

FUNCTIONAL SERVICING & STORMWATER MANAGEMENT REPORT

IN SUPPORT OF OPA AND REZONING APPLICATION

7859 Yonge Street

City of Markham



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File Number: 17086

Prepared For:

Tridel Corporation
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1	Issued for OPA/ZBA – 1 st Submission	March 08, 2018
No.	Revision	Date



EXECUTIVE SUMMARY

Counterpoint Engineering Inc. has been retained by Tridel to prepare this Functional Servicing and Stormwater Management Report in support of an Official Plan Amendment and Rezoning Application for the proposed residential development. The subject site is located at the South-West corner of Royal Orchard Boulevard and Bayview Avenue, in Markham.

The proposed servicing strategy for the site is summarized as follows:

Water Servicing:

A new connection to the existing 250 mm watermain along Royal Orchard Boulevard is proposed to service the development. The combined fire flow and maximum day demand is **8292 L/min**. Flow tests of nearby fire hydrants will be completed in the spring to confirm that the existing watermain system can support the proposed development.

Sanitary Servicing: The site will be serviced with a 250 mm diameter connection to the existing sanitary sewer along Royal Orchard Boulevard. An extension and upgrade of the existing sewer system is required. It will be completed as part of a capital works project by the City of Markham under a separate process. The **192** unit residential building will outlet **9.87 L/s** into the municipal sewer system.

Stormwater Servicing:

Controlled runoff from the majority of the site will be conveyed to the existing sewer system along Royal Orchard Boulevard to the north of the site. Under existing conditions, the storm sewer along Royal Orchard Boulevard has been experiencing capacity issues. The City of Markham has been addressing these issues with capital work improvements and allowance has been made for the proposed development. The total peak flow to the municipal sewer system is **47.3 L/s**.

Quantity Control – Will be provided on-site by an underground storage tank within the first parking level in combination with an inlet control device (e.g. orifice plate) to ensure



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Royal Orchard Boulevard, Markham

that the peak flows up to and including the 100-year post-development can be attenuated to the pre-development release rates.

Quality Control – Enhanced level quality control (80% of total suspended solid removal) will be achieved with the installation of an OGS unit on-site as well as LID initiatives such as green roof.

Water Balance –Water balance will be achieved with the combination of an infiltration gallery on the South-West corner of the site as well as through water reuse for irrigation of plantings/green roof areas.

Foundation Drainage – The groundwater table is above several underground parking levels. Therefore, to capture groundwater flow, foundation drains are utilized. All groundwater is to be collected in the storage facility within the building, treated, and allowed to outlet to the municipal storm sewer. It is anticipated that the long-term volume from sub-drain discharge is **2.3 L/s**.

Sincerely,
Counterpoint Engineering Inc.

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1.0 INTRODUCTION

1.1 PURPOSE

This Functional Servicing and Stormwater Management Report has been prepared in support of an Official Plan Amendment and Rezoning Application being submitted for the subject lands.

The purpose of this report is to address conceptually the provision of site grading, storm and sanitary sewers, stormwater management, and water distribution for the proposed residential development. The report will provide details on stormwater management in conformance with the City of Markham's Storm Drainage and Stormwater Management Policies and Design Guidelines, as well as the Toronto Region Conservation Authority ("TRCA") Technical Guidelines for Stormwater Management Submissions.

1.2 BACKGROUND

The subject site is located at the south west corner of Royal Orchard Boulevard and Bayview Avenue in the City of Markham. The subject site is approximately 1.07 ha in size with approximately 46.0 m of frontage on Royal Orchard Boulevard to the north, and approximately 166.5 m of frontage on Royal Orchard Boulevard to the east. The site is included within the boundaries of the Ladies' Golf Club of Toronto, municipally known as 7859 Yonge Street (the "subject site") as seen in **Figure 1** in **Appendix A**. The site is not currently serviced, and the land general slopes towards the south-west corner.

The residential development that is proposed for the subject site consists of two towers- one 12 storeys and one 14 storeys connected by a common ground floor, as well as associated underground parking areas. There will be **192** residential units within the building and 3 levels of underground parking. Refer to drawing **A1.2** in **Appendix A** for a copy of the proposed Architectural Site Plan prepared by Kirkor Architects.



1.3 STUDY PARAMETERS

The background documents listed below have been considered in the functional grading and servicing design for the proposed development and preparation of this Functional Servicing and Stormwater Management Report:

- Architectural plans prepared by Kirkor Architects;
- Toronto Region Conservation Authority Stormwater Management Criteria Document (TRCA Guidelines);
- Fire Underwriters Survey (FUS), 1999;
- Ministry of the Environment and Climate Change Design Guidelines for Sewage Works, 2008 (MOECC Guidelines); and
- City of Markham Engineering Design Criteria.

1.4 EXISTING SOIL, HYDROGEOLOGICAL AND GEOTECHNICAL CONDITIONS

The following reports were prepared by Exp. Services Inc. to investigate the site geotechnical and hydro-geotechnical conditions.

- Hydrogeological Investigation for Bayview Avenue and Royal Orchard Boulevard January 11, 2018.
- Geotechnical Investigation Bayview Avenue and Royal Orchard Boulevard August 31, 2017.

These reports highlight:

- Boreholes indicate that site soils are generally covered with clayey silt for an average depth of 4 m overlain by 220-400 mm of topsoil. Situated under the clayey silt exists a 2-3 m section of silt and silty sand overlaying additional clayey silt and sandy silt.
- Groundwater levels for the site range from 167.61 to 175.01 masl.



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- Groundwater samples were compared to York Region and Markham Storm and Sanitary Sewer Us By-Law Discharge limits and were found to exceed storm sewer requirements for concentrations of total suspended solids (TSS), aluminum (Al), Iron (Fe), Manganese (Mn) and titanium (Ti). All concentration reported satisfied the sanitary sewer discharge limits.
- Category 3-Permit to Take Water (PTTW) will be required during construction as the flows will exceed 400 m³/day (flow rate is taken as 600 m³/day).
- Long-term discharge volume is estimated at 200 m³/day.

1.5 ROYAL ORCHARD BOULEVARD INFRASTRUCTURE

The site is proposed to be serviced by connection to existing infrastructure within Royal Orchard Boulevard to the north of the site. The capacity of these sewers has been extensively studied by the City of Markham due to basement flooding. The following reports have been prepared by others to investigate and offer a design solution(s) for sanitary and storm capacity issues within the subject area.

- West Thornhill Stormwater Flood Remediation Class EA Study, prepared by Clarifica, November 2010.
- West Thornhill Flood Control Implementation Alternative Refinement, Preliminary and Final Design, prepared by XCG Consultants, May 2017.

The City will be proceeding with Phase 4 West Thornhill this year and sufficient capacity for this site will be included in the storm and sanitary sewer improvements.



2.0 WATERMAIN SERVICING

2.1 EXISTING WATER SERVICING

Under existing conditions there is a 250 mm diameter watermain running along the northern section of Royal Orchard Boulevard as well as an existing fire hydrant on the north boulevard. There are currently no service connections to the proposed development. Refer to **Figure 3** in **Appendix A** for the conceptual servicing plan.

2.2 PROPOSED WATER SERVICING STRATEGY

A new connection to the existing 250 mm diameter watermain along Royal Orchard Boulevard is proposed to service the development. Refer to **Figure 3** in **Appendix A** for the conceptual servicing plan.

In accordance with the City of Markham Engineering standards, watermains shall be sized to meet the greater of either the maximum hour demand or the maximum day demand plus fire flow. Maximum daily and hourly demand are calculated using an equivalent population of **576 persons**, an average daily consumption rate of **365 L/c/day** and peaking factors of 2.0 and 4.5 for maximum daily and hourly demand respectively. Maximum day and peak factors were based on City of Markham Watermain Guidelines.

Fire flow demand, according to the Fire Underwriters Survey, should be set to a minimum of 8,000 L/min for contiguous buildings. Therefore, Maximum Day + Fire Flow, which governs the water demand for the proposed development is **8292 L/min**. Refer to **Appendix B** for detailed water service calculations.

The City of Markham Watermain guidelines sets out watermain pressure requirements for residential developments, and are summarized as follows:

- Under normal conditions, the static pressure shall not exceed 650 kPa (95 psi)
- Under maximum hourly demand, the pressure shall not fall below 300 kPa (44 psi)
- Under maximum day demand + fire flow conditions, the pressure shall not fall below 140 kPa (20 psi).

Flow tests of nearby fire hydrants will be completed in the spring of 2018 to confirm capacity to support the proposed development.



3.0 SANITARY SERVICING

3.1 EXISTING SANITARY SERVICING

The subject site has an existing 250 mm diameter sanitary sewer draining west along Royal Orchard Boulevard, which is expected to be up-sized as per the capital improvements discussed above. The existing site does not generate sanitary flow and there are no existing servicing connections. Refer to **Figure 3** for the conceptual servicing plan included in **Appendix A**.

3.2 PROPOSED SANITARY SERVICING

The proposed development will be serviced by a new 250 mm extension and connection to the existing sanitary sewer along Royal Orchard Boulevard. Refer to **Figure 3** for the conceptual servicing plan included in **Appendix A**. As mentioned above, sanitary demands from this development will be accommodated by future capital improvements to downstream sanitary infrastructure.

Contributing sanitary flows from the proposed development were calculated based on City of Markham Sanitary Guidelines. Equivalent population and institutional design flows were determined based on the Ministry of the Environment and Climate Change (MOECC) Guidelines. According to site statistics as provided by the architect, the proposed population of this residential development is **576 persons**. Based on the City of Markham Sanitary Guidelines and MOECC criteria, the average daily flow for a residential development is 365 L/c/day. With a peaking factor of 4 and an infiltration rate of 0.26 L/s/ha, the resultant sanitary design flow is **9.87 L/s**. Refer to **Appendix D** for detailed calculations.



4.0 PROPOSED GRADING STRATEGY

Based on existing topography, the entire site drains towards the South-West portion of the property and onto the adjacent golf course. This area includes a portion of the municipal right of way boulevard of Royal Orchard Boulevard to the east of the property. Existing drainage boundaries are shown in **Figure 4** in **Appendix A**.

The grading stage for this site has been developed primarily in an effort to preserve existing trees along all of the property lines. Therefore, care has been taken to minimize grading changes around the perimeter of the site.

The site grading strategy is as follows:

- The south-west perimeter will continue to drain towards the adjacent golf course as per existing conditions. Existing green space west of the building envelope will be maintained.
- The park block will continue to drain west towards the adjacent golf course. To support a future play area, this portion of the site has been graded relatively flat.
- A swale and two culverts have been designed to capture the external drainage along Royal Orchard Boulevard to the east of the site, and convey storm flow from the boulevard around the building and towards the adjacent golf course.



5.0 STORMWATER MANAGEMENT

5.1 EXISTING STORMWATER CONDITIONS

Under existing conditions, the site is made up of entirely vegetation/pervious land cover. Based on topography, the pre-development conditions consist of one drainage area (101) which drains uncontrolled towards the south-west corner of the site. Additionally, the site receives external overland flow from the western boulevard of the Royal Orchard extension east of the subject site. This flow has not been included in the pre-development peak flow as it will be diverted around the site in post-development conditions. Refer to **Figure 4** in **Appendix A** for pre-development storm drainage conditions.

In accordance to the City of Markham standards, rational method has been utilized to calculate pre-development peak runoff for the 2-year up to the 100-year storm event. Since no existing storm water management controls have been identified on site, it is understood that the site currently discharges uncontrolled and is summarized in **Table 1**. Refer to **Appendix D** for detailed calculations.

Table 1: Pre-development Peak Flows (L/s)

Storm Event	Pre-Development Peak Flow (L/s)
2-Year	58
5-Year	80
10-Year	98
25-Year	128
50-Year	154
100-Year	181

As the existing site is currently being used as a golf course, there are no storm sewer systems or storm connections within the site. However, there is an existing 450 mm diameter storm sewer running west along Royal Orchard Boulevard, currently servicing the blocks to the north of the site. As mentioned previously, it is proposed that upgrades to the storm sewer downstream will be made to satisfy the demands of the proposed development.



5.2 WATER QUANTITY

In the proposed conditions, the site will be divided into several defined drainage areas. Refer to **Figure 5** in **Appendix A** for post-development drainage areas. The 0.20 ha area defined as 203 on the drainage plan drains uncontrolled towards the existing golf course to the west of the property under all storm events. The remainder of the site will be released into the municipal sewer on Royal Orchard Boulevard for all events up to a 5-year storm event. During storm events that exceed the capacity of the sewers, drainage from the park (area 202) will flow overland to the west and drainage from the development area (area 201) will be stored underground. The portion of external drainage area received from Royal Orchard Boulevard to the east will be directed around the building to outlet to the golf course as per existing conditions.

To provide adequate storage and to control run-off from the controlled drainage areas (i.e. area 201), a storage facility and orifice plate are proposed. A storage tank is proposed to be provided on the first parking level to attenuate a 100-year post-development storm event. Approximately **214 m³** of storage will be required. An orifice control will be utilized to control post-development flows below pre-development release rates. Refer to **Appendix D** for preliminary storage and orifice plate calculations.

Groundwater collected by foundations drains will be treated internally and will discharge to the storm sewer downstream of the storage and orifice control. The groundwater flow has been taken into consideration to ensure that the allowable release rate is maintained. **Table 2** outlines the post-development flow for the 2-year, 5-year and 100-year storm events. As required, the total release rate in the post-development condition is within the allowable pre-development release rate targets.



Table 2: Post-Development Release Rates (L/s)

Storm Event	Design Flows				Total Release Rate (L/s)	Target Allowable Release Rate (L/s) (pre-development)
	201 (L/s)	202 (L/s)	203 (L/s)	Groundwater (L/s)		
2-Year	34.0	9.0	11.0	2.3	54.0	58.0
5-year	34.0	13.0	15.0	2.3	62.0	80.0
100-Year	34.0	29.0	35.0	2.3	100.3	181.0

The proposed storm sewers within the site and through the adjacent park have been sized to accommodate flow from up to a 5-year storm event. Refer to **Appendix D** for the Storm Sewer Design Sheet. The proposed minor system will outlet approximately **47.3 L/s** to the municipal sewer located along Royal Orchard Boulevard to the north of the site. The existing sanitary and storm lines along Royal Orchard Boulevard will need to be extended eastward to accommodate the new connection while protecting existing trees. Refer to **Figure 3** in **Appendix A** for concept servicing figure.

In major storm and emergency events, the three drainage areas (areas 201, 202 and 203, per Figure 5) will drain as follows:

- The 0.20 ha defined as 203 and the 0.17 ha defined as 202, will drain overland to the adjacent golf course based on existing topography.
- The 0.70 ha defined as 201 will be directed east, and will spill overland towards the proposed ditch along Royal Orchard Boulevard and will be conveyed towards the adjacent golf course.

5.3 WATER QUALITY

The City of Markham SWM Guidelines state that 80% of total suspended solids (TSS) removal is required as per MOECC guidelines, and treatment must be provided for a minimum of 90% of volume. An OGS unit and Low Impact Development measures such as green roof area (to be designed during detailed design stage) will be provided to achieve quality control.



5.4 WATER BALANCE

The existing development is a vegetated golf course. As such, infiltration controls the majority of the precipitation. Due to the change in land use, a water budget analysis is required to determine the annual infiltration volume lost in the post-development condition. According to the TRCA, sufficient effort is to be taken to maintain pre-development infiltration rates. Refer to **Figure 6** and **Figure 7** in **Appendix A** for pre-development and post-development water balance plans respectively. As per TRCA guidelines, the required storage that needs to be retained in post-development conditions is **16.8 m³** to provide retention of 5mm over the entire site area in all storm events. See **Appendix D** for water balance calculations.

An underground infiltration unit is proposed at the south-west corner of the property. The proposed location of this unit is shown in **Figure 3** conceptual servicing plan in **Appendix A**.

An infiltration rate for the soil has not been confirmed by the geotechnical consultant. Since clay is found in the soil stratigraphy, a conservative infiltration rate of 6 mm/hr has been used for preliminary calculations. Using this rate, the maximum depth for the gallery such that the drawdown time is less than 48 hours, is 0.28 m. The footprint of the proposed infiltration gallery is constrained by minimum setbacks to the building and the property line, thus the maximum area that can be utilized for infiltration is 22.0 m by 3.80 m. Using this footprint and depth, the gallery can provide up to **9.4 m³** of storage. Refer to **Appendix D** for detailed calculations.

As nearly the entire square footage of the site will be occupied by underground parking, infiltration alone cannot satisfy water balance requirements. In addition to the infiltration gallery proposed, on-site water reuse programs should be incorporated to satisfy the remaining water budget. The preferred method for this development will be using rain water for irrigation purposes.

5.5 FOUNDATION DRAINAGE

The proposed building will host multiple levels of underground parking. It is assumed based on the geotechnical report and the site plan received to date, that the parking levels require the foundations to be set below the groundwater table. Should the building design require a foundation drainage system, it is anticipated based on the Hydrogeotechnical Report prepared by Exp, that the long-term volume from sub-drain discharge is 200 m³/day. All groundwater to



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Royal Orchard Boulevard, Markham*

be discharged must be treated to meet all applicable storm guidelines and is to outlet to the storm sewer.

According to the Ontario Water Resources Act, a permit to take water application will be required for long-term discharge in addition of an application during the construction phase.



6.0 CONCLUSIONS

Based on the assessment provided above, the existing and/or proposed city infrastructure can accommodate the proposed change in land use as follows:

Water Servicing:

A new connection to the existing 250 mm watermain along Royal Orchard Boulevard is proposed to service the development. The combined fire flow and maximum day demand is **8292 L/min**. Flow tests of nearby fire hydrants will be completed in the spring to confirm that the existing watermain system can support the proposed development.

Sanitary Servicing: The site will be serviced with a 250 mm diameter connection to the existing sanitary sewer along Royal Orchard Boulevard. An extension and upgrade of the existing sewer system is required. It will be completed as part of a capital works project by the City of Markham under a separate process. The **192** unit residential building will outlet **9.87 L/s** into the municipal sewer system.

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Quantity Control – Will be provided on-site by an underground storage tank within the first parking level in combination with an inlet control device (e.g. orifice plate) to ensure that the peak flows up to and including the 100-year post-development can be attenuated to the pre-development release rates.



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Quality Control – Enhanced level quality control (80% of total suspended solid removal) will be achieved with the installation of an OGS unit on-site as well as LID initiatives such as green roof.

Water Balance –Water balance will be achieved with the combination of an infiltration gallery on the South-West corner of the site as well as through water reuse for irrigation of plantings/green roof areas.

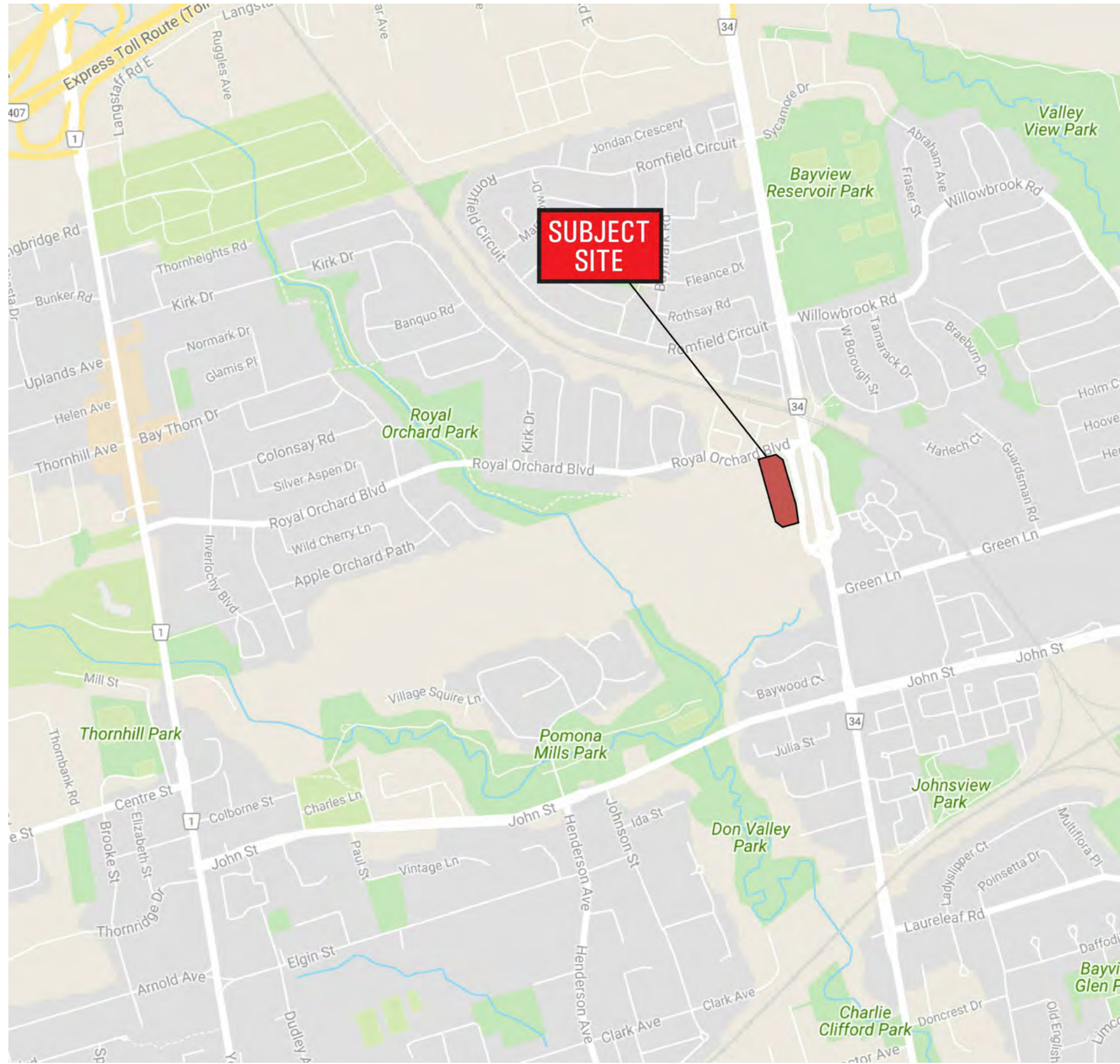
Foundation Drainage – The groundwater table is above several underground parking levels. Therefore, to capture groundwater flow, foundation drains are utilized. All groundwater is to be collected in the storage facility within the building, treated, and allowed to outlet to the municipal storm sewer. It is anticipated that the long-term volume from sub-drain discharge is **2.3 L/s**.



*Ladies' Golf Club of Toronto
Royal Orchard Boulevard, Markham*

Appendix A

Figures



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LADIES' GOLF CLUB OF
 TORONTO
 MARKHAM, ONTARIO
 TRIDEL CORPORATION

SITE LOCATION PLAN

PROJECT No. 17086

FIGURE No. **1**

SCALE: N.T.S

Contractor Must Check And Verify All Dimensions On The Job.
 Do Not Scale The Drawings.
 All Drawings, Specifications And Related Documents Are The Copyright Of The Architect And Must Be Returned Upon Request.
 Reproduction Of Drawings, Specifications And Related Documents In Part Or Whole Is Forbidden Without The Architects Written Permission.
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No.: Revision: Date:

ISSUED FOR CONSULTANT COORDINATION

February 22, 2018

No. Issued For: Date:

Drawing Title:

Site Plan

Project:

Tridel

Ladies' Golf Club of Toronto

7859 Yonge Street

Scale:

1 : 250

Drawn by:

Author

Checked by:

Checker

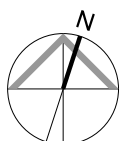
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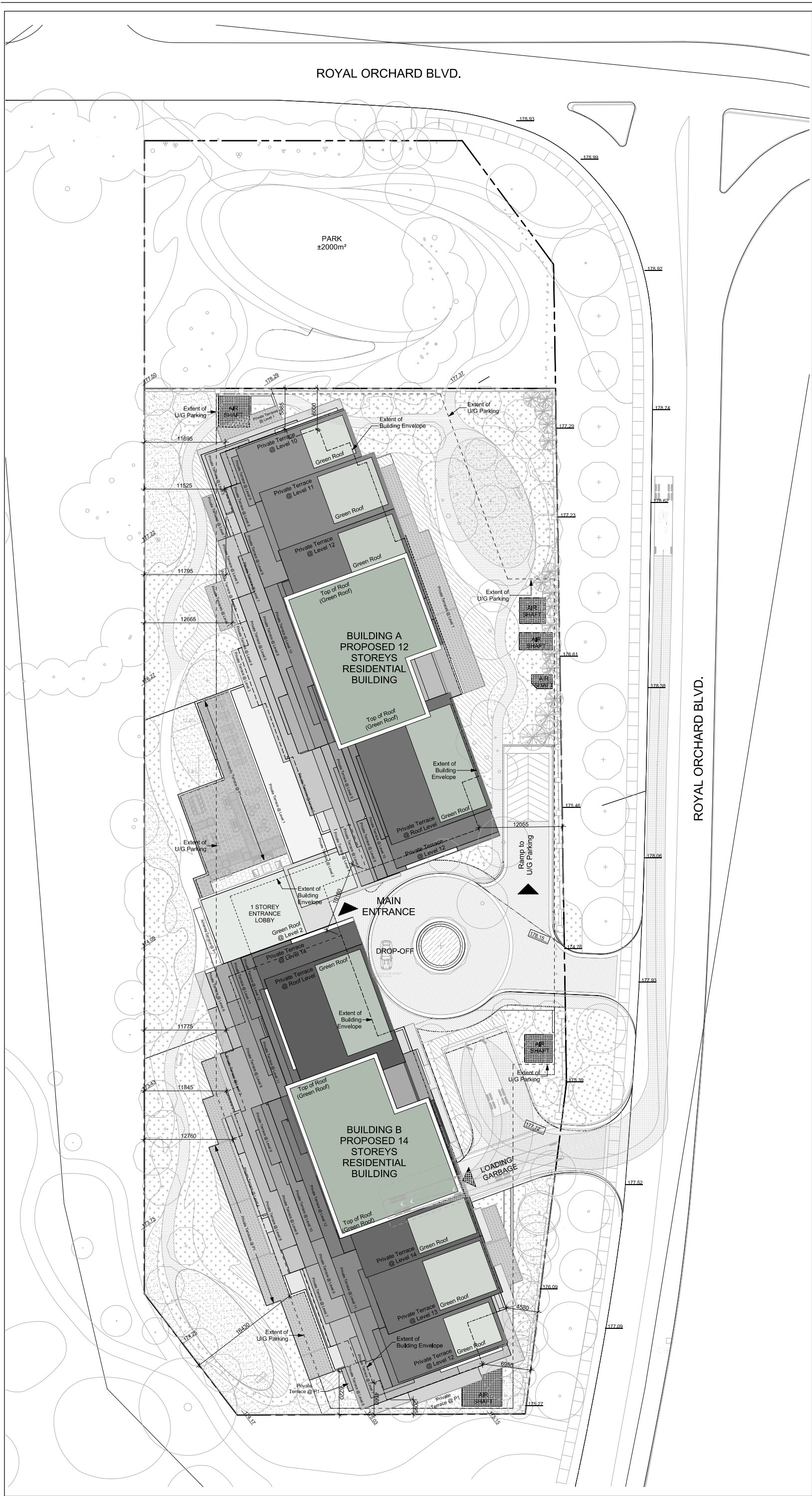
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February 22, 2018

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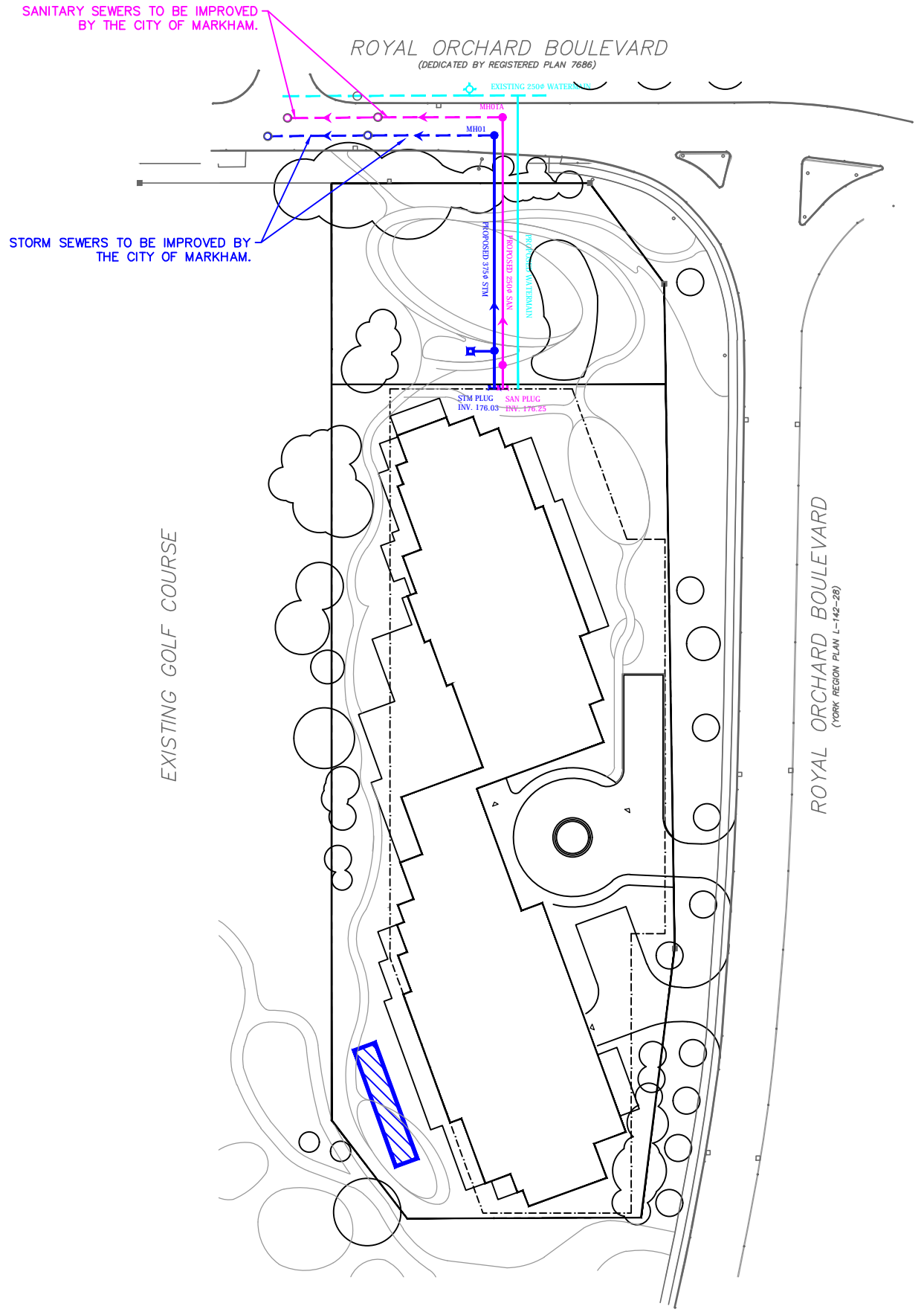


A1.2



Floor Plan Level 1 **1**
 Scale: 1 : 250 **A1.2**

8
8
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LEGEND

- EXISTING SANITARY SEWER
- PROPOSED SANITARY SEWER
- EXISTING STORM SEWER
- PROPOSED STORM SEWER
- PROPOSED CATCHBASIN
- PROPOSED UNDERGROUND STORAGE TANK
- EXISTING WATERMAIN
- PROPOSED WATER/FIRE MAIN
- EXISTING FIRE HYDRANT
- PROPOSED FIRE HYDRANT

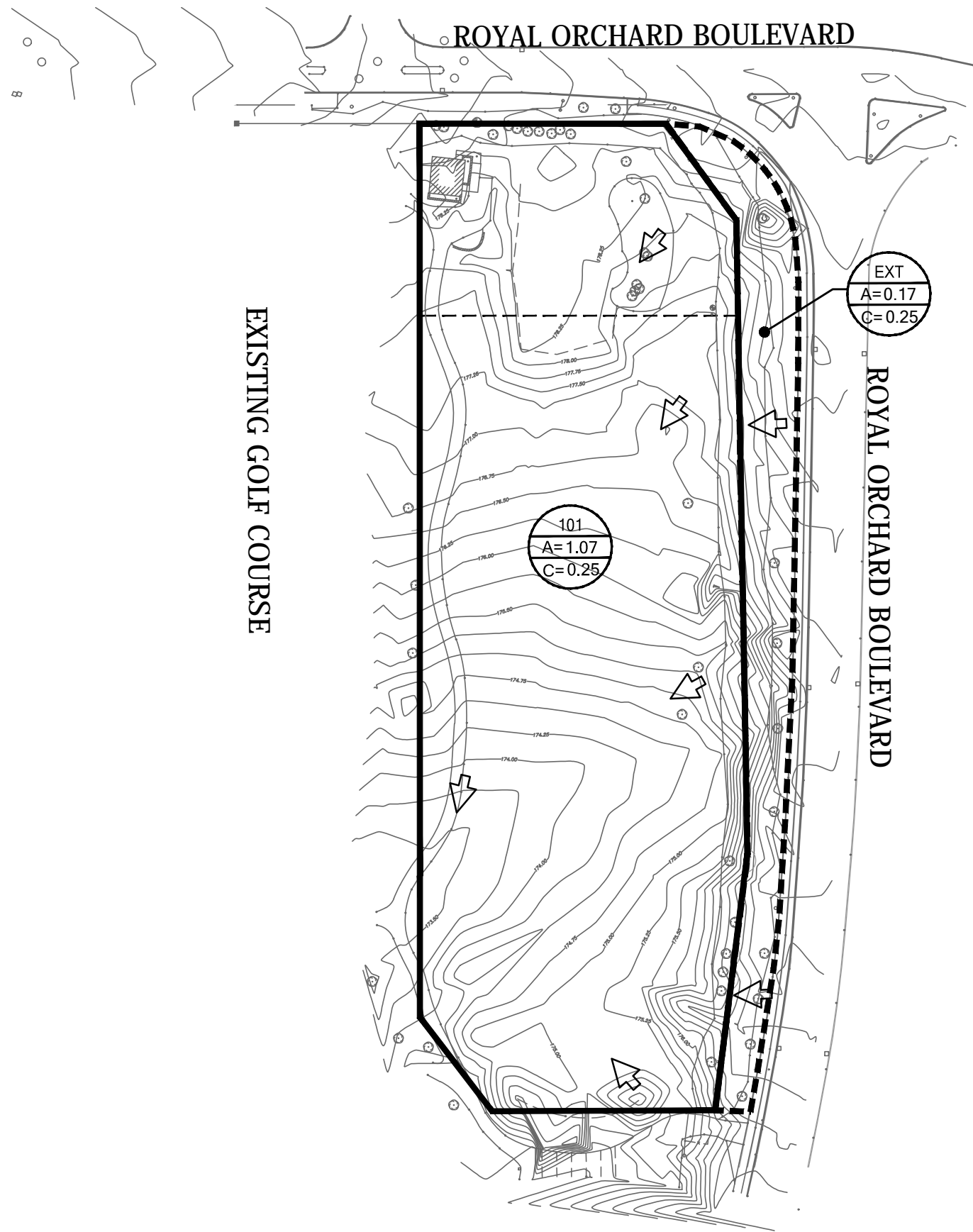
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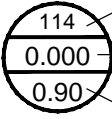

LADIES' GOLF CLUB OF
TORONTO
MARKHAM, ONTARIO
TRIDEL CORPORATION

**CONCEPTUAL SERVICING
PLAN**

PROJECT No. 17086
SCALE: 1:1000

FIGURE No. **3**



- LEGEND:**
-  DRAINAGE AREA BOUNDARY
 -  EXTERNAL AREA DRAINING TO SITE
 -  AREA ID
DRAINAGE AREA IN HECTARES
COMPOSITE RUNOFF COEFFICIENT
 -  OVERLAND FLOW PATH

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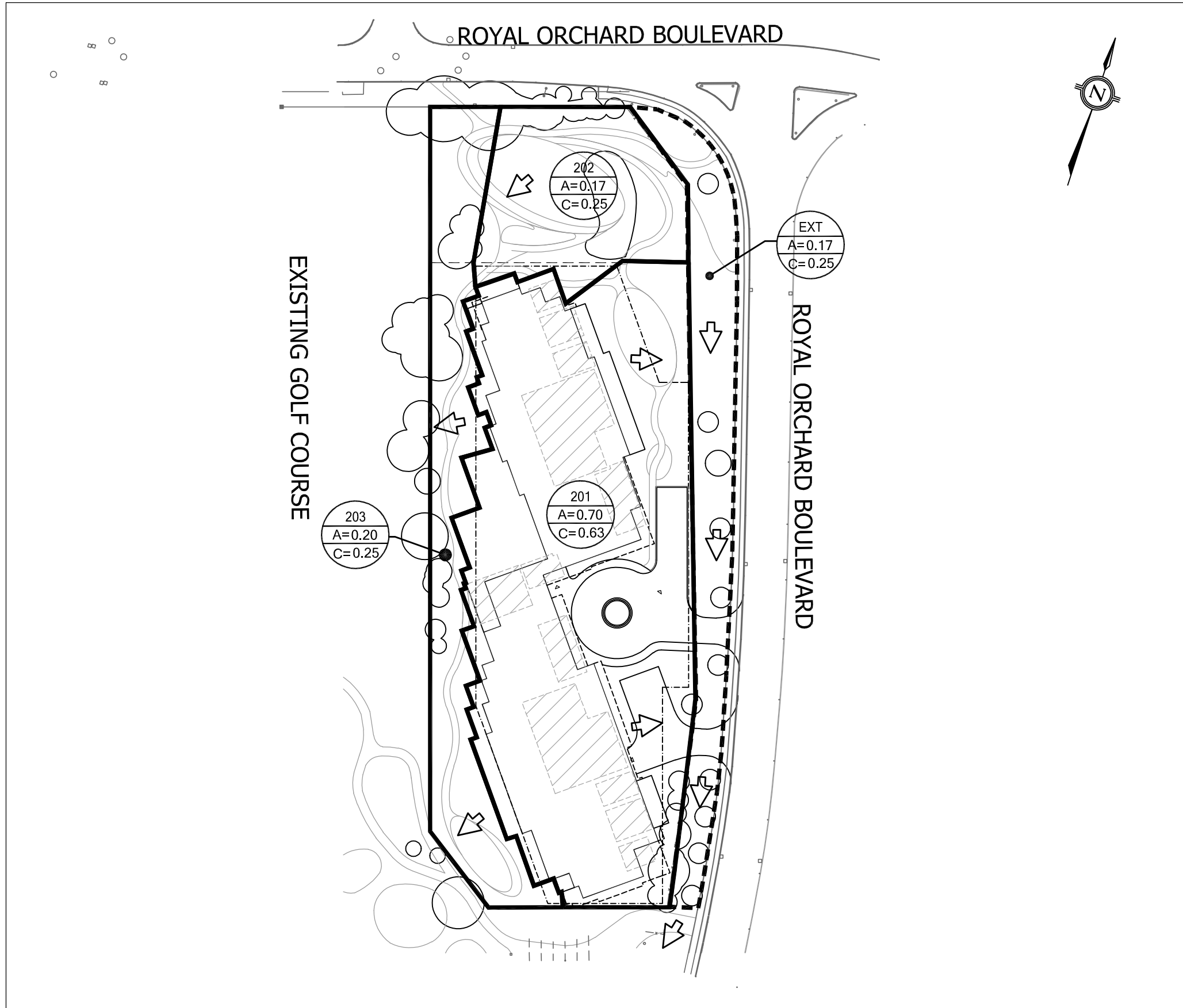
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**PRE DEVELOPMENT
STORM DRAINAGE PLAN**

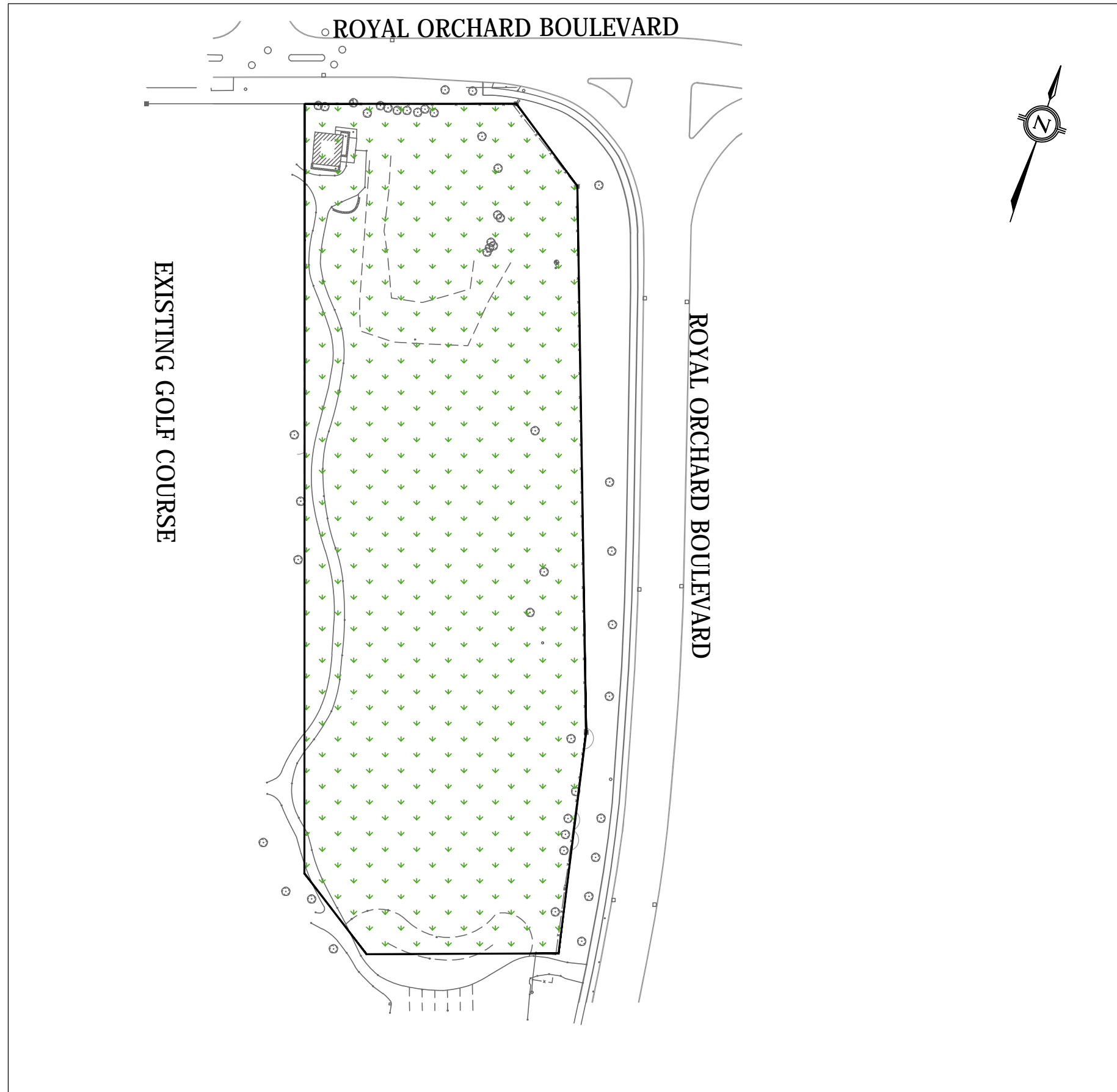
PROJECT No. 17086
SCALE: 1:1000

FIGURE No. **4**






- LEGEND:**
-  DRAINAGE AREA BOUNDARY
 -  EXTERNAL AREA DRAINING TO SITE
 -  AREA ID
DRAINAGE AREA IN HECTARES
COMPOSITE RUNOFF COEFFICIENT
 -  OVERLAND FLOW PATH

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<p>LADIES' GOLF CLUB OF TORONTO MARKHAM, ONTARIO TRIDEL CORPORATION</p>	
<p>POST DEVELOPMENT MINOR STORM DRAINAGE PLAN</p>	
PROJECT No. 17086	FIGURE No. 5
SCALE: 1:1000	



LEGEND:

				% COVERAGE
	PERVIOUS AREAS	(i=0%)	10,703 sq.m.	100 %
	BUILDING	(i=100%)	0	0
	IMPERVIOUS PAVEMENT	(i=100%)	0	0
TOTAL			10,703 sq.m. (i=0%)	

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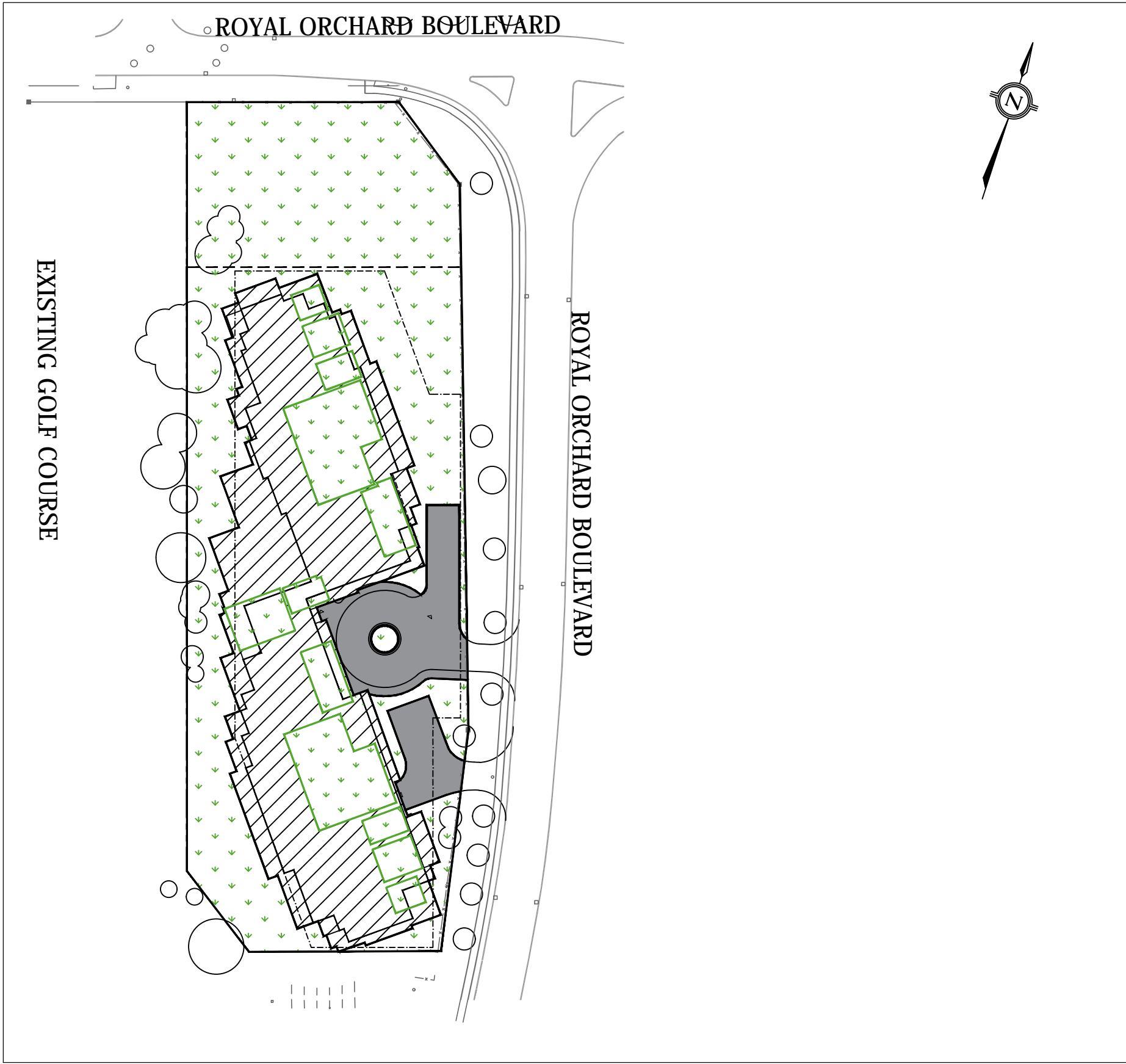
LADIES' GOLF CLUB OF
TORONTO
MARKHAM, ONTARIO
TRIDEL CORPORATION

PRE DEVELOPMENT
WATER BALANCE PLAN




PROJECT No. 17086


SCALE: 1:1000

FIGURE No. **6**



LEGEND:

				% COVERAGE
	PERVIOUS AREAS	(i=0%)	6553 sq.m.	61 %
	BUILDING	(i=100%)	3210	30
	IMPERVIOUS PAVEMENT	(i=100%)	940	9
TOTAL			10,703 sq.m.	(i=39%)

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**POST DEVELOPMENT
WATER BALANCE PLAN**

PROJECT No. 17086	FIGURE No. 7
SCALE: 1:1000	



*Ladies' Golf Club of Toronto
Royal Orchard Boulevard, Markham*

Appendix B

Water Servicing Design Calculations

Counterpoint Engineering Inc.

Water Demand Design Calculations

Project: Ladies' Golf Club of Toronto
Project No: 17086
Location: Markham, Ontario
Site Area: 1.07 ha
Date: 2018-02-23

Population

Suite	3	ppu
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	Residential Units		Total Units
	Building A	Building B	
Level P1	0	7	7
Level 1	13	9	22
Level 2	14	9	23
Level 3 to 5	24	24	48
Levels 6 to 7	14	16	30
Levels 8	7	7	14
Levels 9	6	7	13
Level 10	5	7	12
Level 11	4	6	10
Level 12	2	5	7
Level 13	0	4	4
Level 14	0	2	2
TOTAL UNITS	89	103	192

	Population
Residential	576
Total Equivalent Population	576

City of Markham Watermain Guidelines

Per Capita Demand

Residential Demand	365	(l/capita/day)
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Peaking Factors

Land Use	Minimum Hour	Maximum Hour	Maximum Day
Residential	0.70	4.50	2.00

Water Demand based on Equivalent Population

Land Use	Population	Average Daily Demand (l/min)	Maximum Hour (l/min)	Maximum Day (l/min)	Fire Flow Required (l/min)	Max Day + Fire Flow (l/min)
Totals	576	102.2	657.0	292.0	8000	8292

Counterpoint Engineering Inc.

REQUIRED FIRE FLOW WORKSHEET - PROPOSED DEVELOPMENT

Fire Underwriters Survey

Project : Ladies' Golf Club of Toronto

Project No: 17086

Guide for Determination of Required Flow Copyright I.S.O

$$F = 220C\sqrt{A}$$

where

- F = the required fire flow in litres per minute.
- C = coefficient related to the type of construction.
 - = 1.5 for wood frame construction (structure essentially all combustible).
 - = 1.0 for ordinary construction (brick or other masonry walls, combustible floor and interior).
 - = 0.8 for non-combustible construction (unprotected metal structural components, masonry or metal walls).
 - = 0.6 for fire-resistive construction (fully protected frame, floors, roof).
- A = The total floor area in square metres (including all storeys, but excluding basements at least 50 percent below grade) in the building being considered.

Type of Construction		Class Factor
WF	Wood Frame	1.5
OC	Ordinary Construction	1.0
NC	Non-Combustible	0.8
FC	Fire-Resistive	0.6

Area Notes for Fire Resistive Buildings (from FUS manual, 1999):

If Vertical Openings are inadequately protected (less than 1-hour fire rating): Area is the total of the two largest adjoining floors (above ground level) plus 50% of the area of each of the next 8 adjoining floors above that.

Contents		% Reduction
NC	Non-Combustible	25
LC	Limited Combustible	15
C	Combustible	0
FB	Free Burning	15
RB	Rapid Burning	25

If Vertical Openings are adequately protected (at least 1-hour fire rating): Area is the total of the largest floor (above ground level) plus 25% of the area of each of the next 2 immediately adjoining floors above that.

1) **Fire Flow**

Type of Construction:

C=

A*=

F=

FC
0.6
5703 m ²
9,968 L/min

Note: Assuming fire resistive building. Assuming Vertical Openings are adequately protected. Area is the total of the largest floor (level 1) plus 25% of the next 2 adjoining floors above.

2) **Occupancy Reduction/Surcharge**

Contents Factor:

Reduction/Surcharge of

F=

C		
0%	=	0 L/min
9968L/min + 0 L/min	=	9,968 L/min

3) **System Type Reduction**

NFPA 13 Sprinkler:

Standard Water Supply:

Fully Supervised:

Total

Reduction of

F=

YES	30%	
YES	10%	
YES	10%	
Total	50%	
50% L/min	=	4,984 L/min
9968L/min - 4,984 L/min	=	4,984 L/min

4) **Separation Charge**

Building Face

North

East

South

West

Total

Dist(m)	Charge
46	0%
46	0%
46	0%
46	0%
Total	0%

of 9968.4 L/min = 0 L/min

(max exposure charge can be 75%)

Separation	Charge	Separation	Charge
0 to 3m	25%	20.1 to 30 m	10%
3.1 to 10m	20%	30.1 to 45m	5%
10.1 to 20m	15%		

F= 4984L/min + 0L/min = 4,984 L/min (2,000L/min < F < 45,000L/min)

F=	5,000 L/min	(round to the nearest 1,000L/min)
F=	83 L/s	
F=	1,321 gpm	



*Ladies' Golf Club of Toronto
Royal Orchard Boulevard, Markham*

Appendix C

Sanitary Servicing Design Calculations



*Ladies' Golf Club of Toronto
Royal Orchard Boulevard, Markham*

Appendix D

Stormwater Management Design Calculations



SWM DESIGN CALCULATIONS
The Minor System Pre-development 2-Year Flow Rate Calculations

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	651.63
Event	2-year	b	3.75
		c	0.8

Site Data

Area (ha)	0.86
Runoff Coefficient	0.25
AC	0.22
Tc (min)	10.47
Rainfall Intensity (mm/hr)	78
Rational Flow Rate (l/s)	47

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)



SWM DESIGN CALCULATIONS
The Site Pre-development 2-Year Flow Rate Calculations

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 23-Feb-18

Date: 23-Feb-18

Rainfall Data

Location:	Markham, Ont	a	651.63
Event	2-year	b	3.75
		c	0.8

Site Data

Area (ha)	1.07
Runoff Coefficient	0.25
AC	0.27
Tc (min)	10.47
Rainfall Intensity (mm/hr)	78
Rational Flow Rate (l/s)	58

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)



SWM DESIGN CALCULATIONS
The Site Pre-development 5-Year Flow Rate Calculations

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 23-Feb-18

Date: 23-Feb-18

Rainfall Data

Location:	Markham, Ont	a	1045.41
Event	5-year	b	4.9
		c	0.83

Site Data

Area (ha)	1.07
Runoff Coefficient	0.25
AC	0.27
Tc (min)	10.47
Rainfall Intensity (mm/hr)	108
Rational Flow Rate (l/s)	80

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)



SWM DESIGN CALCULATIONS
The Site Pre-development 10-Year Flow Rate Calculations

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 23-Feb-18

Date: 23-Feb-18

Rainfall Data

Location:	Markham, Ont	a	1331.42
Event	10-year	b	5.26
		c	0.84

Site Data

Area (ha)	1.07
Runoff Coefficient	0.25
AC	0.27
Tc (min)	10.47
Rainfall Intensity (mm/hr)	132
Rational Flow Rate (l/s)	98

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)



SWM DESIGN CALCULATIONS
The Site Pre-development 25-Year Flow Rate Calculations

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 23-Feb-18

Date: 23-Feb-18

Rainfall Data

Location:	Markham, Ont	a	1817.88
Event	25-year	b	6.22
		c	0.87

Site Data

Area (ha)	1.07
Runoff Coefficient	0.275
AC	0.29
Tc (min)	10.47
Rainfall Intensity (mm/hr)	157
Rational Flow Rate (l/s)	128

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)



SWM DESIGN CALCULATIONS
The Site Pre-development 50-Year Flow Rate Calculations

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 23-Feb-18

Date: 23-Feb-18

Rainfall Data

Location:	Markham, Ont	a	1918.97
Event	50-year	b	6
		c	0.86

Site Data

Area (ha)	1.07
Runoff Coefficient	0.3
AC	0.32
Tc (min)	10.47
Rainfall Intensity (mm/hr)	172
Rational Flow Rate (l/s)	154

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)



SWM DESIGN CALCULATIONS
The Site Pre-development 100-Year Flow Rate Calculations

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 23-Feb-18

Date: 23-Feb-18

Rainfall Data

Location:	Markham, Ont	a	2167.43
Event	100-year	b	6.03
		c	0.86

Site Data

Area (ha)	1.07
Runoff Coefficient	0.3125
AC	0.33
Tc (min)	10.47
Rainfall Intensity (mm/hr)	194
Rational Flow Rate (l/s)	181

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)



SWM DESIGN CALCULATIONS
Quantity Control Summary Table (2-year)

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	651.63
Event	2-year	b	3.75
		c	0.8

Area ID	Area (ha)	Runoff Coefficient	TC (min)	Storage Available (m ³)	Storage Required (m ³)	Max. Designed / Release Rate (m ³ /s)	Description	Orifice Size (mm)	Orifice Release Rate (m ³ /s)
201 (to Minor System)	0.70	0.63	10	214	42	0.034	Building Envelope	100	0.034
202 (to Minor System)	0.17	0.25	10	N/A	N/A	0.009	Park		
203 (to Major System)	0.20	0.25	10	N/A	N/A	0.011	Uncontrolled		
Total	1.07			214	42	0.055			

2-year Allowable release rate overall is 0.058 m³/s



SWM DESIGN CALCULATIONS
Post-development Required Storage Calculations (CONT 201)

Project Name: Ladies Golf Club

Prepared by: R.K.

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	651.63
Event	2-Year	b	3.75
		c	0.8

Site Data

Area (ha)	0.7
Runoff Coefficient	0.63
AC	0.44
Tc (min)	10
Time Increment (min)	5
Release Rate (l/s)	30
Storage Required (m ³)	42

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)

Time (min)	Rainfall Intensity (mm/hr)	Storm Runoff (m ³ /s)	Runoff Volume (m ³)	Released Volume (m ³)	Storage Volume (m ³)
10.47	78	0.10	60	19	41
15.47	61	0.08	70	28	42
20.47	51	0.06	77	37	40
25.47	44	0.05	82	46	36
30.47	39	0.05	87	55	32
35.47	35	0.04	90	64	26
40.47	31	0.04	94	73	21
45.47	29	0.04	97	82	15
50.47	27	0.03	99	91	8
55.47	25	0.03	102	100	2
60.47	23	0.03	104	109	0
65.47	22	0.03	106	118	0
70.47	21	0.03	108	127	0
75.47	20	0.02	109	136	0
80.47	19	0.02	111	145	0
85.47	18	0.02	113	154	0
90.47	17	0.02	114	163	0
95.47	16	0.02	116	172	0
100.47	16	0.02	117	181	0
105.47	15	0.02	118	190	0
110.47	15	0.02	120	199	0
115.47	14	0.02	121	208	0
120.47	14	0.02	122	217	0



SWM DESIGN CALCULATIONS
Post-development 2-Year Flow Rate Calculations (Uncontrolled Park 202)

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	651.63
Event	2-year	b	3.75
		c	0.8

Site Data

Area (ha)	0.17
Runoff Coefficient	0.25
AC	0.04
Tc (min)	10
Rainfall Intensity (mm/hr)	80
Rational Flow Rate (l/s)	9

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)



SWM DESIGN CALCULATIONS
Post-development 2-Year Flow Rate Calculations (Uncontrolled 203)

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	651.63
Event	2-year	b	3.75
		c	0.8

Site Data

Area (ha)	0.2
Runoff Coefficient	0.25
AC	0.05
Tc (min)	10
Rainfall Intensity (mm/hr)	80
Rational Flow Rate (l/s)	11

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)



SWM DESIGN CALCULATIONS
Quantity Control Summary Table (5-year)

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	1045.41
Event	5-year	b	4.9
		c	0.83

Area ID	Area (ha)	Runoff Coefficient	TC (min)	Storage Available (m ³)	Storage Required (m ³)	Designed / Release Rate (m ³ /s)	Description	Orifice Size (mm)	Orifice Release Rate (m ³ /s)
201 (to minor system)	0.70	0.79	10	214	66	0.034	Building	100	0.034
202 (to minor system)	0.17	0.25	10	N/A	N/A	0.013	Park		
203 (to major system)	0.20	0.25	10	N/A	N/A	0.015	Uncontrolled		
Total	1.07			214	66	0.063			

5-year Allowable release rate overall is 0.080 m³/s

2-year Allowable release rate to the minor system is 0.049 m³/s



SWM DESIGN CALCULATIONS
Post-development Required Storage Calculations (CONT 201)

Project Name: Ladies Golf Club

Prepared by: R.K.

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	1045.41
Event	5-year	b	4.9
		c	0.83

Site Data

Area (ha)	0.7
Runoff Coefficient	0.63
AC	0.44
Tc (min)	10
Time Increment (min)	5
Release Rate (l/s)	34
Storage Required (m ³)	66

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)

Time (min)	Rainfall Intensity (mm/hr)	Storm Runoff (m ³ /s)	Runoff Volume (m ³)	Released Volume (m ³)	Storage Volume (m ³)
10.47	108	0.13	83	21	62
15.47	86	0.11	97	32	66
20.47	71	0.09	108	42	66
25.47	61	0.08	115	52	63
30.47	54	0.07	121	62	59
35.47	49	0.06	127	72	54
40.47	44	0.05	131	83	49
45.47	40	0.05	135	93	42
50.47	37	0.05	139	103	36
55.47	35	0.04	142	113	29
60.47	33	0.04	145	123	21
65.47	31	0.04	147	134	14
70.47	29	0.04	150	144	6
75.47	27	0.03	152	154	0
80.47	26	0.03	154	164	0
85.47	25	0.03	156	174	0
90.47	24	0.03	158	185	0
95.47	23	0.03	160	195	0
100.47	22	0.03	162	205	0
105.47	21	0.03	163	215	0
110.47	20	0.02	165	225	0
115.47	20	0.02	167	236	0
120.47	19	0.02	168	246	0



SWM DESIGN CALCULATIONS
Post-development 5-Year Flow Rate Calculations (Uncontrolled Park 202)

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	1045.41
Event	5-year	b	4.9
		c	0.83

Site Data

Area (ha)	0.17
Runoff Coefficient	0.25
AC	0.04
Tc (min)	10
Rainfall Intensity (mm/hr)	111
Rational Flow Rate (l/s)	13

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)



SWM DESIGN CALCULATIONS
Post-development 5-Year Flow Rate Calculations (Uncontrolled 203)

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	1045.41
Event	5-year	b	4.9
		c	0.83

Site Data

Area (ha)	0.2
Runoff Coefficient	0.25
AC	0.05
Tc (min)	10
Rainfall Intensity (mm/hr)	111
Rational Flow Rate (l/s)	15

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)



SWM DESIGN CALCULATIONS
Quantity Control Summary Table (100-year)

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	2167.43
Event	100-year	b	6.03
		c	0.86

Area ID	Area (ha)	Runoff Coefficient	TC (min)	Storage Available (m ³)	Storage Required (m ³)	Designed / Release Rate (m ³ /s)	Description	Orifice Size (mm)	Orifice Release Rate (m ³ /s)
201 (to minor system and storage)	0.70	0.79	10	214	214	0.034	Building	100	0.034
202 (to minor and major system)	0.17	0.25	10	N/A	N/A	0.029	Park		
203 (to major system)	0.20	0.25	10	N/A	N/A	0.035	Uncontrolled		
Total	1.07			214	214	0.098			

Allowable release rate is 0.181 m³/s



SWM DESIGN CALCULATIONS
Post-development Required Storage Calculations (201)

Project Name: Ladies Golf Club

Prepared by: R.K.

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	2167.43
Event	100-year	b	6.03
		c	0.86

Site Data

Area (ha)	0.7
Runoff Coefficient	0.7875
AC	0.55
Tc (min)	10
Time Increment (min)	5
Release Rate (l/s)	34
Storage Required (m ³)	214

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)

Time (min)	Rainfall Intensity (mm/hr)	Storm Runoff (m ³ /s)	Runoff Volume (m ³)	Released Volume (m ³)	Storage Volume (m ³)
10.47	194	0.30	187	21	166
15.47	155	0.24	220	32	189
20.47	129	0.20	244	42	202
25.47	112	0.17	261	52	209
30.47	98	0.15	275	63	213
35.47	88	0.13	287	73	214
40.47	80	0.12	297	83	214
45.47	73	0.11	306	93	212
50.47	67	0.10	313	104	210
55.47	63	0.10	320	114	206
60.47	59	0.09	326	124	202
65.47	55	0.08	332	134	197
70.47	52	0.08	337	145	192
75.47	49	0.08	342	155	187
80.47	47	0.07	346	165	181
85.47	45	0.07	350	175	175
90.47	43	0.07	354	186	168
95.47	41	0.06	358	196	162
100.47	39	0.06	361	206	155
105.47	38	0.06	365	217	148
110.47	36	0.06	368	227	141
115.47	35	0.05	371	237	134
120.47	34	0.05	374	247	126



SWM DESIGN CALCULATIONS
Post-development 100-Year Flow Rate Calculations (202)

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	2167.43
Event	100-year	b	6.03
		c	0.86

Site Data

Area (ha)	0.17
Runoff Coefficient	0.3125
AC	0.05
Tc (min)	10
Rainfall Intensity (mm/hr)	199
Rational Flow Rate (l/s)	29

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)



SWM DESIGN CALCULATIONS
Post-development 100-Year Flow Rate Calculations (203)

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	2167.43
Event	100-year	b	6.03
		c	0.86

Site Data

Area (ha)	0.2
Runoff Coefficient	0.3125
AC	0.06
Tc (min)	10
Rainfall Intensity (mm/hr)	199
Rational Flow Rate (l/s)	35

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)

SWM DESIGN CALCULATIONS (Appendix A2)
Orifice Calculations (Area 201)

Project Name: Ladies Golf Club
Municipality: Markham
Project No.: 17086
Date: 8-Mar-18

Prepared by: E.S

Last Revised: 8-Mar-18

Area: 201

Orifice Characteristics

Orifice Diameter (mm)	100
C_d	0.61
Orifice Invert Elevation (m)	176.15
100-Year Ponding Ground Level (m)	178.80
Downstream Tailwater (m)	176.15
Head on Orifice (m)	2.60
Flow from Orifice (m^3/s)	0.034
Allowable Flow (m^3/s)	0.034

Orifice Equation:

$$Q = C_d \times A \times (2gH)^{0.5}$$

$g = 9.81 (m/s^2)$ gravity

C_d = coefficient of discharge

$C_d = 0.6$ for Sharp Orifice

$C_d = 0.8$ for Tube Orifice

where: Q = flow rate (m^3/s)

H = head on the weir (m)

A = area of orifice (m^2)



SWM DESIGN CALCULATIONS
Post-development 5-Year Flow Rate Calculations (Uncontrolled 203)

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	1045.41
Event	5-year	b	4.9
		c	0.83

Site Data

Area (ha)	0.2
Runoff Coefficient	0.25
AC	0.05
Tc (min)	10
Rainfall Intensity (mm/hr)	111
Rational Flow Rate (l/s)	15

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)



SWM DESIGN CALCULATIONS
Quantity Control Summary Table (100-year)

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	2167.43
Event	100-year	b	6.03
		c	0.86

Area ID	Area (ha)	Runoff Coefficient	TC (min)	Storage Available (m ³)	Storage Required (m ³)	Designed / Release Rate (m ³ /s)	Description	Orifice Size (mm)	Orifice Release Rate (m ³ /s)
201 (to minor system and storage)	0.70	0.79	10	214	214	0.034	Building	100	0.034
202 (to minor and major system)	0.17	0.25	10	N/A	N/A	0.029	Park		
203 (to major system)	0.20	0.25	10	N/A	N/A	0.035	Uncontrolled		
Total	1.07			214	214	0.098			

Allowable release rate is 0.181 m³/s



SWM DESIGN CALCULATIONS
Post-development Required Storage Calculations (201)

Project Name: Ladies Golf Club

Prepared by: R.K.

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	2167.43
Event	100-year	b	6.03
		c	0.86

Site Data

Area (ha)	0.7
Runoff Coefficient	0.7875
AC	0.55
Tc (min)	10
Time Increment (min)	5
Release Rate (l/s)	34
Storage Required (m ³)	214

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)

Time (min)	Rainfall Intensity (mm/hr)	Storm Runoff (m ³ /s)	Runoff Volume (m ³)	Released Volume (m ³)	Storage Volume (m ³)
10.47	194	0.30	187	21	166
15.47	155	0.24	220	32	189
20.47	129	0.20	244	42	202
25.47	112	0.17	261	52	209
30.47	98	0.15	275	63	213
35.47	88	0.13	287	73	214
40.47	80	0.12	297	83	214
45.47	73	0.11	306	93	212
50.47	67	0.10	313	104	210
55.47	63	0.10	320	114	206
60.47	59	0.09	326	124	202
65.47	55	0.08	332	134	197
70.47	52	0.08	337	145	192
75.47	49	0.08	342	155	187
80.47	47	0.07	346	165	181
85.47	45	0.07	350	175	175
90.47	43	0.07	354	186	168
95.47	41	0.06	358	196	162
100.47	39	0.06	361	206	155
105.47	38	0.06	365	217	148
110.47	36	0.06	368	227	141
115.47	35	0.05	371	237	134
120.47	34	0.05	374	247	126



SWM DESIGN CALCULATIONS
Post-development 100-Year Flow Rate Calculations (202)

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	2167.43
Event	100-year	b	6.03
		c	0.86

Site Data

Area (ha)	0.17
Runoff Coefficient	0.3125
AC	0.05
Tc (min)	10
Rainfall Intensity (mm/hr)	199
Rational Flow Rate (l/s)	29

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)



SWM DESIGN CALCULATIONS
Post-development 100-Year Flow Rate Calculations (203)

Project Name: Ladies Golf Club

Prepared by: E.S

Municipality: Markham

Project No.: 17086

Last Revised: 8-Mar-18

Date: 8-Mar-18

Rainfall Data

Location:	Markham, Ont	a	2167.43
Event	100-year	b	6.03
		c	0.86

Site Data

Area (ha)	0.2
Runoff Coefficient	0.3125
AC	0.06
Tc (min)	10
Rainfall Intensity (mm/hr)	199
Rational Flow Rate (l/s)	35

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

- Q = the design flow (m³/s)
- C = the site specific runoff coefficient
- A = the drainage area (ha)
- i = rainfall intensity (mm/hr)

SWM DESIGN CALCULATIONS (Appendix A2)
Orifice Calculations (Area 201)

Project Name: Ladies Golf Club
Municipality: Markham
Project No.: 17086
Date: 8-Mar-18

Prepared by: E.S

Last Revised: 8-Mar-18

Area: 201

Orifice Characteristics

Orifice Diameter (mm)	100
C_d	0.61
Orifice Invert Elevation (m)	176.15
100-Year Ponding Ground Level (m)	178.80
Downstream Tailwater (m)	176.15
Head on Orifice (m)	2.60
Flow from Orifice (m^3/s)	0.034
Allowable Flow (m^3/s)	0.034

Orifice Equation:

$$Q = C_d \times A \times (2gH)^{0.5}$$

$g = 9.81 \text{ (m/s}^2\text{) gravity}$

C_d = coefficient of discharge

$C_d = 0.6$ for Sharp Orifice

$C_d = 0.8$ for Tube Orifice

where: Q = flow rate (m^3/s)

H = head on the weir (m)

A = area of orifice (m^2)

Counterpoint Engineering

Water Balance

Ladies' Golf Club of Toronto

1.07 ha Developed Area

Initial Abstraction Asphalt, I	1 mm
Initial Abstraction Pervious and Green Roof, P	5 mm
As per TRCA guidelines	

Type of Area	Area	Units	% Redevelopment Area
Impervious Asphalt/Paved Area/Roof	0.42	ha	39%
Pervious Grass/Landscaped/Permeable pavers	0.65	ha	61%
Total Area	1.07	ha	

Initial Abstraction (credit)= 3.4 mm

Required Development Retention = (Excess Rainfall- Initial Abstraction) * (Total Development Area)

Required Development Retention = (5.0mm- 3.4mm) * (1.07ha)

Required Development Retention (debit)= 16.8 m³

Calculations for Infiltration Galleries

Pervious Contributing Area 0.65 ha
Impervious Contributing Area 0.42 ha
Total Contributing Area 1.07 ha

Imperviousness= 39%

Total target volume for infiltration mitigation for site = **16.8m³**

Total target volume for quality control and quantity control drainage area = $31.5\text{m}^2/\text{ha} \times 1.07\text{ha} = \mathbf{32.6\text{m}^3}$

Total volume achieved from galleries = **9.4m³**

Gallery 1

Dimensions:	Length=	22.00 m
	Width =	3.80 m
	Depth=	0.28 m
	Voids=	0.40
	Volume=	9.4 m³

Drawdown Time:

Infiltration rate based on geotechnical report: 6 mm/hr. = 0.006m/hr

Drawdown Time = Depth/Infiltration Rate

Drawdown Time = $0.28\text{m}/0.006\text{m/hr} = \mathbf{46.7 \text{ hrs}}$

Drawdown time is less the 48hrs, therefore MOE requirements are being met.
