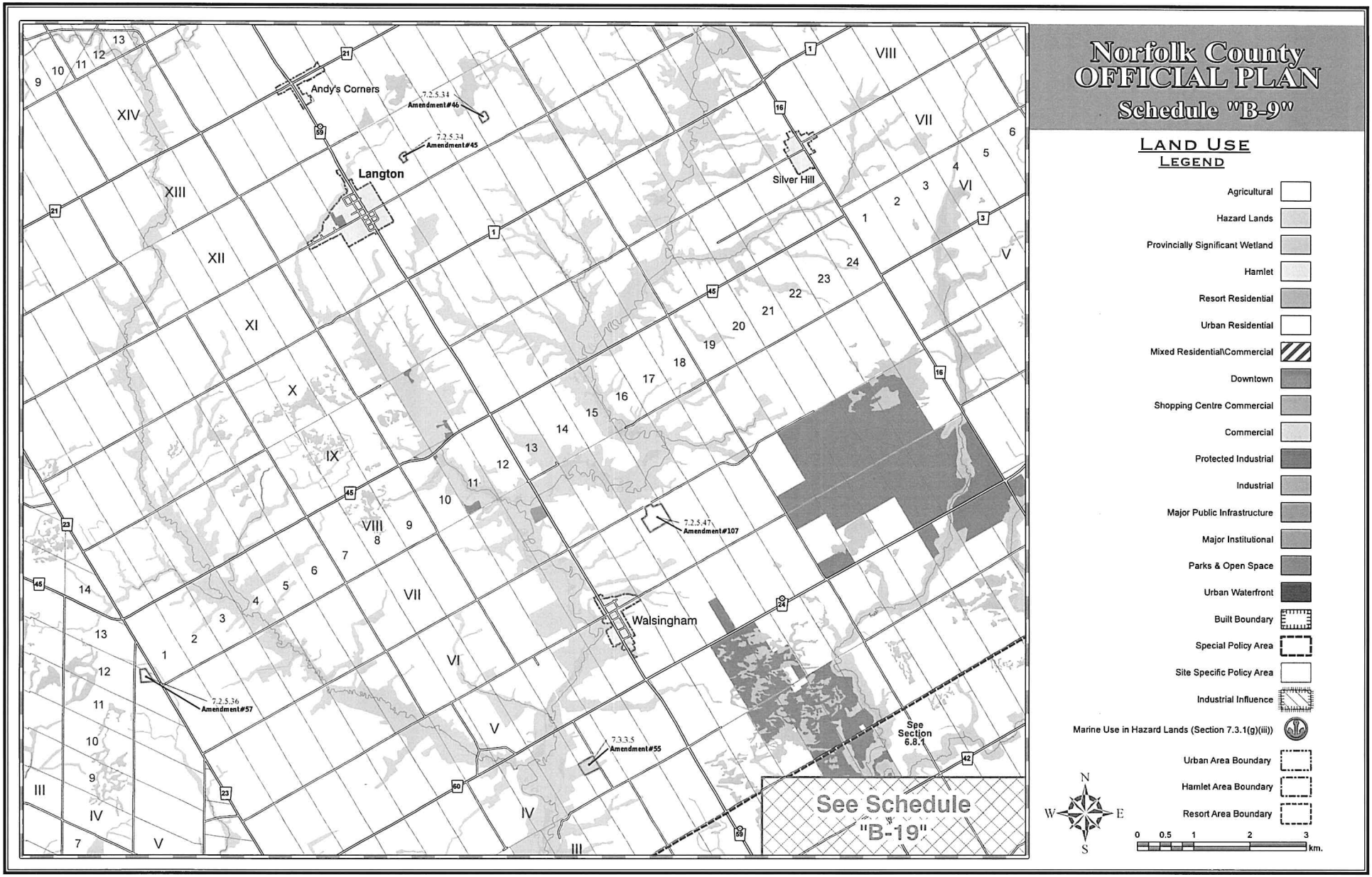
Land Use
Legend

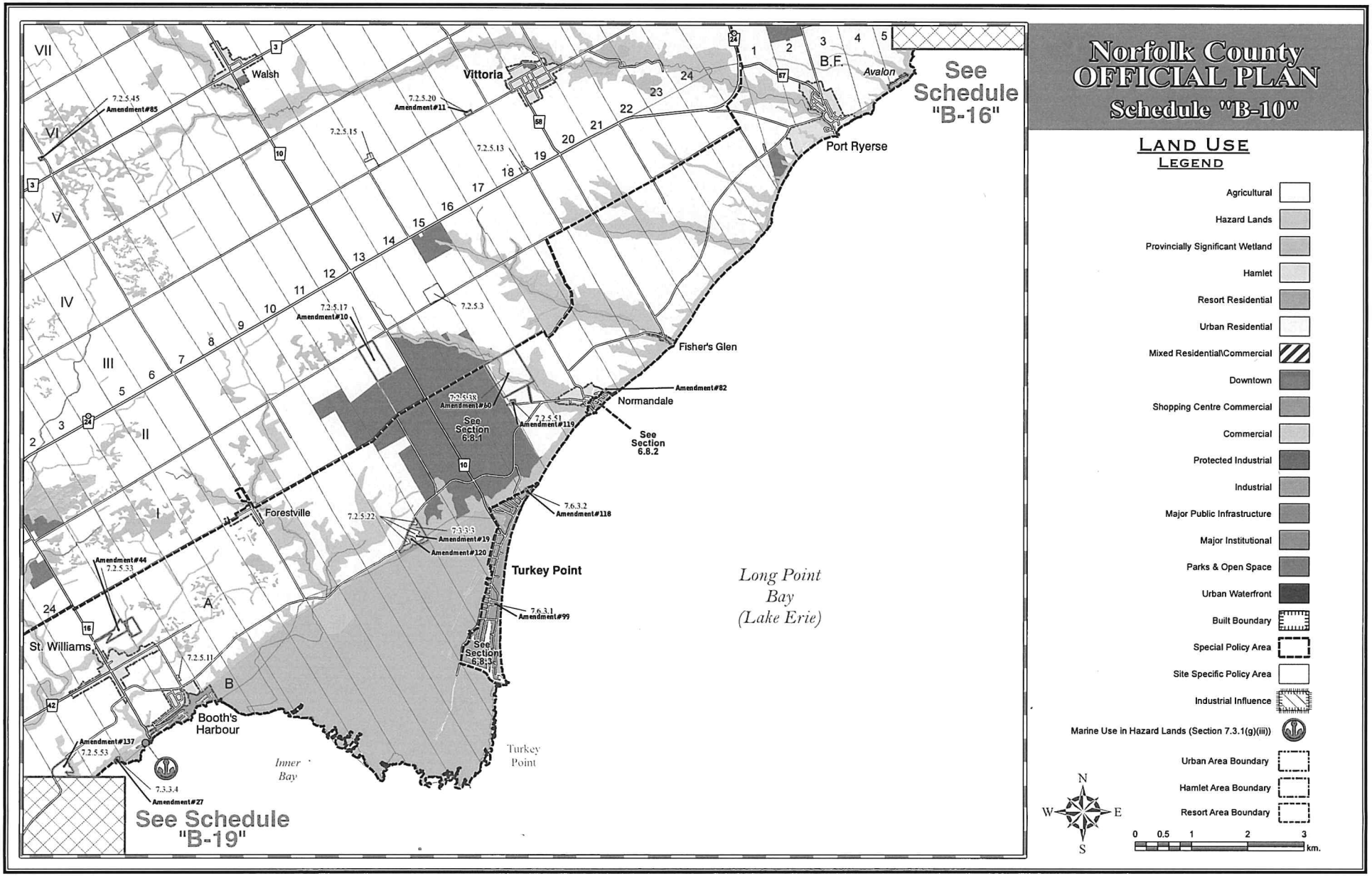
- Agricultural
- Hazard Lands
- Provincially Significant Wetland
- Hamlet
- Resort Residential
- Urban Residential
- Mixed Residential\Commercial
- Downtown
- Shopping Centre Commercial
- Commercial
- Protected Industrial
- Industrial
- Major Public Infrastructure
- Major Institutional
- Parks & Open Space
- Urban Waterfront
- Built Boundary
- Special Policy Area
- Site Specific Policy Area
- Industrial Influence
- Marine Use in Hazard Lands (Section 7.3.1(g)(iii))
- Urban Area Boundary
- Hamlet Area Boundary
- Resort Area Boundary

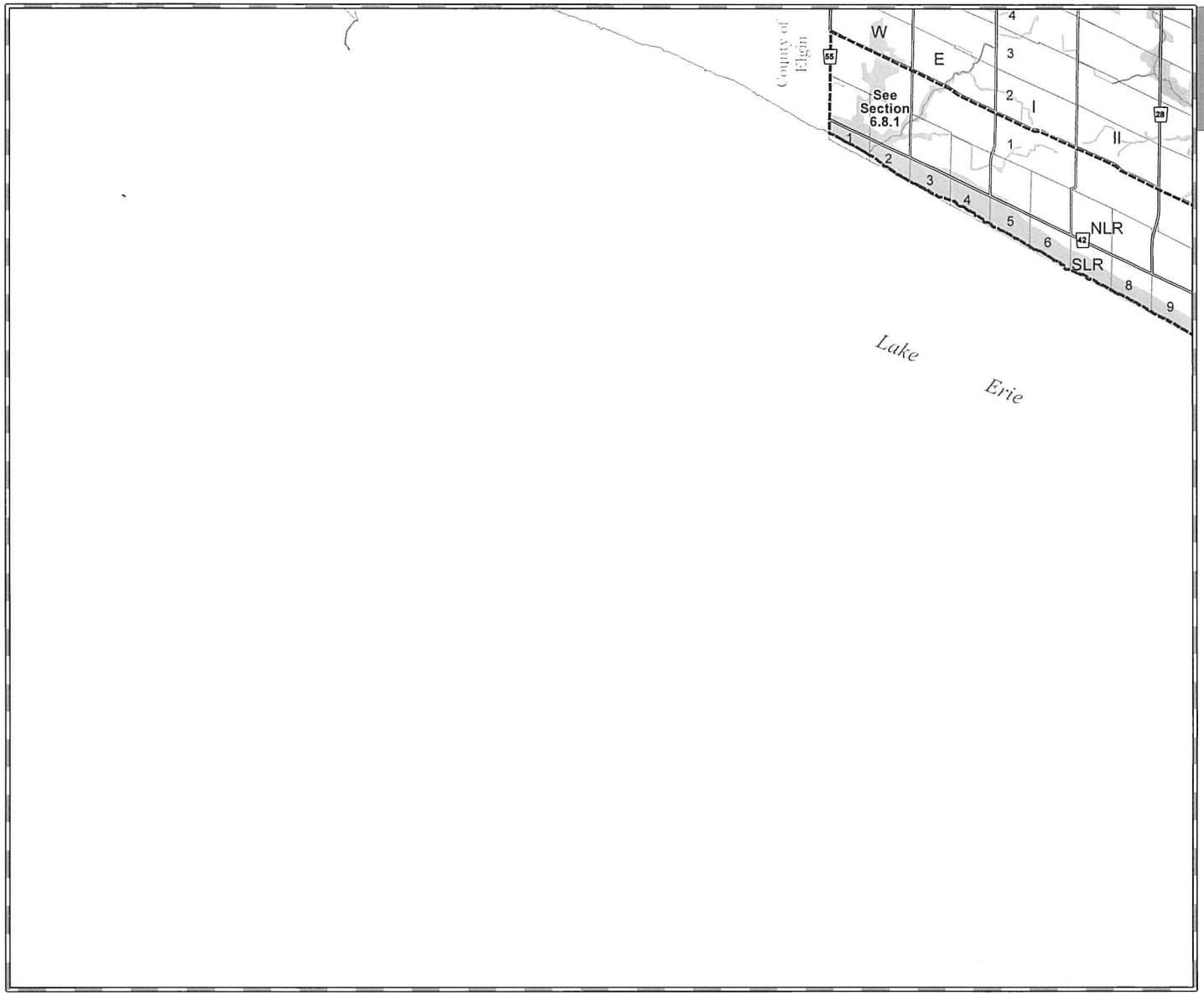
N W E S

0 0.5 1 2 3 km.

Revision Date: January 1, 2022


Norfolk County
OFFICIAL PLAN
Schedule "B-9"
LAND USE
LEGEND
Agricultural
Hazard Lands
Provincially Significant Wetland
Hamlet
Resort Residential
Urban Residential
Mixed Residential\Commercial
Downtown
Shopping Centre Commercial
Commercial
Protected Industrial
Industrial
Major Public Infrastructure
Major Institutional
Parks & Open Space
Urban Waterfront
Built Boundary
Special Policy Area
Site Specific Policy Area
Industrial Influence
Marine Use in Hazard Lands (Section 7.3.1(g)(iii))
Urban Area Boundary
Hamlet Area Boundary
Resort Area Boundary
Andy's Corners
Langton
Silver Hill
Walsingham
7.2.5.34 Amendment#46
7.2.5.34 Amendment#45
7.2.5.47 Amendment#107
7.2.5.36 Amendment#57
7.3.3.5 Amendment#55
See Section 6.8.1
See Schedule "B-19"
N
S
E
W
0 0.5 1 2 3 km.
Revision Date: January 1, 2022


Norfolk County
OFFICIAL PLAN
Schedule "B-10"
LAND USE
LEGEND
Agricultural
Hazard Lands
Provincially Significant Wetland
Hamlet
Resort Residential
Urban Residential
Mixed Residential\Commercial
Downtown
Shopping Centre Commercial
Commercial
Protected Industrial
Industrial
Major Public Infrastructure
Major Institutional
Parks & Open Space
Urban Waterfront
Built Boundary
Special Policy Area
Site Specific Policy Area
Industrial Influence
Marine Use in Hazard Lands (Section 7.3.1(g)(iii))
Urban Area Boundary
Hamlet Area Boundary
Resort Area Boundary
N
W
E
S
0 0.5 1 2 3
km.
See Schedule "B-16"
See Schedule "B-19"
Walsh
Vittoria
Port Ryerse
Avalon
B.F.
Fisher's Glen
Normandale
Forestville
Turkey Point
St. Williams
Booth's Harbour
Inner Bay
Turkey Point
Long Point Bay (Lake Erie)
See Section 6.8.1
See Section 6.8.2
See Section 6.8.3
7.2.5.45 Amendment#85
7.2.5.20 Amendment#11
7.2.5.15
7.2.5.13
7.2.5.17 Amendment#10
7.2.5.3
7.2.5.38 Amendment#60
7.2.5.51 Amendment#119
Amendment#82
7.6.3.2 Amendment#118
7.2.5.22
7.3.3.3 Amendment#19 Amendment#120
7.6.3.1 Amendment#99
Amendment#44 7.2.5.33
7.2.5.11
Amendment#137 7.2.5.53
7.3.3.4 Amendment#27
Revision Date: January 1, 2022



Norfolk County OFFICIAL PLAN

Schedule "B-11"

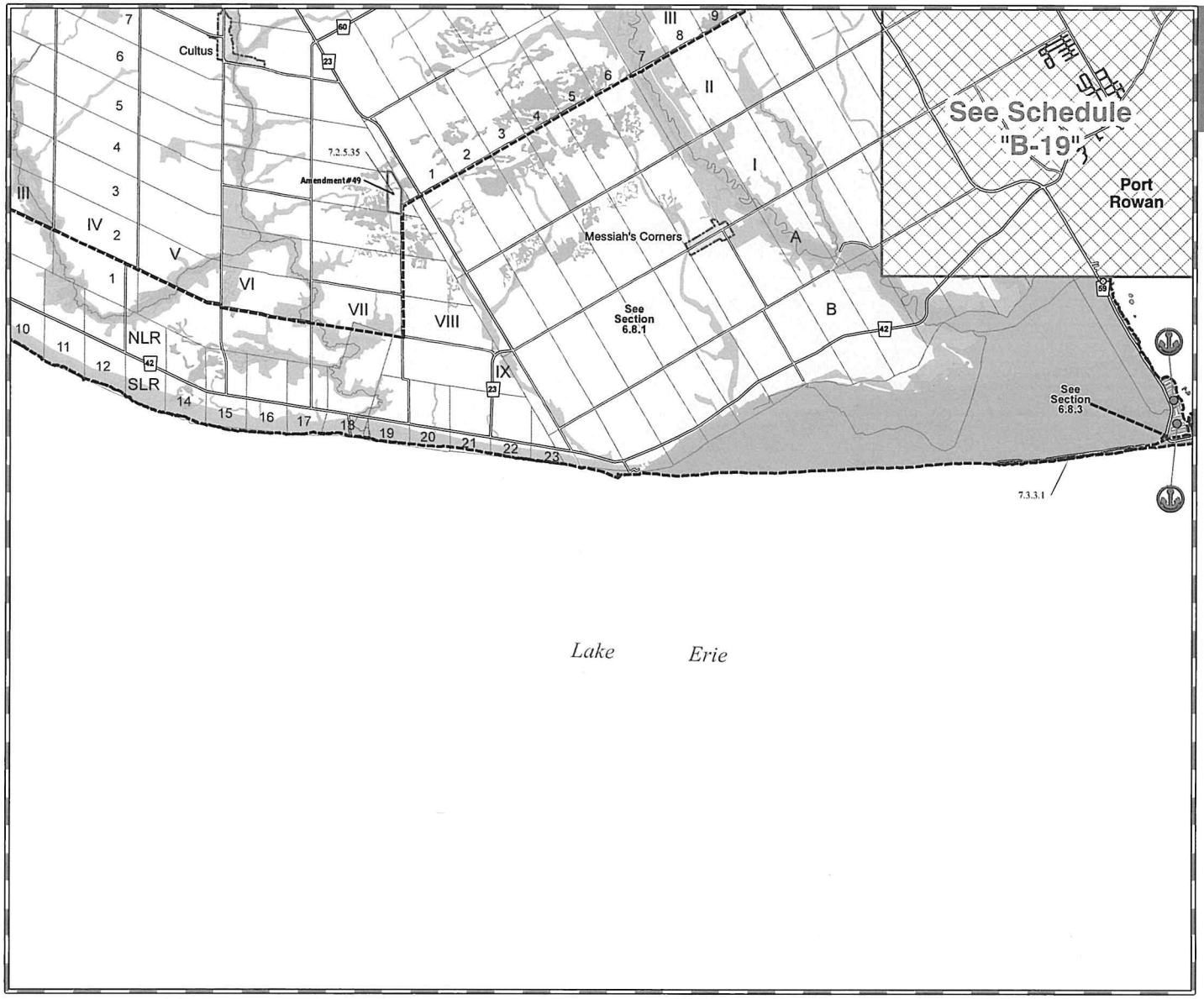
LAND USE
LEGEND

- Agricultural
- Hazard Lands
- Provincially Significant Wetland
- Hamlet
- Resort Residential
- Urban Residential
- Mixed Residential\Commercial
- Downtown
- Shopping Centre Commercial
- Commercial
- Protected Industrial
- Industrial
- Major Public Infrastructure
- Major Institutional
- Parks & Open Space
- Urban Waterfront
- Built Boundary
- Special Policy Area
- Site Specific Policy Area
- Industrial Influence
- Marine Use in Hazard Lands (Section 7.3.1(g)(iii))
- Urban Area Boundary
- Hamlet Area Boundary
- Resort Area Boundary

N
W E
S

0 0.5 1 2 3 km.

Revision Date: January 1, 2022



Norfolk County OFFICIAL PLAN

Schedule "B-12"

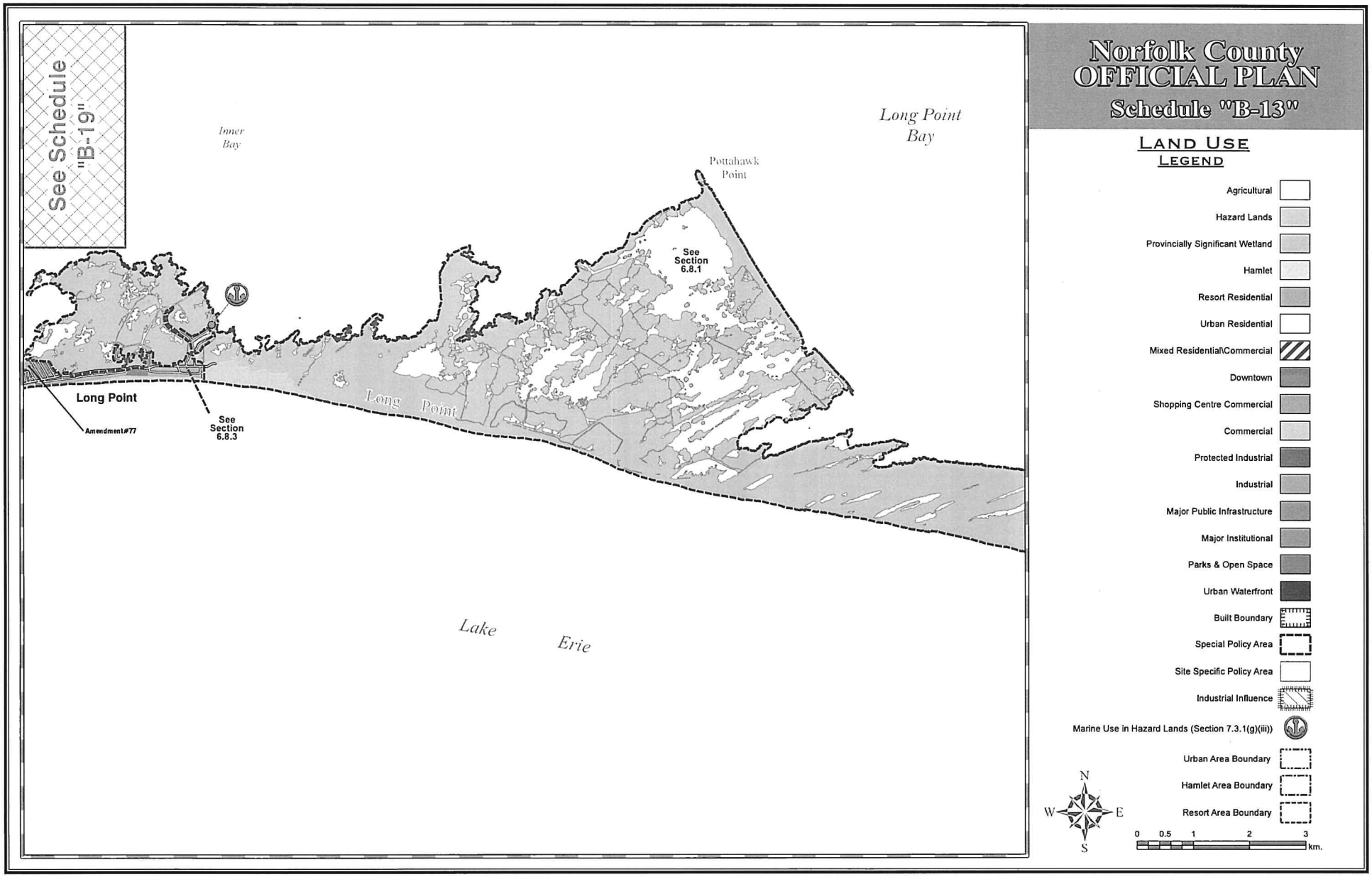
LAND USE LEGEND

- Agricultural
- Hazard Lands
- Provincially Significant Wetland
- Hamlet
- Resort Residential
- Urban Residential
- Mixed Residential\Commercial
- Downtown
- Shopping Centre Commercial
- Commercial
- Protected Industrial
- Industrial
- Major Public Infrastructure
- Major Institutional
- Parks & Open Space
- Urban Waterfront
- Built Boundary
- Special Policy Area
- Site Specific Policy Area
- Industrial Influence
- Marine Use in Hazard Lands (Section 7.3.1(g)(iii))
- Urban Area Boundary
- Hamlet Area Boundary
- Resort Area Boundary

N W E S

0 0.5 1 2 3 km.

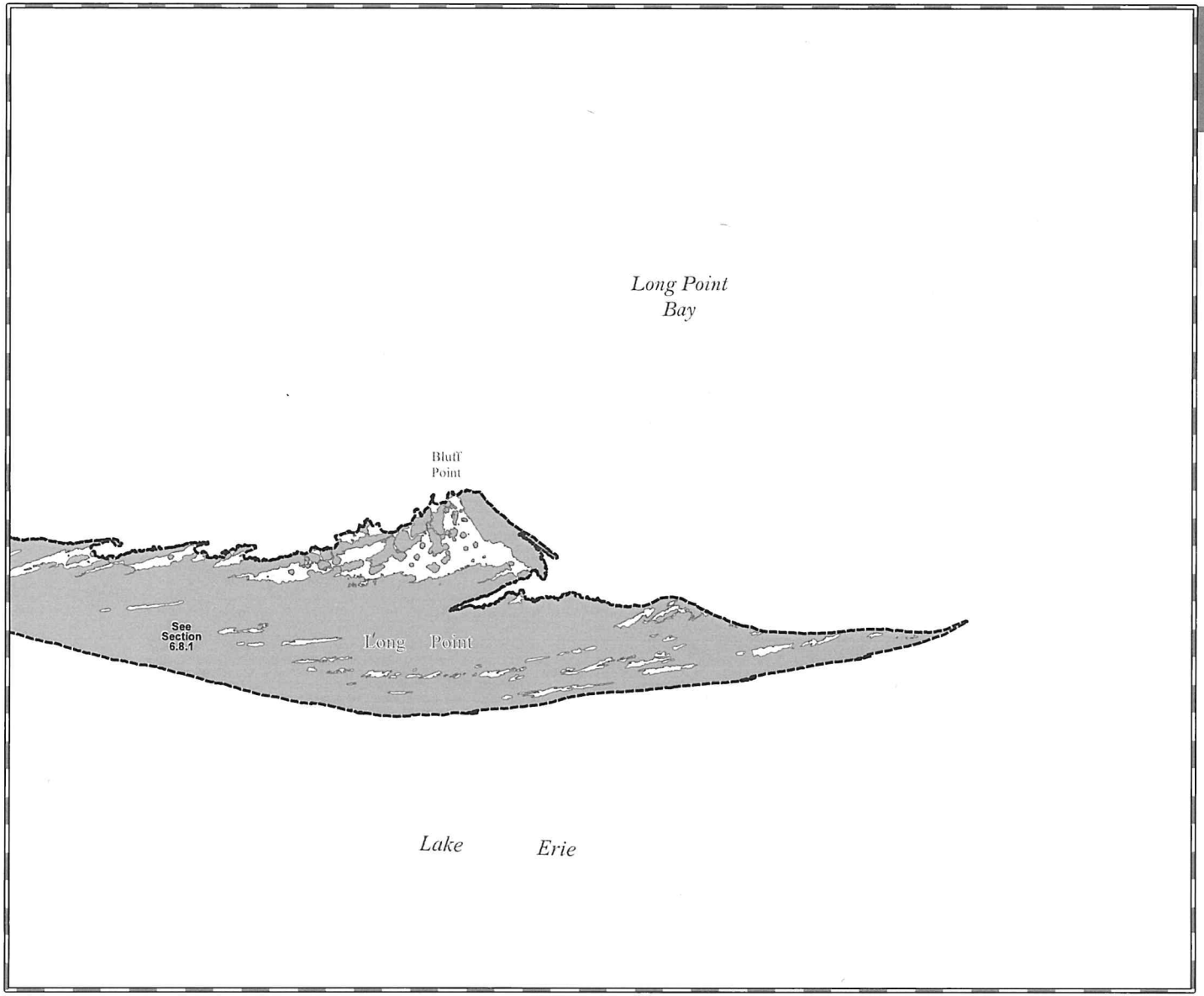
Revision Date: January 1, 2022



Revision Date: January 1, 2022

Norfolk County OFFICIAL PLAN

Schedule "B-14"



LAND USE

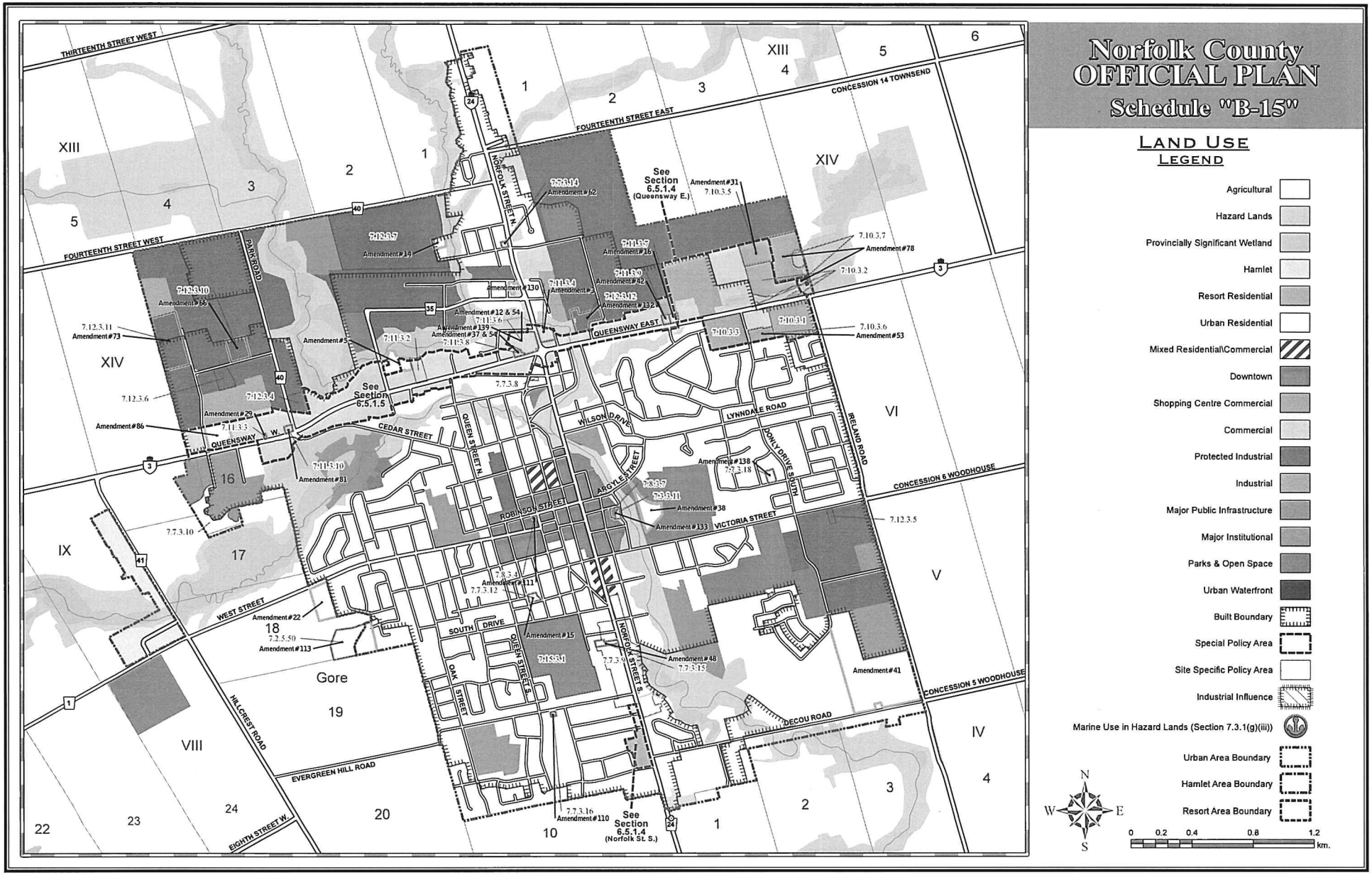
LEGEND

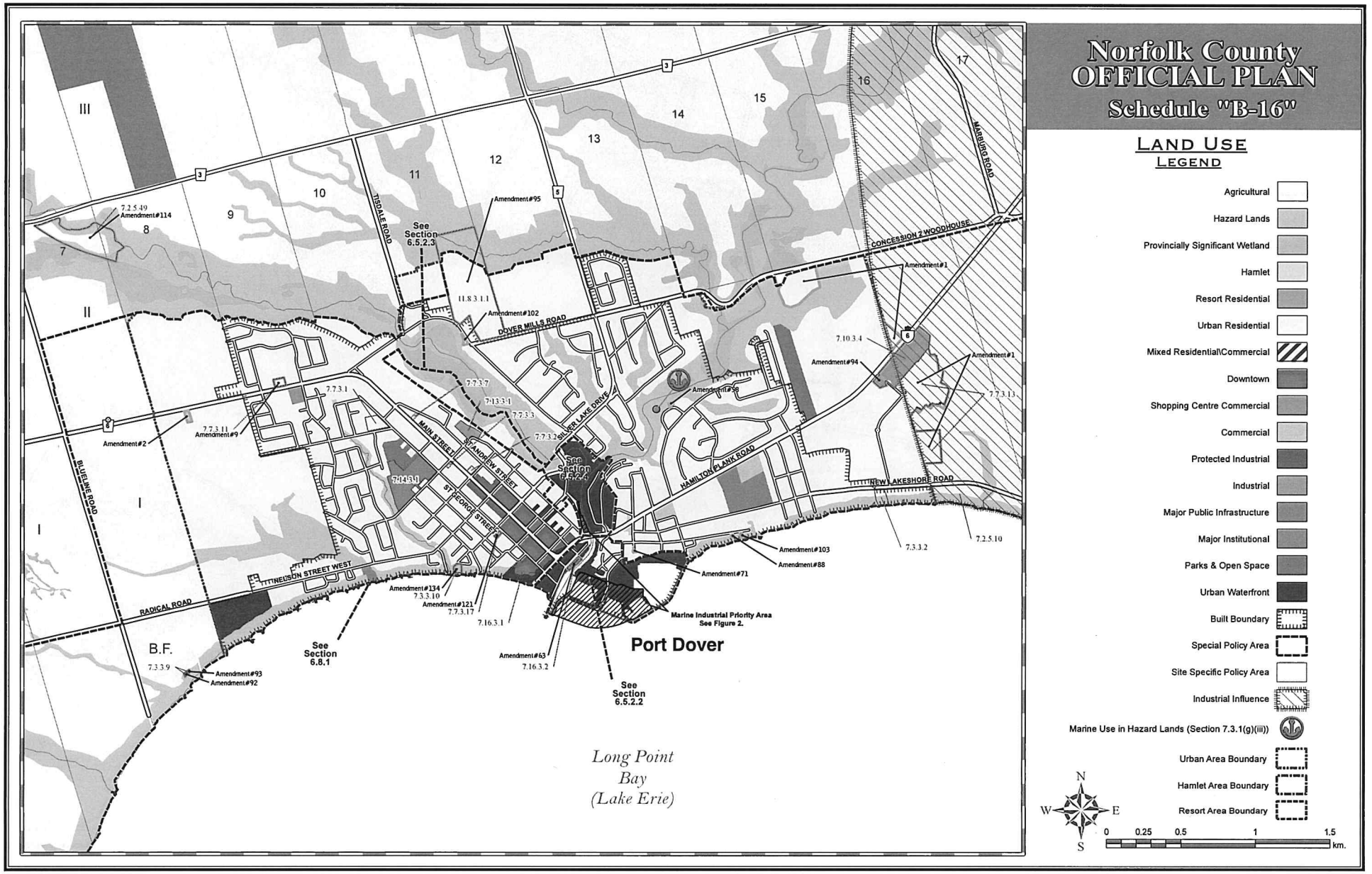
- Agricultural
- Hazard Lands
- Provincially Significant Wetland
- Hamlet
- Resort Residential
- Urban Residential
- Mixed Residential\Commercial
- Downtown
- Shopping Centre Commercial
- Commercial
- Protected Industrial
- Industrial
- Major Public Infrastructure
- Major Institutional
- Parks & Open Space
- Urban Waterfront
- Built Boundary
- Special Policy Area
- Site Specific Policy Area
- Industrial Influence
- Marine Use in Hazard Lands (Section 7.3.1(g)(iii))
- Urban Area Boundary
- Hamlet Area Boundary
- Resort Area Boundary

N
W E
S

0 0.5 1 2 3 km.

Revision Date: January 1, 2022

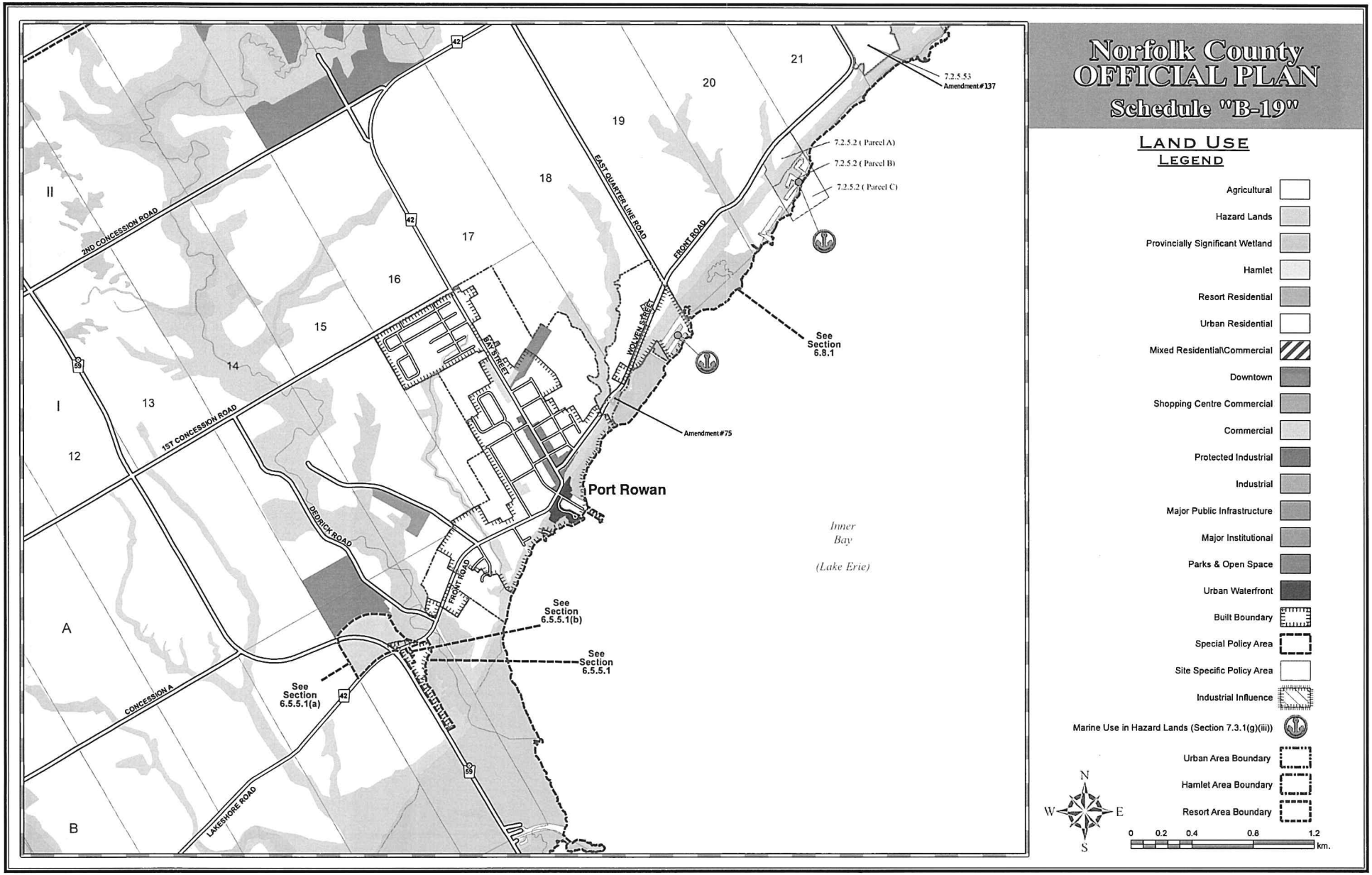

Norfolk County
OFFICIAL PLAN
Schedule "B-15"
LAND USE
LEGEND
Agricultural
Hazard Lands
Provincially Significant Wetland
Hamlet
Resort Residential
Urban Residential
Mixed Residential\Commercial
Downtown
Shopping Centre Commercial
Commercial
Protected Industrial
Industrial
Major Public Infrastructure
Major Institutional
Parks & Open Space
Urban Waterfront
Built Boundary
Special Policy Area
Site Specific Policy Area
Industrial Influence
Marine Use in Hazard Lands (Section 7.3.1(g)(iii))
Urban Area Boundary
Hamlet Area Boundary
Resort Area Boundary
N
W
E
S
0 0.2 0.4 0.8 1.2
km.
THIRTEENTH STREET WEST
FOURTEENTH STREET WEST
FOURTEENTH STREET EAST
CONCESSION 14 TOWNSEND
CONCESSION 6 WOODHOUSE
CONCESSION 5 WOODHOUSE
QUEENSWAY
QUEENSWAY EAST
QUEENSWAY W.
CEDAR STREET
WILSON DRIVE
LYNNDALE ROAD
VICTORIA STREET
ROBINSON STREET
ARGYLE STREET
QUEEN STREET N.
QUEEN STREET S.
NORFOLK STREET N.
NORFOLK STREET S.
DONLY DRIVE SOUTH
IRELAND ROAD
PARK ROAD
WEST STREET
SOUTH DRIVE
OAK STREET
HILLCREST ROAD
EVERGREEN HILL ROAD
EIGHTH STREET W.
DECOU ROAD
See Section 6.5.1.4 (Queensway E.)
See Section 6.5.1.5
See Section 6.5.1.4 (Norfolk St. S.)
Gore
Revision Date: January 1, 2022

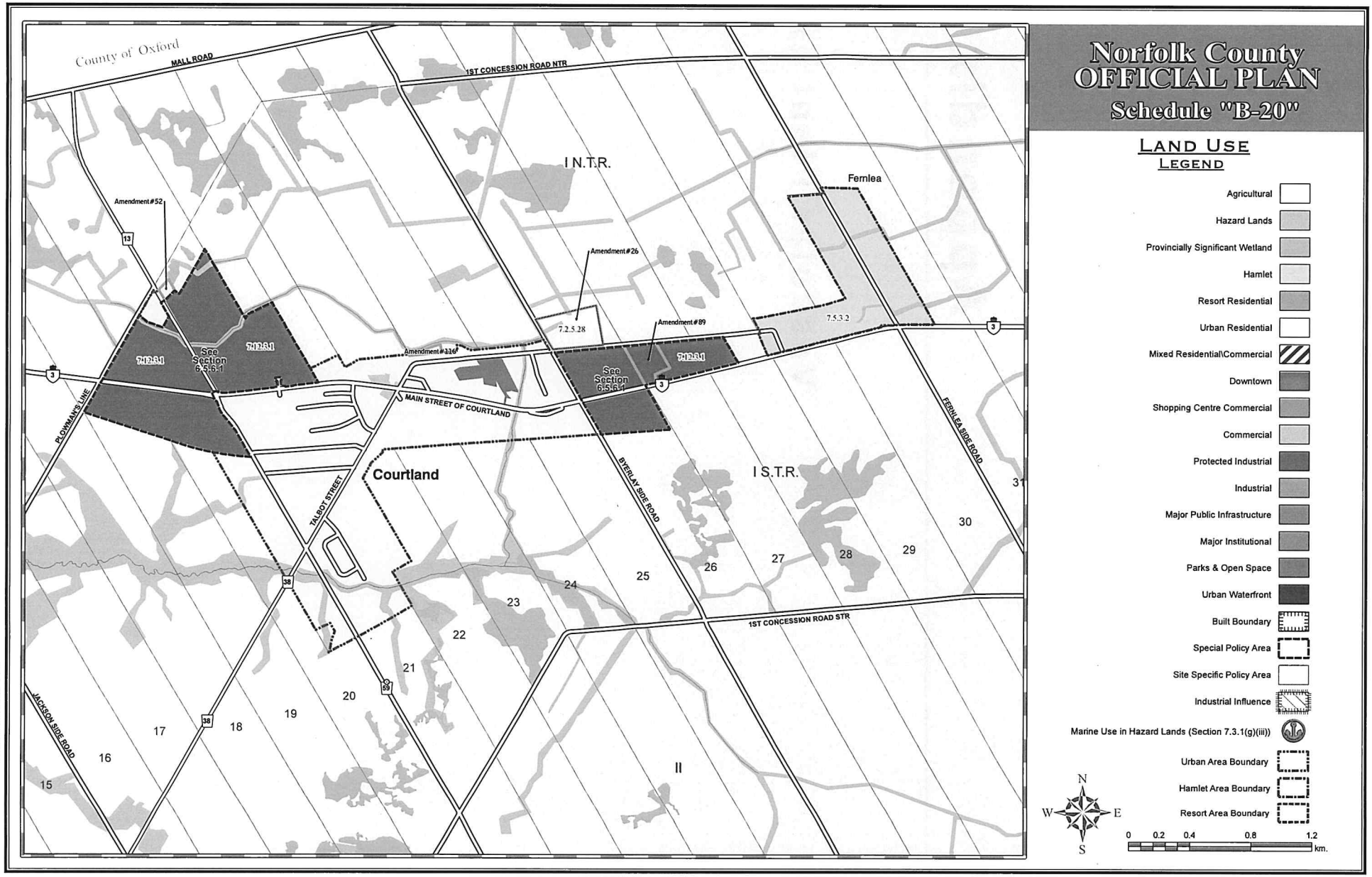


Revision Date: January 1, 2022

Norfolk County
OFFICIAL PLAN
Schedule "B-17"
LAND USE
LEGEND
Agricultural
Hazard Lands
Provincially Significant Wetland
Hamlet
Resort Residential
Urban Residential
Mixed Residential\Commercial
Downtown
Shopping Centre Commercial
Commercial
Protected Industrial
Industrial
Major Public Infrastructure
Major Institutional
Parks & Open Space
Urban Waterfront
Built Boundary
Special Policy Area
Site Specific Policy Area
Industrial Influence
Marine Use in Hazard Lands (Section 7.3.1(g)(iii))
Urban Area Boundary
Hamlet Area Boundary
Resort Area Boundary
N
W
E
S
0 0.2 0.4 0.8 1.2
km.
Delhi
Gilbertville
I N.T.R.
I S.T.R.
II
XI
XII
XIII
XIV
19
20
21
22
23
24
43
44
45
46
47
48
WINDHAM ROAD 11
WINDHAM ROAD 12
WINDHAM ROAD 13
WINDHAM ROAD 14
HAWTREY ROAD
NORWICH ROAD
TALBOT ROAD
OLD MILL ROAD
LEHMAN DAM SIDE ROAD
SCHAFER SIDE ROAD
1ST CONCESSION ROAD STR
DALTON ROAD
TISDALE SIDE ROAD
BILGERS ROAD
NORWOOD ROAD
FERTILIZER ROAD
KING ST
CHURCH STREET EAST
ARGYLE AVENUE
MAIN STREET OF DELHI
IMPERIAL STREET
JAMES STREET
WILSON AVENUE
Amendment #97
Amendment #18
Amendment #136
Amendment #43
Amendment #51
Amendment #122
Amendment #106
7.11.3.1
7.8.3.3
7.8.3.2
7.2.5.46
Revision Date: January 1, 2022

Norfolk County
OFFICIAL PLAN
Schedule "B-18"
LAND USE
LEGEND
Agricultural
Hazard Lands
Provincially Significant Wetland
Hamlet
Resort Residential
Urban Residential
Mixed Residential\Commercial
Downtown
Shopping Centre Commercial
Commercial
Protected Industrial
Industrial
Major Public Infrastructure
Major Institutional
Parks & Open Space
Urban Waterfront
Built Boundary
Special Policy Area
Site Specific Policy Area
Industrial Influence
Marine Use in Hazard Lands (Section 7.3.1(g)(iii))
Urban Area Boundary
Hamlet Area Boundary
Resort Area Boundary
0 0.2 0.4 0.8 1.2
km.
N
W
E
S
Waterford
See Section 6.5.4.1
McMICHAEL ROAD
CONCESSION 7 TOWNSEND
CONCESSION 8 TOWNSEND
WOODLEY ROAD
CONCESSION 10 TOWNSEND
MAIN STREET NORTH
DEER PARK ROAD
MECHANIC ST. W.
WEST CHURCH STREET
WASHINGTON STREET
ST. JAMES STREET SOUTH
MAIN STREET S.
THOMPSON RD. W.
THOMPSON RD. E.
BLUELINE ROAD
BARBERS LANE
Amendment #123
Amendment #117
Amendment #127
Amendment #34
Amendment #39
Amendment #8
Amendment #56
Amendment #21
7.7.3.5
7.7.3.4
7.8.3.6
7.8.3.5
7.7.3.6
7.12.3.3
7.11.3.11
7.2.5.24
Revision Date: January 1, 2022


Norfolk County
OFFICIAL PLAN
Schedule "B-19"
LAND USE
LEGEND
Agricultural
Hazard Lands
Provincially Significant Wetland
Hamlet
Resort Residential
Urban Residential
Mixed Residential\Commercial
Downtown
Shopping Centre Commercial
Commercial
Protected Industrial
Industrial
Major Public Infrastructure
Major Institutional
Parks & Open Space
Urban Waterfront
Built Boundary
Special Policy Area
Site Specific Policy Area
Industrial Influence
Marine Use in Hazard Lands (Section 7.3.1(g)(iii))
Urban Area Boundary
Hamlet Area Boundary
Resort Area Boundary
N
S
E
W
0 0.2 0.4 0.8 1.2
km.
Revision Date: January 1, 2022
2ND CONCESSION ROAD
1ST CONCESSION ROAD
CONCESSION A
LAKESHORE ROAD
EAST QUARTER LINE ROAD
FRONT ROAD
BAY STREET
WOLVEN STREET
DEDRICK ROAD
Port Rowan
Inner Bay
(Lake Erie)
7.2.5.53
Amendment #137
7.2.5.2 (Parcel A)
7.2.5.2 (Parcel B)
7.2.5.2 (Parcel C)
See Section 6.8.1
Amendment #75
See Section 6.5.5.1(b)
See Section 6.5.5.1
See Section 6.5.5.1(a)
I
II
A
B
12
13
14
15
16
17
18
19
20
21
42
59



Revision Date: January 1, 2022

BEACON
ENVIRONMENTAL

Appendix D

Vascular Plant List

Appendix D

Vascular Plant List

Scientific Name	Common Name	CC	CW	COSEWIC	SARO	SRank
Acer negundo	Manitoba Maple	0	0			S5
Acer rubrum	Red Maple	4	0			S5
Acer saccharum	Sugar Maple	4	3			S5
Acer x freemanii	(Acer rubrum X Acer saccharinum)	6	0			SNA
Acer platanoides	Norway Maple	0	5			SE5
Sagittaria latifolia	Broad-leaved Arrowhead	4	-5			S5
Alisma triviale	Northern Water-plantain	1	-5			S5
Rhus typhina	Staghorn Sumac	1	3			S5
Toxicodendron radicans var. radicans	Eastern Poison Ivy	2	0			S5
Toxicodendron radicans var. rydbergii	Western Poison Ivy	2	0			S5
Toxicodendron vernix	Poison Sumac	8	-5			S4
Cicuta maculata	Spotted Water-hemlock	6	-5			S5
Cicuta bulbifera	Bulbous Water-hemlock	5	-5			S5
Sanicula marilandica	Maryland Sanicle	5	3			S5
Aegopodium podagraria	Goutweed	0	0			SE5
Apocynum androsaemifolium	Spreading Dogbane	3	5			S5
Asclepias incarnata	Swamp Milkweed	6	-5			S5
Ilex verticillata	Common Winterberry	5	-3			S5
Arisaema triphyllum	Jack-in-the-pulpit	5	-3			S5
Symplocarpus foetidus	Eastern Skunk Cabbage	7	-5			S5
Achillea millefolium	Common Yarrow	0	3			SE5?
Solidago altissima	Tall Goldenrod	1	3			S5
Symphyotrichum lanceolatum ssp. lanceolatum	Eastern Panicled Aster	3	-3			S5
Bidens cernua	Nodding Beggarticks	2	-5			S5
Bidens frondosa	Devil's Beggarticks	3	-3			S5
Eupatorium perfoliatum	Common Boneset	2	-3			S5
Euthamia graminifolia	Grass-leaved Goldenrod	2	0			S5
Eutrochium maculatum var. maculatum	Spotted Joe Pye Weed	3	-5			S5
Lactuca canadensis	Canada Lettuce	3	3			S5

Scientific Name	Common Name	CC	CW	COSEWIC	SARO	SRank
Solidago gigantea	Giant Goldenrod	4	-3			S5
Solidago rugosa	Rough-stemmed Goldenrod	4	0			S5
Symphyotrichum lateriflorum	Calico Aster	3	0			S5
Symphyotrichum puniceum	Purple-stemmed Aster	6	-5			S5
Symphyotrichum urophyllum	Arrow-leaved Aster	6	5			S4
Tussilago farfara	Coltsfoot	0	3			SE5
Erigeron annuus	Annual Fleabane	0	3			S5
Impatiens capensis	Spotted Jewelweed	4	-3			S5
Podophyllum peltatum	May-apple	5	3			S5
Alnus incana ssp. rugosa	Speckled Alder	6	-3			S5
Betula alleghaniensis	Yellow Birch	6	0			S5
Betula papyrifera	Paper Birch	2	3			S5
Carpinus caroliniana	Blue-beech	6	0			S5
Alnus glutinosa	European Black Alder	0	-3			SE4
Alliaria petiolata	Garlic Mustard	0	0			SE5
Rorippa palustris	Marsh Yellowcress	3	-5			S5
Diervilla lonicera	Northern Bush-honeysuckle	5	5			S5
Sambucus canadensis	Common Elderberry	5	-3			S5
Lonicera tatarica	Tatarian Honeysuckle	0	3			SE5
Triosteum aurantiacum	Orange-fruit Horse-gentian	7	5			S4S5
Viburnum opulus ssp. trilobum	Highbush Cranberry	5	-3			S5
Euonymus alatus	Winged Euonymus	0	5			SE2
Ceratophyllum demersum	Common Hornwort	4	-5			S5
Calystegia sepium	Hedge False Bindweed	2	0			S5
Cornus alternifolia	Alternate-leaved Dogwood	6	3			S5
Cornus sericea	Red-osier Dogwood	2	-3			S5
Cornus racemosa	Grey Dogwood	2	0			S5
Echinocystis lobata	Wild Cucumber	3	-3			S5
Juniperus virginiana	Eastern Red Cedar	4	3			S5
Cuscuta gronovii	Swamp Dodder	4	-3			S5
Carex comosa	Bearded Sedge	5	-5			S5
Carex lacustris	Lake Sedge	5	-5			S5
Carex rosea	Rosy Sedge	2	5			S5
Carex stipata	Awl-fruited Sedge	3	-5			S5
Carex stricta	Tussock Sedge	4	-5			S5
Carex vulpinoidea	Fox Sedge	3	-5			S5
Eleocharis erythropoda	Red-stemmed Spikerush	4	-5			S5
Schoenoplectus tabernaemontani	Soft-stemmed Bulrush	5	-5			S5

Scientific Name	Common Name	CC	CW	COSEWIC	SARO	SRank
Scirpus atrovirens	Dark-green Bulrush	3	-5			S5
Carex hystericina	Porcupine Sedge	5	-5			S5
Carex radiata	Eastern Star Sedge	4	0			S5
Scirpus microcarpus	Red-tinged Bulrush	4	-5			S5
Pteridium aquilinum	Bracken Fern	2	3			S5
Athyrium filix-femina	Common Lady Fern	4	0			S5
Dryopteris marginalis	Marginal Wood Fern	5	3			S5
Matteuccia struthiopteris	Ostrich Fern	5	0			S5
Onoclea sensibilis	Sensitive Fern	4	-3			S5
Dryopteris cristata	Crested Wood Fern	7	-5			S5
Acalypha rhomboidea	Common Three-seeded Mercury	0	3			S5
Euphorbia corollata	Flowering Spurge	7	5			S4
Apios americana	American Groundnut	6	-3			S5
Hylodesmum glutinosum	Large Tick-trefoil	6	5			S4
Gymnocladus dioicus	Kentucky Coffee-tree	6	3	**THR**	**THR**	**S2**
Quercus alba	White Oak	6	3			S5
Quercus rubra	Northern Red Oak	6	3			S5
Quercus velutina	Black Oak	8	5			S4
Quercus ellipsoidalis	Northern Pin Oak	9	5			**S3**
Geranium maculatum	Spotted Geranium	6	3			S5
Ribes americanum	American Black Currant	4	-3			S5
Hamamelis virginiana	American Witch-hazel	6	3			S4S5
Elodea canadensis	Canada Waterweed	4	-5			S5
Hydrocharis morsus-ranae	European Frog-bit	0	-5			SE5
Iris pseudacorus	Yellow Iris	0	-5			SE4
Carya cordiformis	Bitternut Hickory	6	0			S5
Carya ovata	Shagbark Hickory	6	3			S5
Juglans cinerea	Butternut	6	3	**END**	**END**	**S2?**
Juglans nigra	Black Walnut	5	3			S4?
Carya glabra	Pignut Hickory	9	3			**S3**
Juncus effusus	Soft Rush	4	-5			S5
Juncus dudleyi	Dudley's Rush	1	-3			S5
Juncus articulatus	Jointed Rush	5	-5			S5
Mentha spicata	Spearmint	0	-3			SE4
Lycopus uniflorus	Northern Water-horehound	5	-5			S5
Lindera benzoin	Northern Spicebush	6	-3			S4
Lemna minor	Small Duckweed	5	-5			S5?
Spirodela polyrhiza	Great Duckweed	4	-5			S5

Scientific Name	Common Name	CC	CW	COSEWIC	SARO	SRank
Wolffia columbiana	Columbia Watermeal	4	-5			S5
Maianthemum canadense	Wild Lily-of-the-valley	5	3			S5
Maianthemum racemosum	Large False Solomon's Seal	4	3			S5
Maianthemum stellatum	Star-flowered False Solomon's Seal	6	0			S5
Trillium grandiflorum	White Trillium	5	3			S5
Convallaria majalis	European Lily-of-the-valley	0	5			SE5
Morus alba	White Mulberry	0	0			SE5
Nymphaea odorata	Fragrant Water-lily	5	-5			S5
Fraxinus americana	White Ash	4	3			S4
Fraxinus pennsylvanica	Red Ash	3	-3			S4
Ligustrum vulgare	European Privet	0	3			SE5
Circaea canadensis	Broad-leaved Enchanter's Nightshade	2	3			S5
Ludwigia palustris	Marsh Seedbox	5	-5			S5
Oenothera biennis	Common Evening-primrose	0	3			S5
Epipactis helleborine	Broad-leaved Helleborine	0	3			SE5
Oxalis stricta	Upright Yellow Wood-sorrel	0	3			S5
Chelidonium majus	Greater Celandine	0	5			SE5
Phytolacca americana	Common Pokeweed	3	3			S4
Pinus strobus	Eastern White Pine	4	3			S5
Tsuga canadensis	Eastern Hemlock	7	3			S5
Pinus sylvestris	Scots Pine	0	3			SE5
Picea abies	Norway Spruce	0	5			SE3
Larix decidua	European Larch	0	5			SE2
Platanus occidentalis	Sycamore	8	-3			S4
Calamagrostis canadensis	Bluejoint Reedgrass	4	-5			S5
Glyceria striata	Fowl Mannagrass	3	-5			S5
Leersia oryzoides	Rice Cutgrass	3	-5			S5
Phalaris arundinacea	Reed Canarygrass	0	-3			S5
Phleum pratense	Common Timothy	0	3			SE5
Phragmites australis ssp. australis	European Reed	0	-3			SE5
Poa pratensis ssp. pratensis	Kentucky Bluegrass	0	3			SE5
Agrostis stolonifera	Creeping Bentgrass	0	-3			SE5
Persicaria amphibia	Water Smartweed	5	-5			S5
Persicaria lapathifolia	Pale Smartweed	2	-3			S5
Persicaria virginiana	Virginia Smartweed	6	0			S4
Reynoutria japonica	Japanese Knotweed	0	3			SE5

Scientific Name	Common Name	CC	CW	COSEWIC	SARO	SRank
Persicaria hydropiperoides	False Waterpepper	4	-5			S5
Lysimachia ciliata	Fringed Yellow Loosestrife	4	-3			S5
Clematis virginiana	Virginia Clematis	3	0			S5
Thalictrum pubescens	Tall Meadow-rue	5	-3			S5
Actaea rubra	Red Baneberry	6	3			S5
Geum canadense	Canada Avens	3	0			S5
Prunus serotina	Black Cherry	3	3			S5
Prunus virginiana	Chokecherry	2	3			S5
Rubus allegheniensis	Allegheny Blackberry	2	3			S5
Rubus idaeus ssp. strigosus	North American Red Raspberry	2	3			S5
Rubus occidentalis	Black Raspberry	2	5			S5
Rubus pubescens	Dwarf Raspberry	4	-3			S5
Spiraea alba	White Meadowsweet	3	-3			S5
Prunus avium	Sweet Cherry	0	5			SE4
Rosa multiflora	Multiflora Rose	0	3			SE5
Cephalanthus occidentalis	Eastern Buttonbush	7	-5			S5
Galium aparine	Common Bedstraw	4	3			S5
Galium boreale	Northern Bedstraw	7	0			S5
Populus tremuloides	Trembling Aspen	2	0			S5
Salix bebbiana	Bebb's Willow	4	-3			S5
Salix discolor	Pussy Willow	3	-3			S5
Salix eriocephala	Cottony Willow	4	-3			S5
Salix interior	Sandbar Willow	1	-3			S5
Salix petiolaris	Meadow Willow	3	-3			S5
Salix x fragilis	(Salix alba X Salix euxina)	0	0			SNA
Salix amygdaloides	Peach-leaved Willow	6	-3			S5
Linaria vulgaris	Butter-and-eggs	0	5			SE5
Veronica americana	American Speedwell	6	-5			S5
Smilax herbacea	Herbaceous Carrionflower	5	0			S4?
Solanum dulcamara	Bittersweet Nightshade	0	0			SE5
Sparganium eurycarpum	Broad-fruited Burreed	3	-5			S5
Tilia americana	Basswood	4	3			S5
Typha latifolia	Broad-leaved Cattail	1	-5			S5
Typha angustifolia	Narrow-leaved Cattail	0	-5			SE5
Ulmus americana	White Elm	3	-3			S5
Pilea pumila	Dwarf Clearweed	5	-3			S5
Urtica dioica ssp. gracilis	Slender Stinging Nettle	2	0			S5
Phryma leptostachya	Lopseed	6	3			S4S5

Scientific Name	Common Name	CC	CW	COSEWIC	SARO	SRank
Verbena hastata	Blue Vervain	4	-3			S5
Verbena urticifolia	White Vervain	4	0			S5
Viola sororia	Woolly Blue Violet	4	0			S5
Parthenocissus vitacea	Thicket Creeper	4	3			S5
Vitis riparia	Riverbank Grape	0	0			S5

BEACON
ENVIRONMENTAL

Appendix E

Breeding Bird List

Appendix E

Breeding Bird List

Common Name	Scientific Name	Status					Number of Pairs/Territories
		National Species at Risk COSEWICa	Species at Risk in Ontario Listing a	Provincial breeding season SRANK [b]	Regional Status	Area-sensitive (OMNR)c	
Great Blue Heron	*Ardea herodias*			S4			1 - foraging
Green Heron	*Butorides virescens*			S4			1
Canada Goose	*Branta canadensis*			S5			1
Mallard	*Anas platyrhynchos*			S5			1
Red-tailed Hawk	*Buteo jamaicensis*			S5			1
Wild Turkey	*Meleagris gallopavo*			S5			1
Killdeer	*Charadrius vociferus*			S5			3
Mourning Dove	*Zenaida macroura*			S5			4
Chimney Swift	*Chaetura pelagica*	THR	THR	S4			1
Red-bellied Woodpecker	*Melanerpes carolinus*			S4			1
Downy Woodpecker	*Dryobates pubescens*			S5			1
Hairy Woodpecker	*Dryobates villosus*			S5		A	1
Northern Flicker	*Colaptes auratus*			S4			1
Pileated Woodpecker	*Dryocopus pileatus*			S5		A	1
Eastern Wood-Pewee	*Contopus virens*	SC	SC	S4			2
Eastern Phoebe	*Sayornis phoebe*			S5			2
Great Crested Flycatcher	*Myiarchus crinitus*			S4			2
Eastern Kingbird	*Tyrannus tyrannus*			S4			1
Cliff Swallow	*Petrochelidon pyrrhonota*			S4			1
Barn Swallow	*Hirundo rustica*	THR	THR	S4			1
Blue Jay	*Cyanocitta cristata*			S5			2
American Crow	*Corvus brachyrhynchos*			S5			2
Black-capped Chickadee	*Poecile atricapillus*			S5			5
Red-breasted Nuthatch	*Sitta canadensis*			S5		A	1
White-breasted Nuthatch	*Sitta carolinensis*			S5		A	1

Common Name	Scientific Name	Status					Number of Pairs/Territories
		National Species at Risk COSEWICa	Species at Risk in Ontario Listing a	Provincial breeding season SRANK [b]	Regional Status	Area-sensitive (OMNR)c	
House Wren	*Troglodytes aedon*			S5			4
American Robin	*Turdus migratorius*			S5			6
Gray Catbird	*Dumetella carolinensis*			S4			2
Cedar Waxwing	*Bombycilla cedrorum*			S5			2
European Starling	*Sturnus vulgaris*			SE			5
Red-eyed Vireo	*Vireo olivaceus*			S5			2
Yellow Warbler	*Setophaga petechia*			S5			1
American Redstart	*Setophaga ruticilla*			S5		A	1
Common Yellowthroat	*Geothlyphis trichas*			S5			4
Northern Cardinal	*Cardinalis cardinalis*			S5			6
Rose-breasted Grosbeak	*Pheucticus ludovicianus*			S4			1
Indigo Bunting	*Passerina cyanea*			S4			4
Chipping Sparrow	*Spizella passerina*			S5			2
Savannah Sparrow	*Passerculus sandwichensis*			S4		A	5
Song Sparrow	*Melospiza melodia*			S5			8
Red-winged Blackbird	*Agelaius phoeniceus*			S4			7
Common Grackle	*Quiscalus quiscula*			S5			3
Brown-headed Cowbird	*Molothrus ater*			S4			3
Baltimore Oriole	*Icterus galbula*			S4			5
House Finch	*Haemorhous mexicanus*			SNA			2
Purple Finch	*Haemorhous purpureus*			S4			1
American Goldfinch	*Spinus tristis*			S5			5
House Sparrow	*Passer domesticus*			SNA			2

Field Work Conducted On: *June 16 & 25, 2020*

Number of Species: 49
Number of (provincial and national) Species at Risk: 4 - Eastern Wood-Pewee, Barn Swallow, Chimney Swift & Bobolink
Number of S1 to S3 Species: 0

Number of Area-sensitive Species: 6 - Hariry Woodpecker, Red-breasted Nuthatch, White-breasted Nuthatch, American Redstart, Savannah Sparrow, Bobolink

KEY
a COSEWIC = Committee on the Status of Endangered Wildlife in Canada
a Species at Risk in Ontario List (as applies to ESA) as designated by COSSARO (Committee on the Status of Species at Risk in Ontario)
END = Endangered, THR = Threatened, SC = Special Concern

[b] SRANK (from Natural Heritage Information Centre) for breeding status if:
S1 (Critically Imperiled), S2 (Imperiled),S3 (Vulnerable), S4 (Apparently Secure), S5 (Secure)
SNA (Not applicable...'because the species is not a suitable target for conservation activities'; includes non-native species)

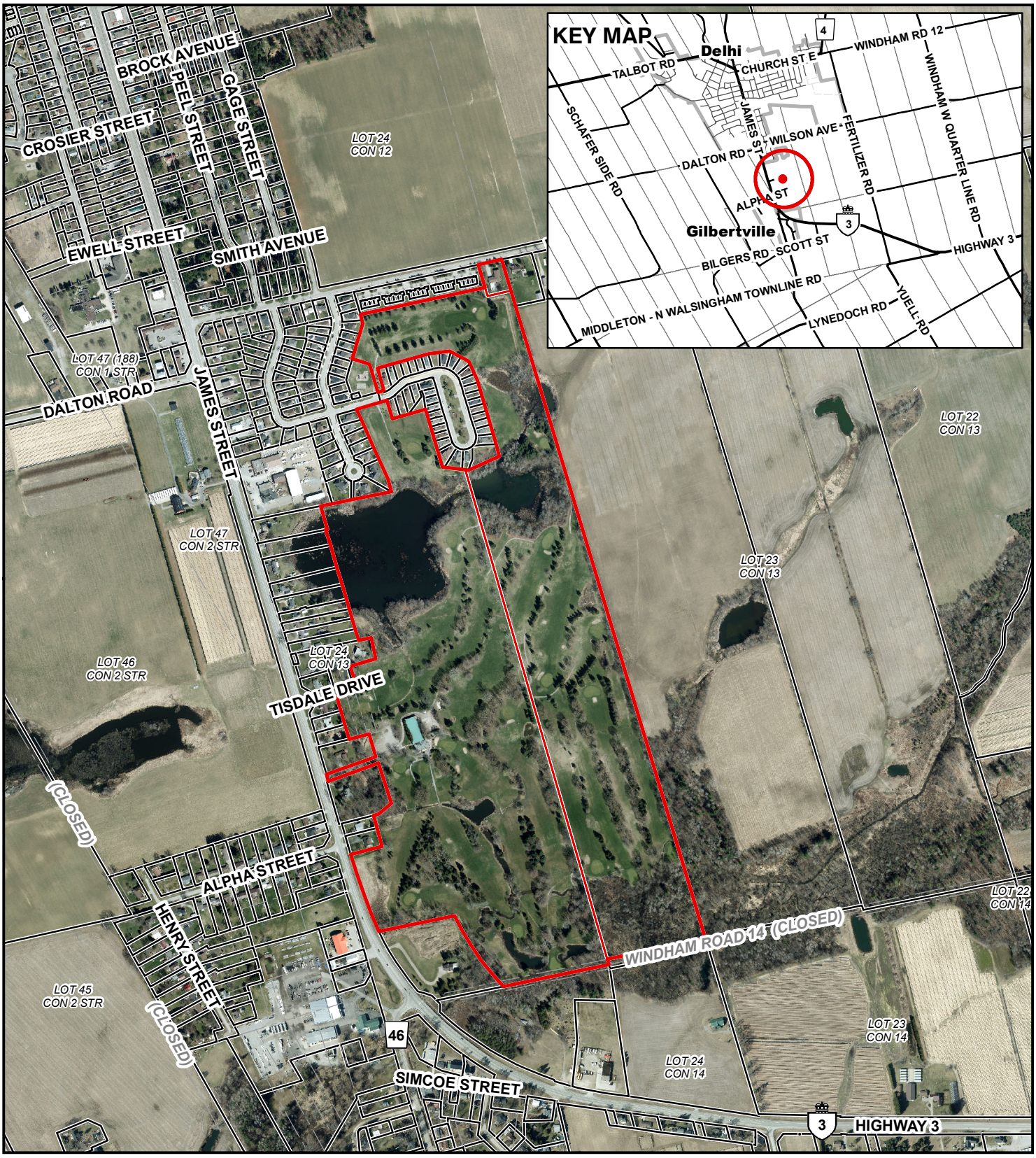
c Ontario Ministry of Natural Resources (OMNR). 2000. Significant Wildlife Habitat Technical Guide (Appendix G). 151 p plus appendices.

MAP A

CONTEXT MAP

Geographic Township of WINDHAM

OPNPL2023036
ZNPL2023037
28CDPL2023069
28TPL2023070



Legend

Subject Lands

Lands Owned

2020 Air Photo

4/17/2023

N

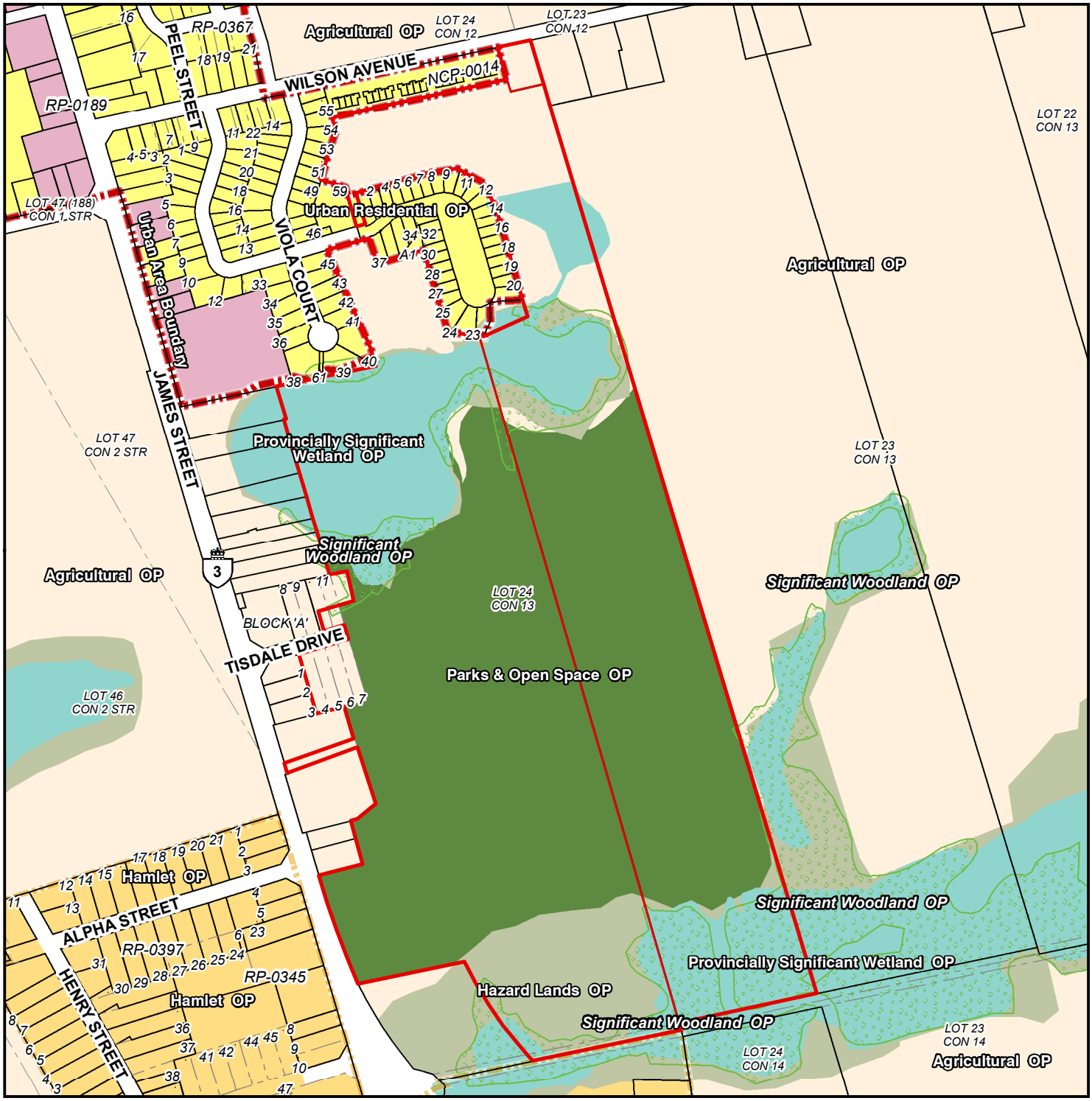
80 40 0 80 160 240 320 Meters

MAP B

PROPOSED OFFICIAL PLAN AMENDMENT MAP

Geographic Township of WINDHAM

OPNPL2023036
ZNPL2023037
28CDPL2023069
28TPL2023070



Legend

- Subject Lands
- Lands Owned

Official Plan Designations

- Agricultural
- Commercial
- Hazard Lands
- Parks & Open Space
- Provincially Significant Wetland
- Urban Area Boundary
- Hamlet
- Hamlet Area Boundary
- Urban Residential
- Significant Woodland

From: Agricultural & Parks & Open Space
To: Urban Residential with Site Specific Policy Area & Parks & Open Space

4/17/2023

N

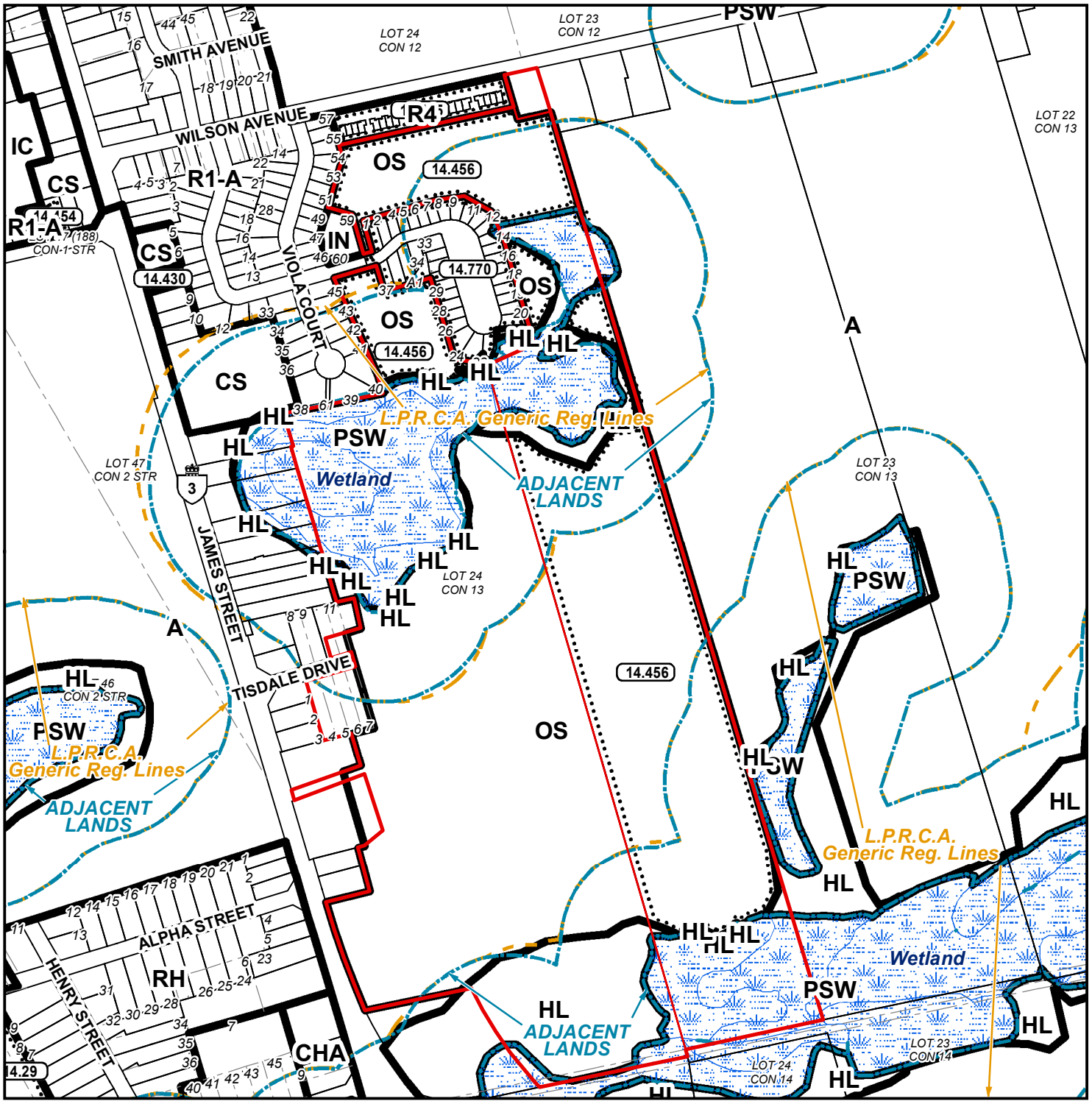
60 30 0 60 120 180 240 Meters

MAP C

PROPOSED ZONING BY-LAW AMENDMENT MAP

Geographic Township of WINDHAM

OPNPL2023036
ZNPL2023037
28CDPL2023069
28TPL2023070



LEGEND

- Subject Lands
- Lands Owned
- Adjacent Lands
- Wetland
- LPRCA Generic RegLines

ZONING BY-LAW 1-Z-2014

- (H) - Holding
- A - Agricultural Zone
- CHA - Hamlet Commercial Zone
- CS - Service Commercial Zone
- IC - Community Institutional Zone
- RH - Hamlet Residential Zone
- HL - Hazard Land Zone
- IN - Neighbourhood Institutional Zone
- OS - Open Space Zone
- PSW - Provincially Significant Wetland Zone
- R1-A - Residential R1-A Zone
- R4 - Residential R4 Zone

From: A & OS with Special Provision 14.456
To: R1-B with Special Provision, R2 with Special Provision, R4 with Special Provision, R5 with Special Provision & OS

4/17/2023

N

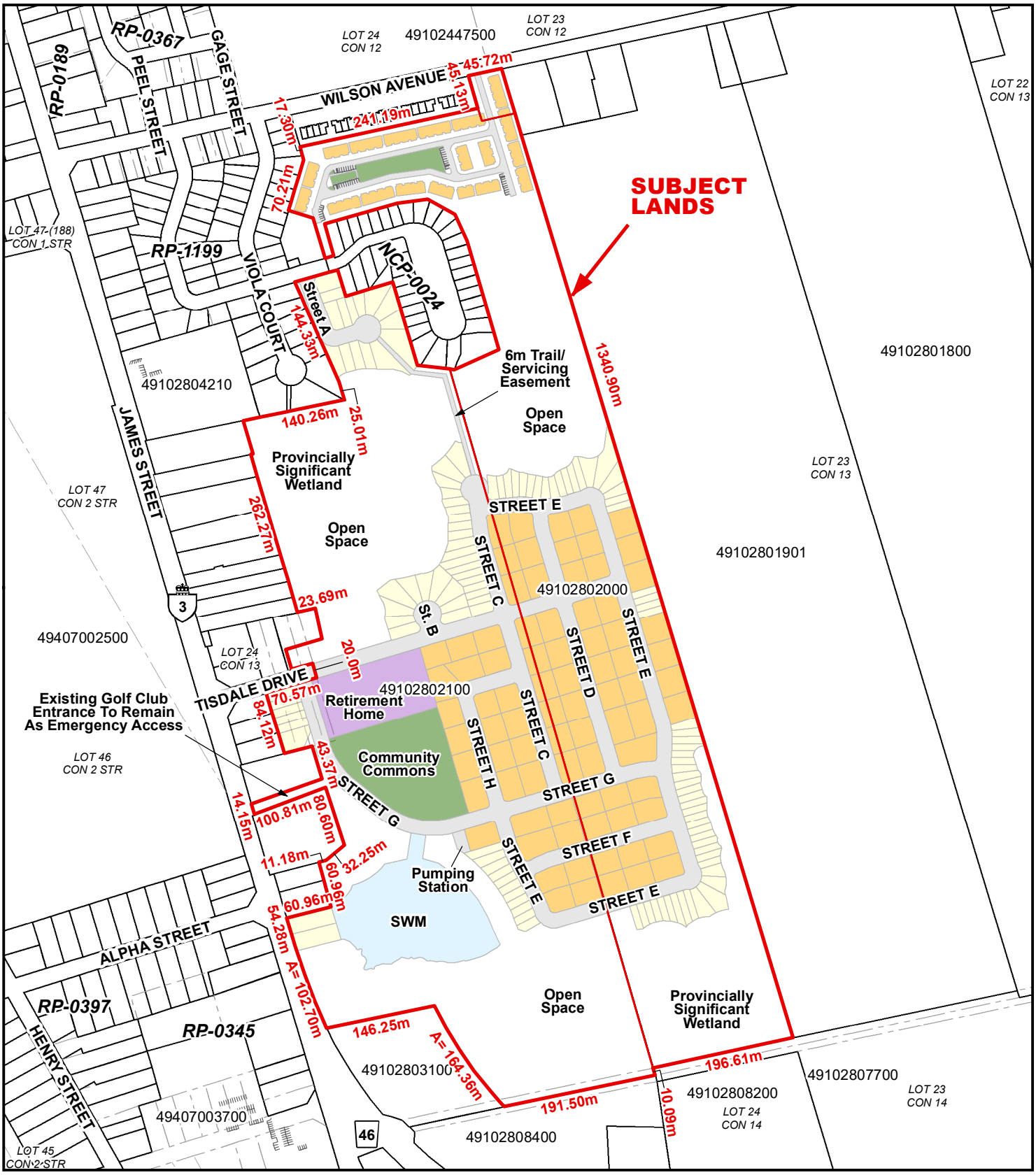
60 30 0 60 120 180 240 Meters

MAP D

CONCEPTUAL PLAN

Geographic Township of WINDHAM

OPNPL2023036
ZNPL2023037
28CDPL2023069
28TPL2023070



Legend

- Subject Lands
- Lands Owned
- Single Family Dwelling
- Multi Family Dwellings
- Ammenity Area/Community Commons
- Retirement Home
- Storm Water Pond
- Other

4/17/2023

N

50 25 0 50 100 150 200 Meters