Stantec

Memo

To:	Leah Lefler City of Guelph	From:	Grant Whitehead Waterloo ON Office
File:	161423338.101	Date:	March 29, 2023

Reference: Revised Water Balance Calculations in Response to First Submission Comments Draft Plan Application - 220 Arkell Road, City of Guelph, Ontario

1.0 BACKGROUND

Stantec Consulting Limited (Stantec) prepared a Hydrogeological Assessment report (Stantec, 2019[1]) on behalf of Rockpoint Properties Inc. for the lands located at 220 Arkell Road in the City of Guelph, Ontario (the Site) in support of a Draft Plan Application. As a part of the assessment, a pre- and post-development water balance was completed for the Site. As provided in the City of Guelph's first submission comments memo dated November 10, 2020[2] and titled *220 Arkell Road Draft Plan of Subdivision and Zoning By-law Amendment Application*, Comment No. 67 states the following:

Comment No. 67 – *Monthly Water Balance calculations have been completed based on three subcatchments (A, B, and C). Pre-development conditions are compared to post-development conditions within these catchments on a monthly basis. This analysis does not enable a comparison of pre- to post-development conditions as the site, under pre-development conditions, has a drainage divide, with approximately 2/3rds drainage going to the wetland and 1/3 going to the woodland on the property to the east. To enable a proper assessment of impacts to wetland hydrology, compare post-development to pre-development conditions for the portion of the subject property located within the wetland's catchment.*

To address this previously mentioned comment, Stantec revised the monthly pre- to post-development water balance calculations to account for this drainage divide, utilizing the same Thornthwaite and Mather (1955[3]) methodology to perform the analysis as described in Stantec (2019a).

2.0 GROUNDWATER MONITORING NETWORK

2.1 SITE MONITORING WELLS

To better delineate high groundwater conditions throughout the Site, Stantec coordinated the installation of additional monitoring wells to compliment the existing four monitoring wells (i.e., BH01-17 to BH04-17) constructed as part of the previous geotechnical investigation (Stantec, 2017[4]). Between March 10 and 11, 2022, Aardvark Drilling Inc. advanced a total of six boreholes in those areas of the Site where the construction of post-development infiltration facilities (e.g., infiltration galleries) are anticipated, with these boreholes being drilled to depths ranging from 6.1 to 9.4 m below ground surface (BGS) and each borehole being equipped with

[1] Stantec Consulting Limited. 2019a. Hydrogeological Assessment, 220 Arkell Road, Guelph, ON. May 28, 2019.
[2] City of Guelph Infrastructure, Development and Enterprise Services, Planning and Building Services. 2020. Internal Memo Re: 220 Arkell Road Draft Plan of Subdivision and Zoning By-law Amendment Application, November 10, 2020.
[3] Thornthwaite, C.W. and Mather, J.W. 1955. The water balance. Philadelphia, PA: Drexel Institute of Technology, Climatological Laboratory Publication No.8.
[4] Stantec Consulting Ltd. (Stantec), 2017. Draft Report, Geotechnical Investigation, 220 Arkell Road Residential Site, Guelph, Ontario. October 23, 2017.

a single monitoring well (i.e., MW101-22 to MW106-22). Adhering to construction requirements outlined under Ontario Regulation 903 (O. Reg. 903) (MOE, 1990[5]), each monitoring well is constructed of 50 mm inside diameter, Schedule 40 polyvinyl chloride (PVC) pipe, having a No. 10 slot screen (0.01-inch slot) measuring 3.0 m in length. The backfilling of the screened interval consisted of silica sand to a height of approximately 0.3 m above the top of screen, followed by granular bentonite to ground surface to prevent a hydraulic connection from occurring between the screened formation and overlying soils. The completion of each monitoring well involved encasing the pipe stick-up within a lockable steel casing. The locations of the on-Site monitoring wells are presented on Figure 1 (Attachment 1).

Following installation, Stantec personal developed and equipped each monitoring well with a Solinst® Levelogger®, which have been collecting continuous groundwater elevation measurements across the Site since April 2022. Data recorded by the Leveloggers installed in MW101-22 to MW106-22 for the period covering from March to November 2022 is presented on the hydrographs shown on Figure 2. Hydrographs presenting historical groundwater monitoring data collected from BH01-17 to BH04-17 (i.e., April 2017 to May 2018) together with data collected from March to November 2022 (except for BH01-17 and BH03-17, which are damaged / inaccessible) is shown on Figure 3. Groundwater elevation fluctuations at these previously mentioned wells are continuing to be collected and will be utilized by Stantec to assist with the designing of the post-development infiltration infrastructure as part of the detail design phases of the development.

2.2 WETLAND PIEZOMETERS

To better understand the pre-development hydroperiod for the portion of Torrance Creek Swamp that directly lies to the southwest of the Site, Stantec established a transect of three drive-point piezometers downgradient of the future outlet of the proposed stormwater management facility (SWMF) (i.e., DP101-22 to DP103-22) (Figure 4). These drive-point piezometers are designed to track the hydroperiod of the wetland following construction of the SWMF to assist in evaluating whether post-development stormwater discharge to the wetland could affect the long-term form and function of the wetland ecosystem. Following a walkthrough of the wetland by Stantec personnel on April 1, 2022, the drive-point piezometers were installed in two topographically low areas where standing water was observed (i.e., DP101-22 and DP103-22) and in an area of higher ground containing no standing water (i.e., DP102-22).

Each drive-point piezometer is constructed of a 0.42 m long steel screen (19 mm diameter) that is connected to 25 mm diameter steel riser pipes. Stantec personnel drove the drive-point piezometers into the substrate using a fence post driver. Following installation, Stantec personal developed and suspended a Solinst® Levelogger® in the pipe of each drive-point piezometer to continuously record groundwater elevation fluctuations. Concurrently, a Levelogger was secured to the exterior and at the base of eauch drive-point piezometer (i.e., pressure transducer resting upright upon the ground surface) to record depths of standing surface water. Data recorded by the Leveloggers installed in DP101-22 to DP103-22 for the period covering from May 25 to November 10, 2022, is presented on the hydrographs shown on Figure 5. Groundwater and surface water elevation fluctuations continue to be monitored at these drive-point piezometers at the issuing of this report.

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[5] Ministry of the Environment, Conservation and Parks (MECP) (formerly Ministry of the Environment). 1990. Wells. Regulation under the Ontario Water Resources Act. Regulation 903 of the Revised Regulations of Ontario, 1990.

3.0 WATER BALANCE ANALYSIS RESULTS

3.1 PRE-DEVELOPMENT

The pre-development water balance for the Site was split into two separate analyses to reflect the surface water divide that characterizes the property. Catchment 106 is analyzed as one land unit given that surface water runoff from this catchment is interpreted to flow in a south to southwest direction towards the Torrance Creek Swamp (Figure 1). Also included in the water balance calculations for Catchment 106 are Catchments 208-1 and 208-2, which are associated with the adjacent Arkell Meadows Subdivision to the south where runoff from these lands drain and flow into Torrance Creek Swamp. Similarly, Catchment 110 is analyzed as a separate land unit as surface water runoff is interpreted to flow in a north to northeast direction across this catchment towards an off-Site woodlot (Figure 1).

The Site was broken down into a series of sub-areas based on topographic, soil type, and land cover characteristics. Figure 1 shows the distribution of the sub-areas used in the pre-development water balance analysis. As presented in Tables 1 and 2 (Attachment 2), the overall infiltration factor (IF) for a sub-area represents the sum of infiltration factors assigned to each of the sub-area characteristics (i.e., topography, soil type, land use) based on published values presented by the MECP (2003[6]). The IF is then multiplied against the water surplus (WS) calculated for a given sub-area to provide a calculated value of infiltration (INF). The sum of all sub-area INF volumes associated with each catchment then represents the overall annual pre-development infiltration volume for that catchment.

Topographic conditions across the Site are deemed to be rolling to hilly based on calculated slopes ranging from 0.5% to 15%, with the high point situated in the centre of the Site (coinciding with drainage divide). The two main soil types that characterize the Site include glaciofluvial sand and gravel or stone-poor, silty to sandy till (i.e., Port Stanley Till). Land cover throughout the Site based on the Ecological Land Classification (ELC) mapping prepared by Stantec (2019b[7]) consists of pasture/shrub lands and urban lawn (associated with the on-Site residence). Based on these parameters, infiltration factors ranged from 0.45 to 0.70 in the sub-areas (where a value of 1.00 indicates that the full WS volume infiltrates).

The Guelph Arboretum climate station provided long-term monthly average (1971-2000) air temperature and precipitation data for use in the water balance analysis. Located approximately five kilometres to the northwest of the Site, the assumption is that the monthly average precipitation and air temperatures recorded at the station is reflective of the precipitation and air temperature fluctuation trends that have historically occurred at the Site.

3.1.1 Surface Water Flows Westward to Torrance Creek Swamp

Based on the previously mentioned water balance components, the annual volume of infiltration occurring within Catchment 106, 208-1, and 208-2 (Figure 1) under the pre-development condition is calculated to be 10,139 m^3, equating to a rate of 225 mm/year (Table 1). This calculated infiltration rate falls within the range of

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[6] (MECP) Ministry of the Environment, Conservation and Parks (formerly Ministry of the Environment). 2003. Stormwater Management Planning and Design Manual. March 2003.
[7] Stantec Consulting Limited. 2019b. 220 Arkell Road - Guelph, ON, Environmental Impact Study. August 28, 2019.

infiltration rates reported for fine to medium sand by the MECP (1995[8]) (i.e., fine to medium sand) and is considered an acceptable representation of the soils that form the subsurface of the Site. The annual volume of pre-development runoff is calculated at 8,660 m^3, equating to a rate of 192 mm/year (Table 1). A summary of the pre-development water balance components for Catchments 106, 208-1, and 208-2 is provided below.

Pre-Development Infiltration (INF)	10,139	m^3/yr	225	mm/yr	0.3	L/s
Pre-Development Runoff (R)	8,660	m^3/yr	192	mm/yr	0.3	L/s
Pre-Development Evapotranspiration (ET)	22,882	m^3/yr	507	mm/yr	0.7	L/s
Total = INF + R + ET	41,681	m^3/yr	924	mm/yr	1.3	L/s
Precipitation	41,681	m^3/yr	923	mm/yr	1.3	L/s

As shown in Figure 4, infiltration occurring within Catchment 106 that recharges the groundwater system will flow to the south and southwest towards Torrance Creek Swamp. As documented in Appendix D of Stantec (2019a), downward vertical hydraulic gradients are mapped as occurring beneath Torrance Creek Swamp, which suggests that this wetland is a groundwater recharge feature.

3.1.2 Surface Water Flows Eastward to Off-Site Woodlot

Based on the previously mentioned water balance components, the annual volume of infiltration occurring within Catchment 110 (Figure 1) under the pre-development condition is calculated to be 5,294 m^3, equating to a rate of 214 mm/year (Table 2). The annual volume of pre-development runoff is calculated to be 4,035 m^3, equating to a rate of 163 mm/year (Table 1). A summary of the pre-development water balance components for Catchment 110 is provided below.

Pre-Development Infiltration (INF)	5,294	m^3/yr	214	mm/yr	0.2	L/s
Pre-Development Runoff (R)	4,035	m^3/yr	163	mm/yr	0.1	L/s
Pre-Development Evapotranspiration (ET)	13,463	m^3/yr	545	mm/yr	0.4	L/s
Total = INF + R + ET	22,793	m^3/yr	923	mm/yr	0.7	L/s
Precipitation	22,793	m^3/yr	923	mm/yr	0.7	L/s

As shown in Figure 4, infiltration occurring within Catchment 110 that recharges the groundwater system is also interpreted to flow to the south and southwest towards Torrance Creek Swamp.

3.1.3 Site Infiltration

As previously mentioned, infiltration that occurs across the Site under the pre-development conditions (regardless of which surface water catchment that this infiltration occurs) that recharges the groundwater system is interpreted to flow to the south and southwest towards Torrance Creek Swamp. As such, the annual volume of infiltration occurring throughout the Site under the pre-development condition is 15,433 m^3 (i.e., 10,139 m^3 from Catchments 106, 208-1, and 208-2 (Section 3.1.1) + 5,294 m^3 from Catchment 110 (Section 3.1.2)), for an equivalent recharge rate of 221 mm/year.

[8] Ministry of Environment and Energy. 1995. MOEE Hydrogeological Technical Information Requirements for Land Development Applications. April 1995.

3.2 POST-DEVELOPMENT (UNMITIGATED)

The projected post-development catchments for the Site are presented in Figure 6 and new sub-areas were derived accordingly based on topographic, soil type and land cover characteristics. For the analysis, the distribution of surficial soils found under the pre-development condition is assumed to remain relatively unchanged under the post-development condition, with the topography becoming less hilly and transitioning to predominantly rolling (due to grading) and the land cover becoming more representative of developed area having varying degrees of impervious surfaces (e.g., rooftops, concrete/asphalt roadways, and walkways) and urban vegetation cover (e.g., urban lawns). Under the post-development condition, a larger proportion of the Site (i.e., Catchment 200) will drain to the southwest and into the SWM facility (i.e., to Catchment 203), with this water then being slowly discharged to the Torrance Creek Swamp. Runoff occurring in Catchments 202, 204, 205-1/205-2, 206, 207A/B, and 209 (and off-Site Catchments 208-1 and 208-2) will flow overland and directly into the wetland (i.e., will not pass through the SWM facility). For Catchment 201A/B, runoff occurring in this portion of the Site will be directed northward towards the off-Site woodlot.

Stantec has assumed that all infiltration occurring in the remaining pervious areas of the Site under the post-development condition that recharges the groundwater system will flow to the south and southwest towards Torrance Creek Swamp.

3.2.1 Surface Water Flows Westward to Torrance Creek Swamp

Based on the previously mentioned water balance components, the annual volume of infiltration occurring within combined Catchments 200, 202 to 204, 205-1/205-2, 206, 207A/B, 208-1/208-2, and 209 (Figure 6) under the post-development condition is calculated to be 8,648 m^3, equating to a rate of 148 mm/year (Table 3). The annual volume of surface water runoff projected to occur under the post-development condition within these combined catchments is 26,156 m^3 (446 mm/year) (Table 3). Overall, an infiltration deficit of 1,491 m^3 (i.e., from 10,139 m^3 to 8,648 m^3) is projected to occur in the previously mentioned catchment areas, with surface water runoff volumes increasing by 17,496 m^3 (i.e., from 8,660 m^3 to 26,156 m^3) within this same area (which will be directed to the Torrance Creek Swamp) from the pre- to post-development condition. A summary of the post-development water balance components for the flows moving towards Torrance Creek Swamp is provided below.

SUMMARY - WITH NO INFILTRATION AUGMENTATION / MITIGATION MEASURES						
Post-Development Infiltration (INF)	8,648	m^3/yr	148	mm/yr	0.3	L/s
Post-Development Runoff (R)	26,156	m^3/yr	446	mm/yr	0.8	L/s
Post-Development Evapotranspiration (ET)	19,259	m^3/yr	329	mm/yr	0.6	L/s
Total = INF + R + ET	54,062	m^3/yr	923	mm/yr	1.7	L/s
Precipitation	54,062	m^3/yr	923	mm/yr	1.7	L/s

Pre-Development Infiltration	10,139	m^3/yr
Infiltration Deficit	**-1,491**	**m^3/yr**
Pre-Development Runoff	8,660	m^3/yr
Runoff Surplus	**17,496**	**m^3/yr**

3.2.2 Surface Water Flows Eastward to Off-Site Woodlot

For Catchment 201A/B (Figure 3), the post-development annual volume of infiltration and surface water runoff occurring within this catchment is estimated at 2,718 m^3 (241 mm/year) and 1,554 m^3 (138 mm/year), respectively (Table 4). These volumes represent a 2,576 m^3 and 2,481 m^3 reduction in infiltration and surface water runoff volumes associated with the catchment areas that direct water to the off-Site woodlot to the northeast under the pre-development condition (i.e., Catchment 110). A summary of the post-development water balance components for the flows moving east to the off-Site woodlot is provided below.

Post-Development Infiltration (INF)	2,718	m^3/yr	241	mm/yr	0.1	L/s
Post-Development Runoff (R)	1,554	m^3/yr	138	mm/yr	0.0	L/s
Post-Development Evapotranspiration (ET)	6,141	m^3/yr	544	mm/yr	0.2	L/s
Total = INF + R + ET	10,413	m^3/yr	923	mm/yr	0.3	L/s
Precipitation	10,413	m^3/yr	923	mm/yr	0.3	L/s

Pre-Development Infiltration	5,294	m^3/yr
Infiltration Deficit	**-2,576**	**m^3/yr**
Pre-Development Runoff	4,035	m^3/yr
Runoff Deficit	**-2,481**	**m^3/yr**

3.2.3 Site Infiltration

All infiltration occurring across the Site that reaches the groundwater table as recharge under the post-development condition (whether occurring within that surface water catchment areas that direct runoff west towards Torrance Creek Swamp or east towards the off-site woodlot) will flow to the south and southwest through the groundwater system towards Torrance Creek Swamp. The combined total annual infiltration that occurs throughout the Site is calculated to be 11,366 m^3 (i.e., 8,648 m^3 from Catchments 200, 202 to 204, 205-1/205-2, 206, 207A/B, 208-1/208-2, and 209 (Section 3.2.1) + 2,718 m^3 from Catchment 201A/B (Section 3.2.2)), which will result in an annual infiltration deficit of 4,067 m^3 under the post-development condition (i.e., 11,366 m^3 - 15,433 m^3 = 4,067 m^3).

3.3 POST-DEVELOPMENT (MITIGATED)

As shown in the above post-development scenario where no infiltration measures are in place, the Site will produce a large runoff surplus to Torrance Creek Swamp and an overall infiltration deficit across the property. Based on the results of the *Geotechnical Investigation* (Stantec 2019c[9]), the Site soils generally consist of a mix of glacial till to sand, which are both typically conducive to infiltration practices. The estimated percolation rate for these soils correspond to factored infiltration rates of 5 to 30 mm/hour; however, as per City of Guelph guidelines, the performing of in-situ infiltration tests using the double-ring infiltrometer or the Guelph Permeameter (a constant head permeameter designed to measure in-situ vertical hydraulic conductivities of a given substrate) will be required at the detailed design stage at the locations and depths of the proposed infiltration trenches to confirm the underlying soil infiltration rates. Since the Site soils appear to be conducive

[9] Stantec Consulting Ltd. 2019c. Geotechnical Investigation Report, 220 Arkell Road Residential Site, Guelph, Ontario. June 11, 2019.

for infiltration, infiltration galleries are proposed throughout the Site at both lot level and end-of-pipe locations to mitigate the previously mentioned post-development infiltration deficits.

Infiltration galleries receiving rooftop runoff will be designed to infiltrate 25 mm precipitation events from the single-family lots and multi-residential block. In reviewing the proposed grading design in relation to the observed high groundwater elevations, Stantec estimates that using approximately 1.2 m of cover over a 0.5 m deep stone infiltration gallery will allow rooftop galleries to be constructed on each single-family lot (proposed gallery locations shown on Drawing C-400, Attachment 1). Although the location of the multi-residential block may change throughout the Site Plan process, the current location of this block was checked to determine the feasibility of accepting rooftop infiltration, with Stantec concluding that rooftop areas can be directed to this centralized infiltration gallery to infiltrate the 25 mm precipitation event. Similar to the single-family lots, the multi-residential block gallery is designed (i.e., 0.5 m height) to provide greater than 1.0 m of separation from the seasonal high groundwater elevation (refer to Drawing C-400). The rooftop galleries proposed in the multi-residential block will be equipped with overflow pipes to permit overflow discharge to the local storm sewer system and/or adjacent open space lands if the galleries become full during a rain event.

End-of-pipe (EOP) infiltration is also proposed for the on-Site dry stormwater management facility (SWMF) (i.e., Catchment 203) using a subsurface storage system (ADS Stormtech SC-160LP chambers), which will allow for the incorporation of a winter bypass. The infiltration system is sized to infiltrate the remaining 25 mm runoff volume from the Site after accounting for rooftop infiltration (i.e., runoff not being captured by the rooftops; that is, other on-Site impervious surfaces such as roadways and sidewalks). The system will be shut-off through the months of December to March to prevent infiltration of chlorides from salt laden runoff.

To infiltrate this additional runoff, the previously mentioned Stormtech SC-160LP (or equivalent system) is proposed to maintain the low profile required to provide groundwater separation and cover. The system will be approximately 39 m in length by 24 m in width and be placed below the dry SWMF, as shown on Drawing C-410. The invert of the chamber will be 334.35 m AMSL, which based on the latest spring high groundwater level data from MW106-22 of 333.69 m AMSL, achieves a separation of 0.66 m. Although the recommended one meter of separation is not achieved during the period of highest groundwater levels recorded at MW106-22, the gallery will be above the existing ground surface (through importing fill) and will likely only be unable to achieve this one meter of separation during the early spring (i.e., March); however, the one meter of separation will be achieved over the remainder of the year as the groundwater table steadily declines (Figure 2). Further calculations and potential modifications to the system design shall be completed during the detailed design stage to raise the facility, if possible, or explore other products/structure configurations so that the proposed EOP infiltration system functions year-round. There is a stone layer beneath this chamber invert (0.15 m thick); however, the volume in this stone layer has not been accounted for to provide sufficient infiltration volume at a higher separation from the groundwater table. The top of stone for the gallery is located at an elevation of 334.80 m AMSL, the elevation of the overflow pipe to the wetland, allowing the trench to become fully utilized before flowing downstream. Details on the infiltration system are included on Drawing C-410.

3.3.1 Surface Water Flows Westward to Torrance Creek Swamp

As discussed in Section 3.2.1, the annual unmitigated infiltration deficit for the catchment areas draining to the Torrance Creek Swamp (i.e., Catchments 200, 202 to 204, 205-1/205-2, 206, 207A/B, 208-1/208-2, and 209; Figure 3) is calculated at 1,491 m^3, with surface water runoff volumes increasing to 17,495 m^3 from the pre- to post-development condition (Table 3). With the implementation of the post-development infiltration augmentation measures discussed above (i.e., rooftop runoff from the single-family lots plus the multi-residential block directed to on-Site infiltration galleries, together with other impervious and pervious surface runoff directed to EOP infiltration SWMF), an additional 11,420 m³ of stormwater will be annually returned to the subsurface across the Site (i.e., reducing the unmitigated runoff annual volume of 26,156 m³ to 14,735 m³). Consequently, this additional infiltration will reduce the post-development annual runoff surplus to the Torrance Creek Swamp to 6,075 m³ (i.e., 14,735 m³ - 8,660 m³). As shown in Figure 7, the greatest monthly runoff surpluses will occur during the winter/spring when the EOP infiltration will be offline, with the lowest runoff surpluses occurring in the late fall.

Post-Development Infiltration (INF)	20,068	m^3/yr	342	mm/yr	0.6	L/s
Post-Development Runoff (R)	14,735	m^3/yr	251	mm/yr	0.5	L/s
Post-Development Evapotranspiration (ET)	19,259	m^3/yr	329	mm/yr	0.6	L/s
Total = INF + R + ET	54,062	m^3/yr	923	mm/yr	1.7	L/s
Precipitation	54,062	m^3/yr	923	mm/yr	1.7	L/s

Pre-Development Infiltration	10,139	m^3/yr
Infiltration Surplus	**9,930**	**m^3/yr**
Pre-Development Runoff	8,660	m^3/yr
Runoff Surplus	**6,075**	**m^3/yr**

To assess the potential effects of the runoff surplus on the downstream system, an assessment of the potential increase in ponding depth within the Torrance Creek Swamp due to the maximum monthly surplus volume of runoff being discharged to this wetland was approximated. As shown on Figure 8, based on topographic contour data obtained from the GRCA (2021[10]), the portion of the Torrance Creek Swamp basin located downstream of the Site is relatively flat over a 24.3 hectare (ha) area (i.e., basin perimeter as defined by the 332.5 m AMSL contour) prior to discharging to a more defined and continuous watercourse downstream (i.e., Torrance Creek). Using the maximum monthly runoff surplus of 920 m³ entering the Torrance Creek Swamp from the Site (greatest monthly surplus observed from pre- to post-development; that is, in December, Figure 7), this volume of discharge would result in surface water levels within the previously mentioned basin increasing by less than 5 mm (0.005 m). This rise in the surface water level also assumes that no infiltration is occurring within the wetland; however, this is a conservative assumption given that annual infiltration rates beneath the wetland are reported to range from 92 mm to 345 mm (Figure 9). In addition, although post-development runoff will be directed to the Torrance Creek Swamp during those months when runoff under the pre-development condition is low to absent (e.g., May to October), the groundwater table is typically at its lowest elevations during these months. As such, it is reasonable to assume that any ponding of this runoff during these months (i.e., when the vegetation is not dormant) will be limited as infiltration will not be impeded by a high groundwater table beneath the wetland. As such, this influx of post-development runoff to the wetland is not expected to detrimentally impact the long-term ecological form of this feature.

[10] Grand River Conservation Authority. 2021. Grand River Information Network (GRIN) - https://data.grandriver.ca/.

Reference: **Revised Water Balance Calculations in Response to First Submission Comments**
Draft Plan Application - 220 Arkell Road, City of Guelph, Ontario

3.3.2 Surface Water Flows Eastward to Off-Site Woodlot

Since post-development infiltration augmentation measures are only proposed for construction in the catchments flowing westward towards the Torrance Creek Swamp, the water balance calculations for flows eastward to the woodlot remain unchanged from the unmitigated scenario as presented in Section 3.2.2.

3.3.3 Site Infiltration

All infiltration occurring across the Site that reaches the groundwater table as recharge under the post-development condition (whether occurring within that surface water catchment areas that direct runoff west towards Torrance Creek Swamp or east towards the off-site woodlot) will flow to the south and southwest through the groundwater system towards Torrance Creek Swamp. Under the post-development scenario where infiltration augmentation measures are employed, the combined total annual infiltration that will occur throughout the Site is calculated to be 22,786 m^3 (i.e., 20,068 m^3 from Catchments 200, 202 to 204, 205-1/205-2, 206, 207A/B, 208-1/208-2, and 209 (Section 3.3.1) + 2,718 m^3 from Catchment 201A/B (Section 3.2.2)), which will result in an annual infiltration surplus of 7,353 m^3 at the Site under the post-development condition (i.e., 22,786 m^3 - 15,433 m^3 = 7,353 m^3).

4.0 CONCLUSIONS

Based on the material presented in this memo, the following conclusions are provided:

- Proposed on-Site infiltration augmentation measures will enhance groundwater recharge and reduce excess surface water runoff being discharged to the Torrance Creek Swamp. The proposed measures include rooftop infiltration galleries on all single-family lots and the multi-residential block units, which are sized for the 25 mm storm event and will receive rooftop runoff, as well as an SWMF end-of-pipe infiltration system sized for the remaining 25 mm of runoff volume (from other on-Site impervious and pervious surfaces).

- Lot level infiltration galleries throughout the Site have been designed to maintain greater than or equal to oner meter of separation from seasonal high groundwater levels. The EOP infiltration gallery achieves 0.66 m of separation from the seasonal high groundwater level during the early spring (i.e., March), but proceeds to achieve the one meter of separation over the remainder of the year.

- The Site is projected to experience an annual infiltration volume surplus of 7,353 m^3 from the pre- to post-development condition, with annual runoff volumes to Torrance Creek Swamp increasing by 6,075 m^3. Runoff volumes being directed northward to the off-Site woodlot will decrease by 2,481 m^3.

- The increase in post-development runoff discharged to the Torrance Creek Swamp is expected to raise surface water ponding within the wetland by no more than 0.005 m (5 mm) for a given month. This ponding is also expected to be temporary (i.e., not cumulative from month to month) as the Torrance Creek Swamp is identified to be a groundwater recharge feature (i.e., the runoff entering the wetland is expected to be infiltrated while present within this natural heritage feature).

Regards,

Reference: Revised Water Balance Calculations in Response to First Submission Comments
Draft Plan Application - 220 Arkell Road, City of Guelph, Ontario

Stantec Consulting Limited

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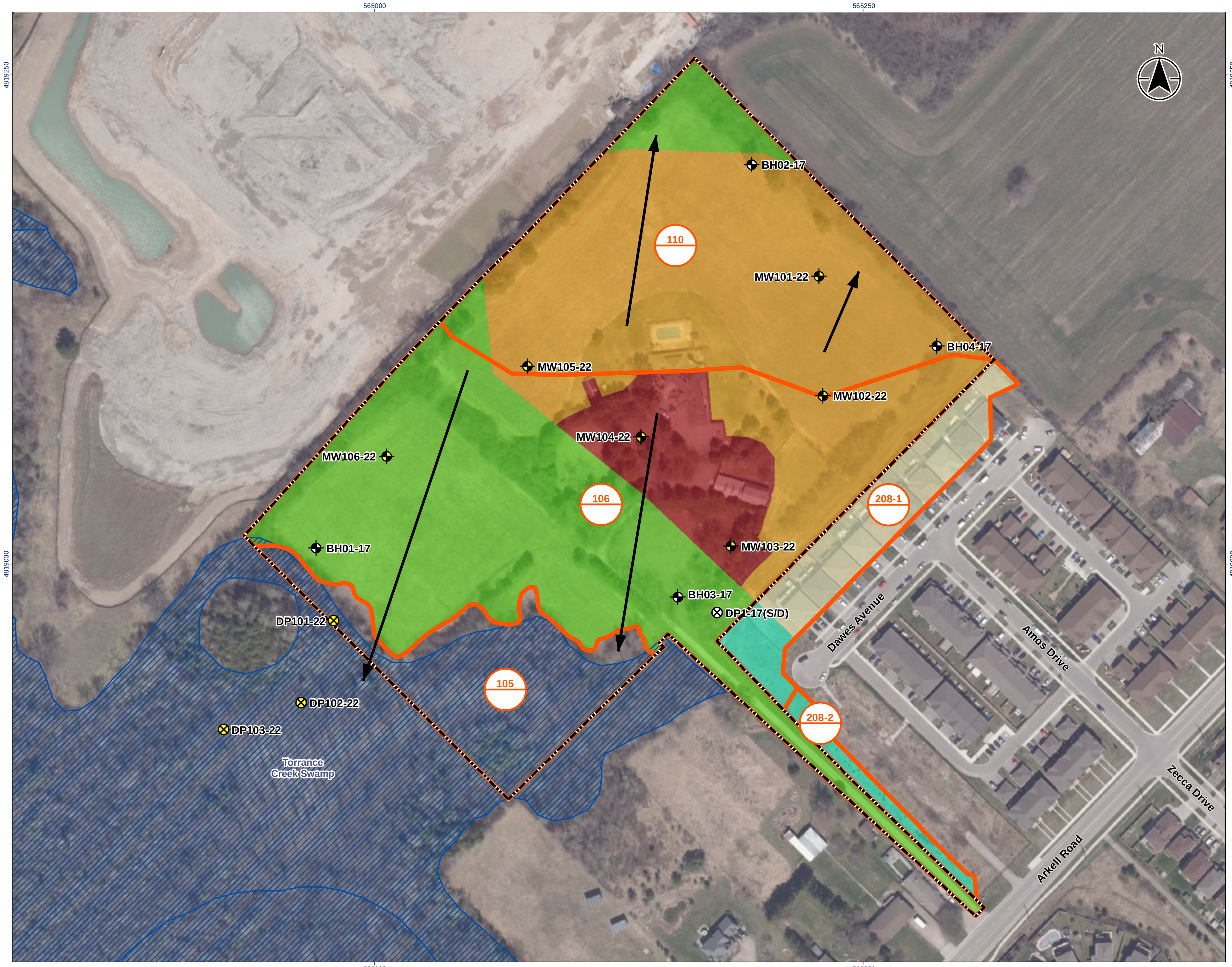
Attachment: Attachment 1: Figures
- Figure 1 - Pre-Development Water Balance
- Figure 2 - Hydrographs – MW101-22 to MW106-22
- Figure 3 - Hydrographs – BH01-17 to BH04-17 and DP1-17(S/D)
- Figure 4 - Groundwater Flow – March 2022
- Figure 5 – Hydrographs – MW101-22 to MW106-22
- Figure 6 - Post-Development Water Balance
- Figure 7 - Hydrograph – Monthly Pre- and Post-Development Runoff Flows Westward to Torrance Creek Swamp
- Figure 8 - Torrance Creek Swamp - Runoff Receiving Basin
- Figure 9 - Annual Recharge Rates (GRCA)
- Drawing C-400: Conceptual Grading Plan
- Drawing C-410: Stormwater Management Facility Drawing

Attachment 2: Tables
- Table 1 – Pre-Development Monthly Water Balance Calculations – Lands Draining Westward to Torrance Creek Swamp
- Table 2 – Pre-Development Monthly Water Balance Calculations – Lands Draining Eastward to Woodlot
- Table 3 – Post-Development Monthly Water Balance Calculations – Lands Draining Westward to Torrance Creek Swamp
- Table 4 – Post-Development Monthly Water Balance Calculations – Lands Draining Eastward to Woodlot

c. Melissa Straus, Stantec Consulting Ltd..
Kevin Brousseau, Stantec Consulting Ltd.

ATTACHMENT 1:
Figures



Stantec

Legend

- Site Boundary
- Monitoring Well (Stantec, 2022)
- Monitoring Well (Stantec, 2017)
- Drive-Point Piezometer (Stantec, 2022)
- Drive-Point Piezometer (Stantec, 2017)
- Overland Flow Direction
- Wetland - Evaluated (Provincial)
- Stormwater Catchment (Existing Conditions)

Water Balance Sub-Areas

- Sub-Area A - Rolling to Hilly, Silty Sand to Sand Till, Pasture and Shrubs
- Sub-Area B - Rolling to Hilly, Silty Sand to Sand Till, Urban Lawn
- Sub-Area C - Rolling to Hilly, Sand, Pasture and Shrubs
- Sub-Area F - Rolling, Silty Sand to Sand Till, Urban Lawn, 40% Impervious
- Sub-Area G - Rolling, Sand, Urban Lawn, 40% Impervious

0 50 100 metres

1:2,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2017.
3. Topographic contours presented on site as surveyed by Stantec (2017). Topographic data beyond the site boundaries should be considered approximate and for illustrative purposes only.
4. Orthoimagery © First Base Solutions, 2021. Imagery flown in 2020.

Project Location
Guelph, Ontario

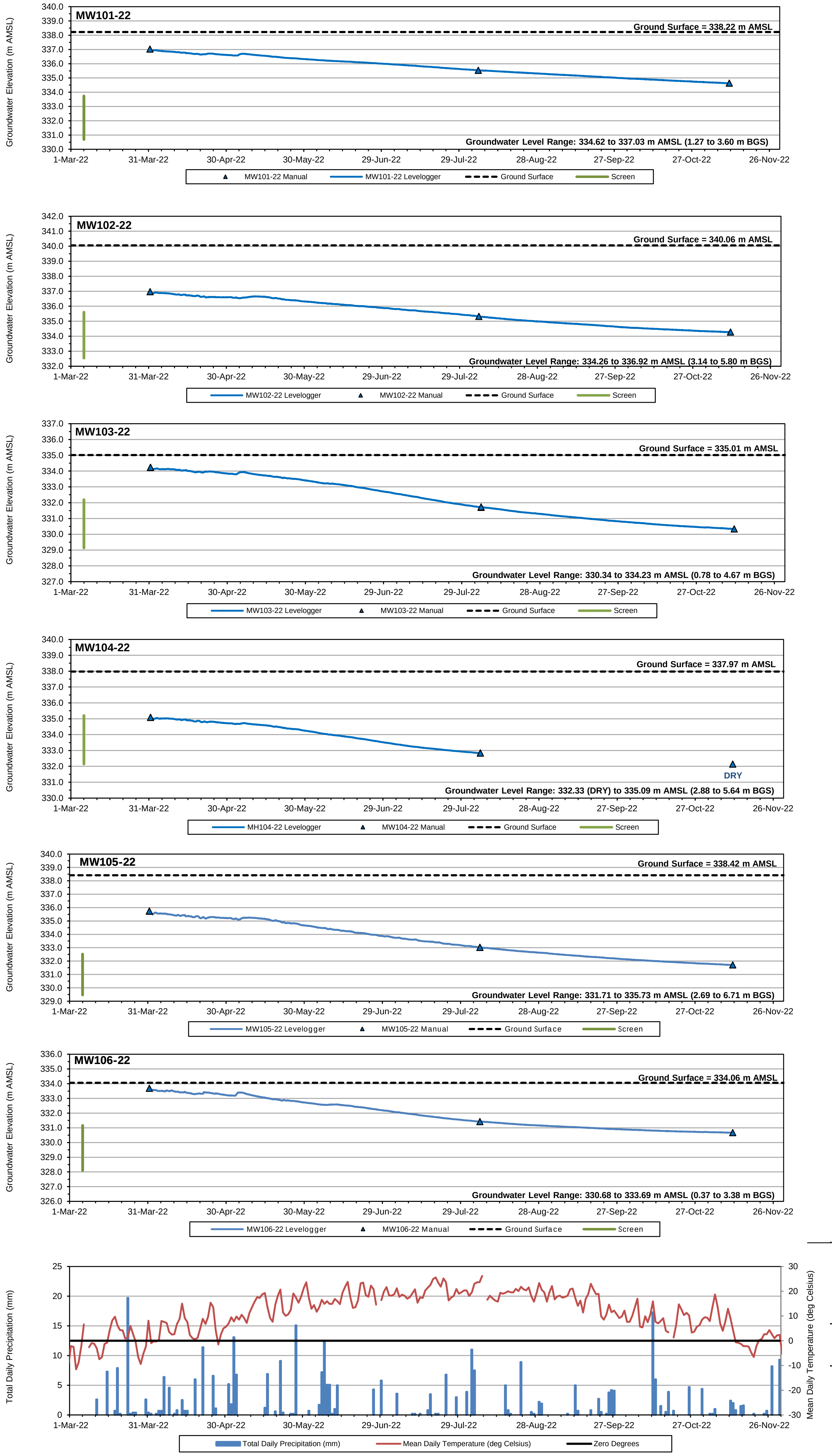
161423338 REVA
Prepared by PRM on 2023-03-27
Technical Review by GW on 2023-03-27

Client/Project
ROCKPOINT PROPERTIES INC.
HYDROGEOLOGICAL ASSESSMENT
220 ARKELL ROAD, GUELPH, ONTARIO

Figure No.
1

Title
Pre-Development Water Balance

\\Cd1004-f01\01614\active\161413338\planning\drawings\GIS\MXD\Hydrogeology\Water_Balance_Memo\161423338_Water_Bal_Memo_Fig01_Pre_Dev_Water_Balance_No_Labels.mxd Revised: 2023-03-27 By: pmoser



Client/Project

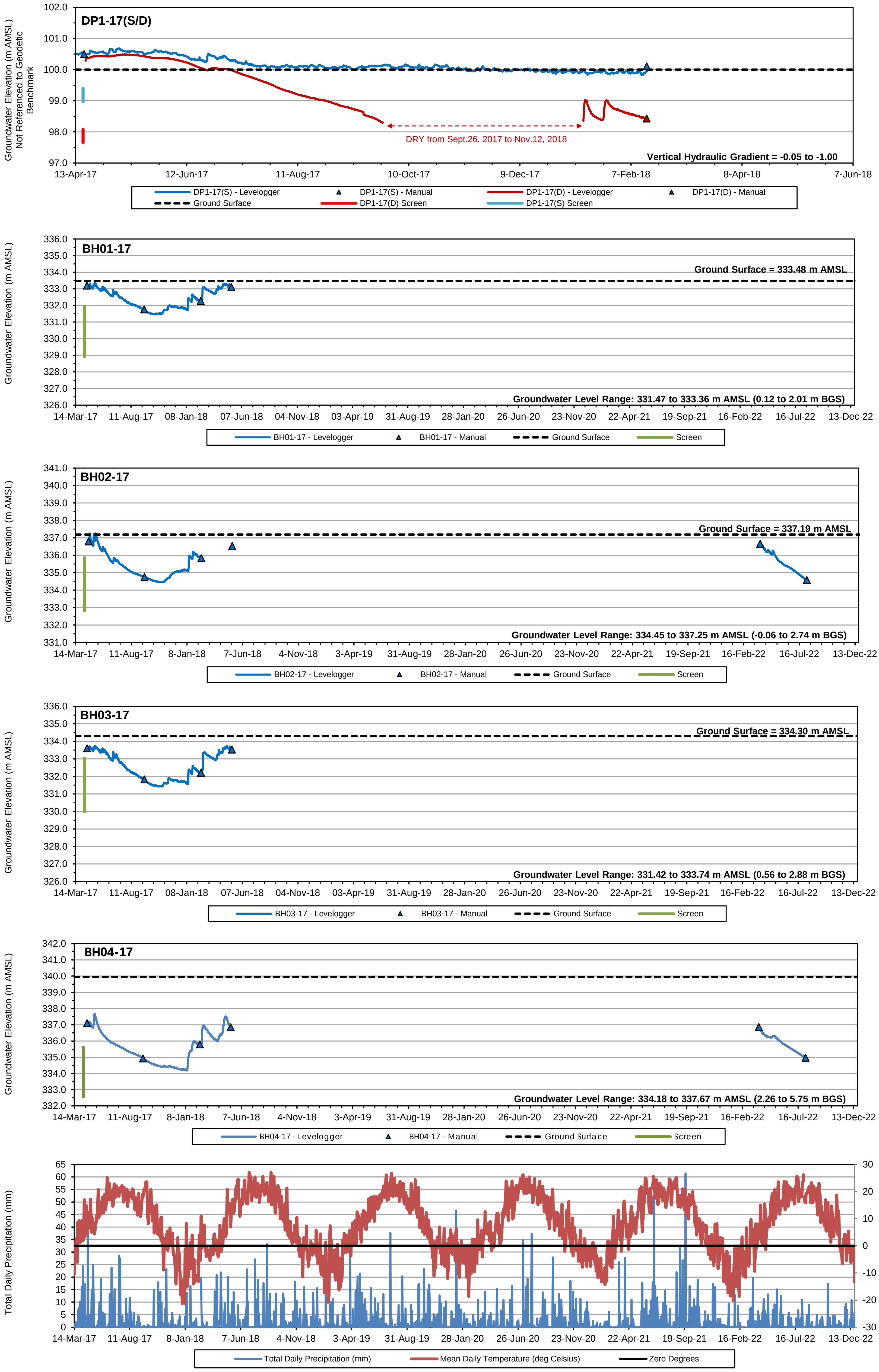
ROCKPOINT PROPERTIES INC.
HYDROGEOLOGICAL ASSESSMENT
220 ARKELL ROAD, GUELPH, ONTARIO

Stantec

Figure No.

2

Title **HYDROGRAPHS**
MW101-22 to MW106-22



Client/Project
ROCKPOINT PROPERTIES INC.
HYDROGEOLOGICAL ASSESSMENT
220 ARKELL ROAD, GUELPH, ONTARIO

Figure No.
3

Title
HYDROGRAPHS
BH01-17 to BH04-17 and DP1-17(S/D)

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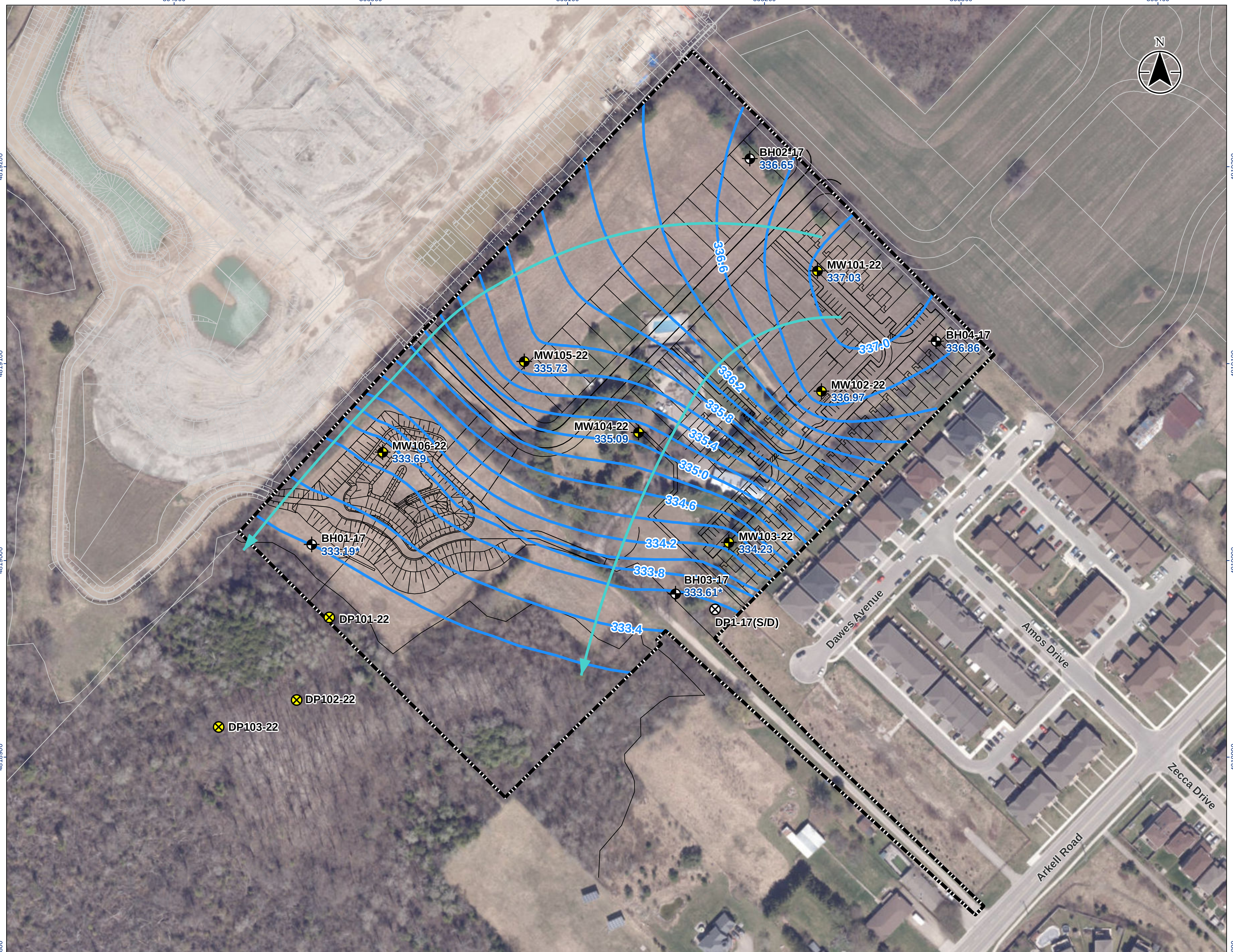


Stantec

- Site Boundary
- Monitoring Well (Stantec, 2022)
- Monitoring Well (Stantec, 2017)
- Drive-Point Piezometer (Stantec, 2022)
- Drive-Point Piezometer (Stantec, 2017)
- 337.10 Groundwater Elevation (mAMSL)
- * Groundwater Elevation (April, 2017)
- Proposed Subdivision
- Groundwater Contour (mAMSL)
- Interpreted Direction of Groundwater Flow

0 50 100 metres

1:2,000 (At original document size of 11x17)

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2017.
3. Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
4. * - Groundwater Elevation (April 2017)

Project Location
Guelph, Ontario

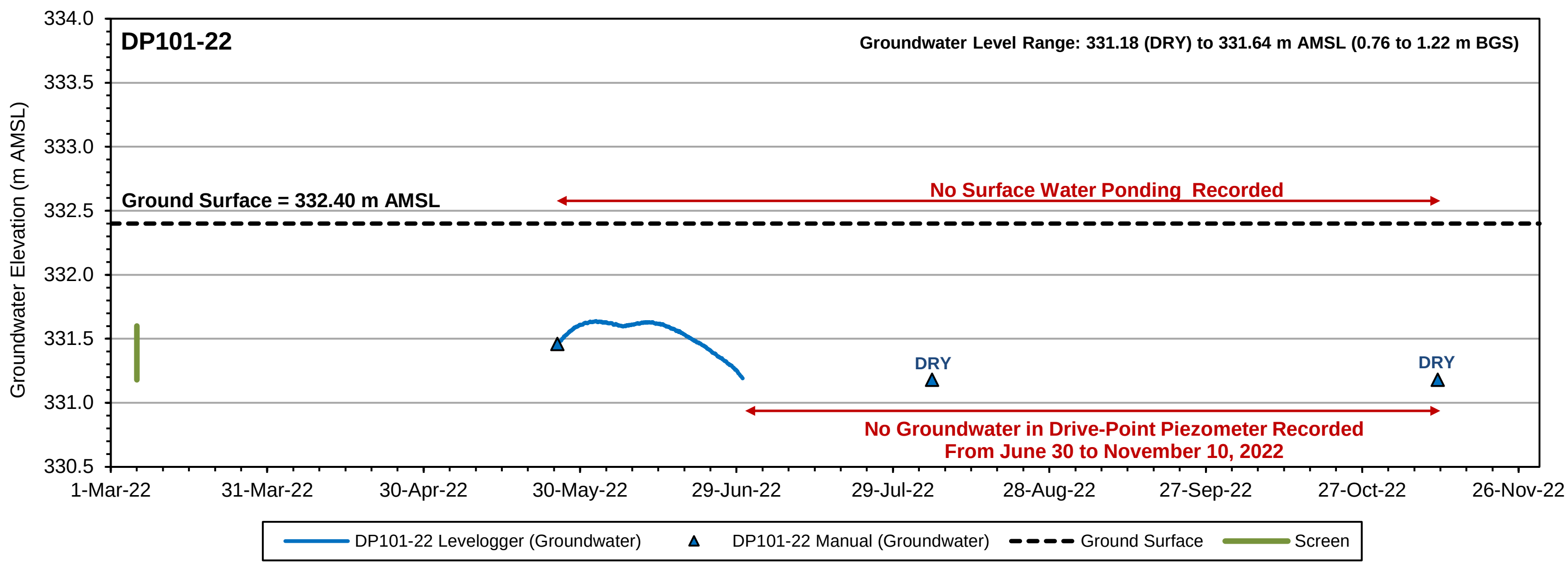
161413338 REVA
Prepared by PRM on 2023-02-22
Technical Review by GW on 2023-02-22

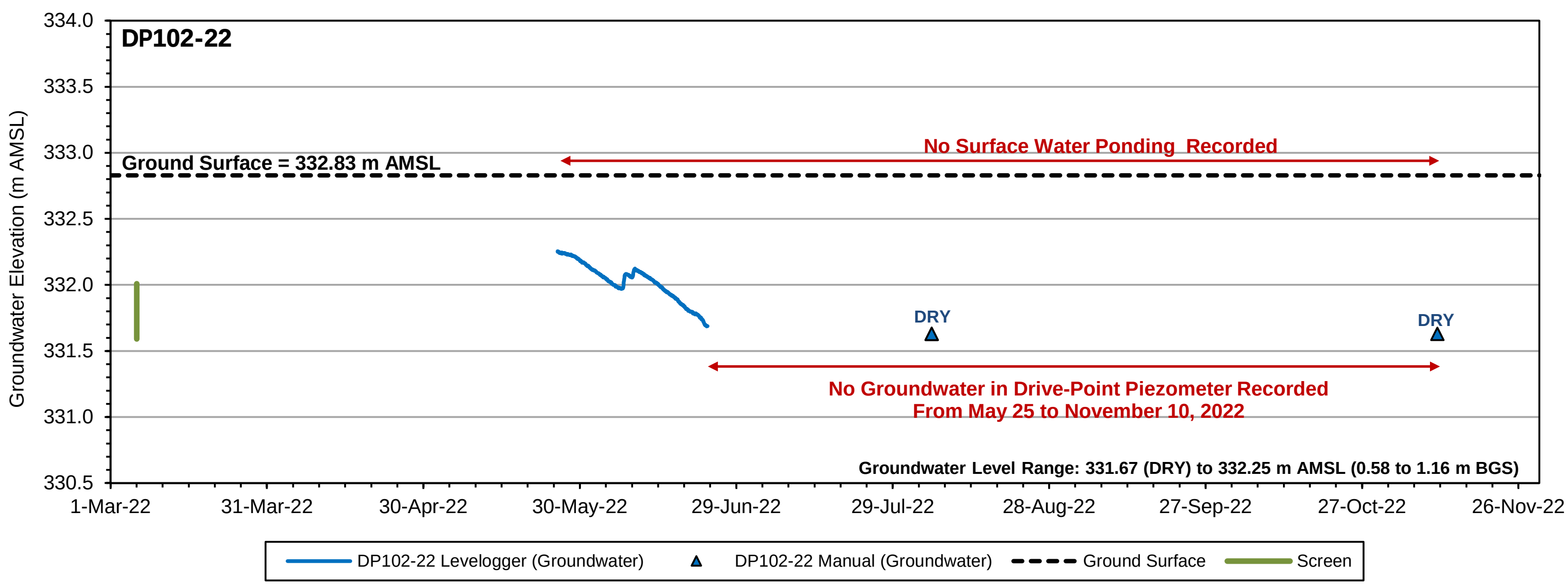
Client/Project
ROCKPOINT PROPERTIES INC.
HYDROGEOLOGICAL ASSESSMENT
220 ARKELL ROAD, GUELPH, ONTARIO

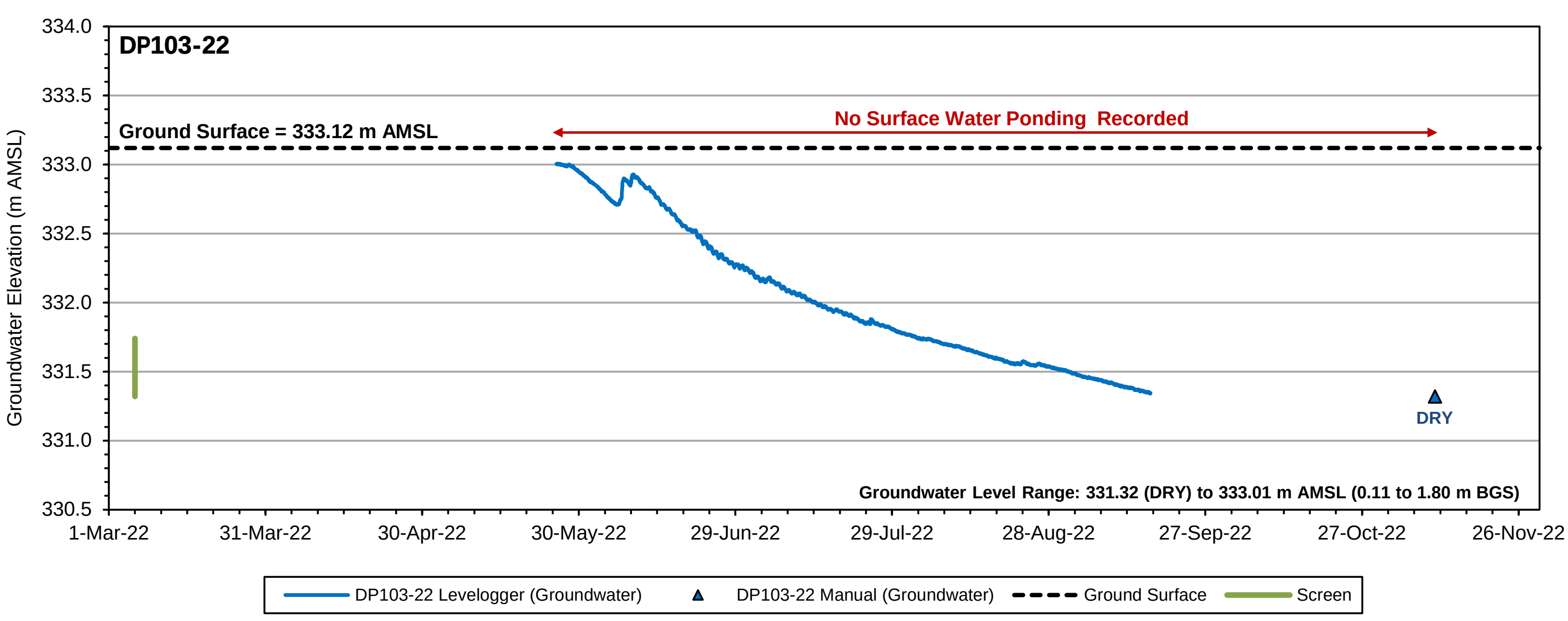
Figure No.
4

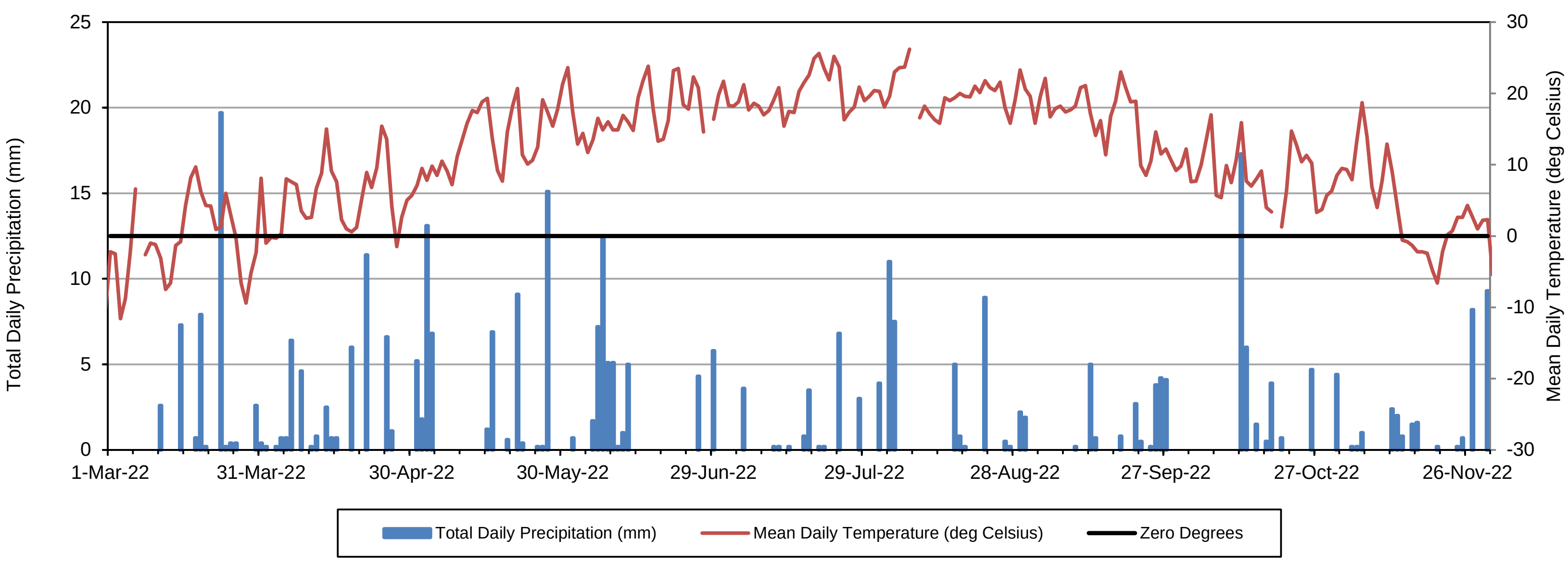
Title
Groundwater Flow - March 2022

\\Cd1004-f01\work_group\01614\active\161413338\planning\drawing\GIS\MXD\Hydrogeology\Water_Balance_Memo\161413338_Water_Bal_Memo_Fig02_GW_Flow_March2022.mxd Revised: 2023-02-22 By: pmoser







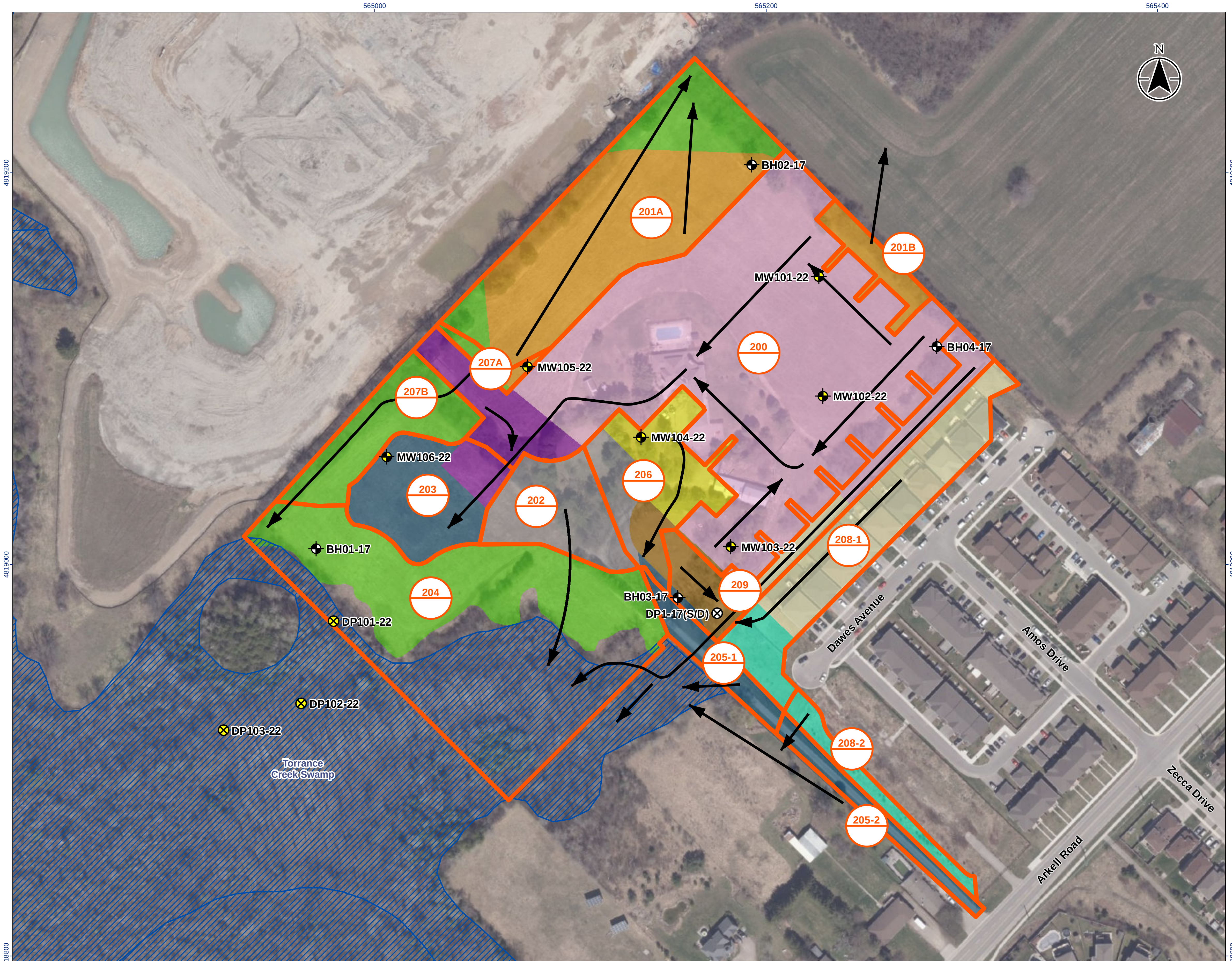


Stantec

Client/Project
ROCKPOINT PROPERTIES INC.
HYDROGEOLOGICAL ASSESSMENT
220 ARKELL ROAD, GUELPH, ONTARIO

Figure No.
5

Title
HYDROGRAPHS
DP101-22 to DP103-22



Stantec

Legend

- Monitoring Well (Stantec, 2022)
- Monitoring Well (Stantec, 2017)
- Drive-Point Piezometer (Stantec, 2022)
- Drive-Point Piezometer (Stantec, 2017)
- Overland Flow Direction
- Wetland - Evaluated (Provincial)
- Stormwater Catchment (Proposed Conditions)

Water Balance Sub-Areas

- Sub-Area A - Rolling, Silty Sand to Sand Till, Pasture and Shrubs, No Impervious Cover
- Sub-Area C - Rolling, Sand, Pasture and Shrubs, No Impervious Cover
- Sub-Area D - Rolling, Silty Sand to Sand Till, Urban Lawn, 65% Impervious
- Sub-Area E - Rolling, Sand, Urban Lawn, 65% Impervious
- Sub-Area F - Rolling, Silty Sand to Sand Till, Urban Lawn, 40% Impervious
- Sub-Area G - Rolling, Sand, Urban Lawn, 40% Impervious
- Sub-Area H - Rolling, Sand, Pasture and Shrubs, 15% Impervious
- Sub-Area I - Rolling, Silty Sand to Sand Till, Urban Lawn, 20% Impervious Cover
- Sub-Area J - Rolling, Sand, Urban Lawn, 20% Impervious Cover
- Sub-Area K - Rolling, Sand, Urban Lawn, 10% Impervious Cover

0 50 100 metres

1:2,000 (At original document size of 11x17)

Notes

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3. Topographic contours presented on site as surveyed by Stantec (2017). Topographic data beyond the site boundaries should be considered approximate and for illustrative purposes only.
4. Orthoimagery © First Base Solutions, 2021. Imagery flown in 2020.

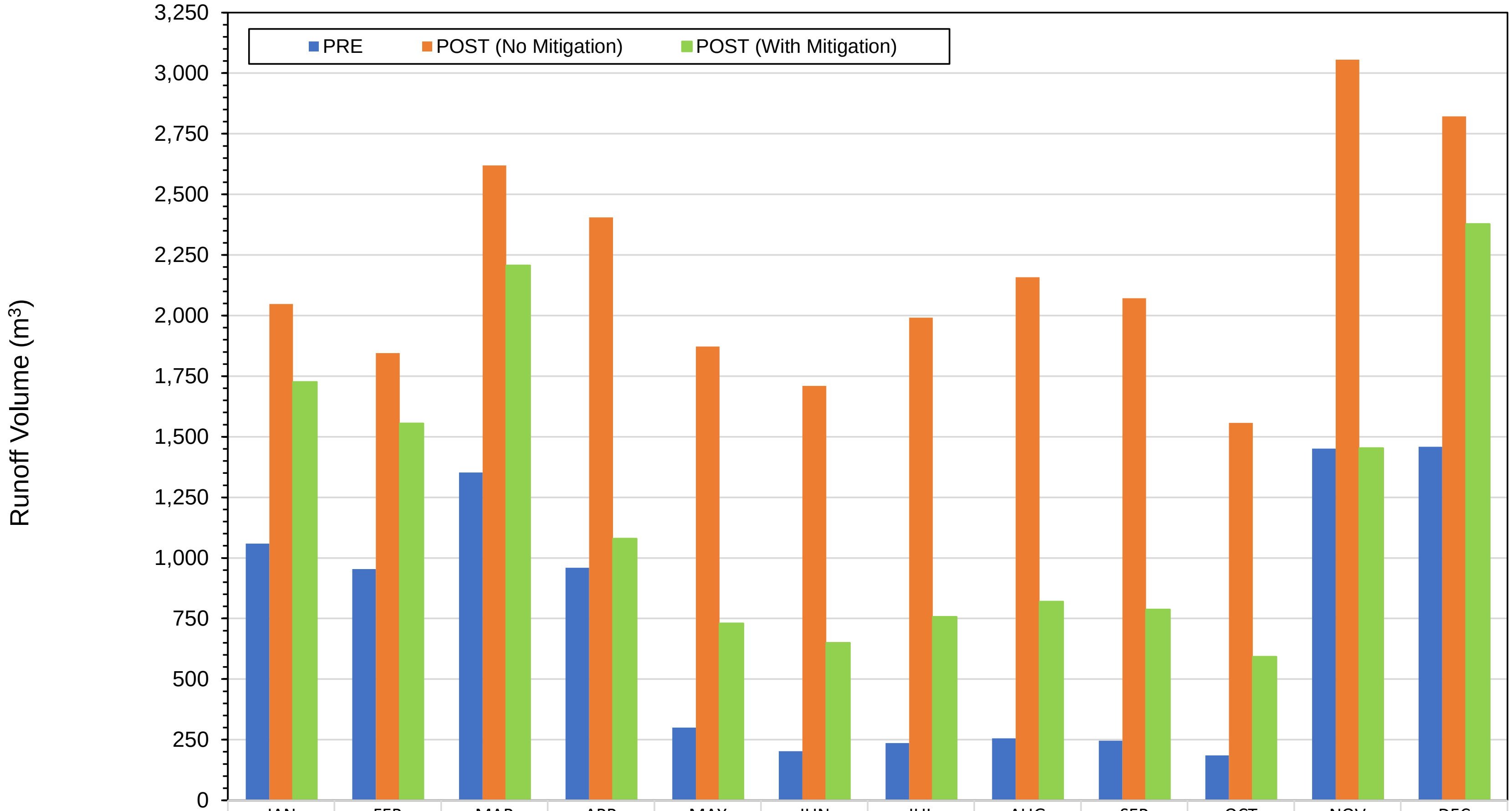
Project Location
Guelph, Ontario

161423338 REVA
Prepared by PRM on 2023-03-27
Technical Review by GW on 2023-03-27

Client/Project
ROCKPOINT PROPERTIES INC.
HYDROGEOLOGICAL ASSESSMENT
220 ARKELL ROAD, GUELPH, ONTARIO

Figure No.
6

Title
Post-Development Water Balance



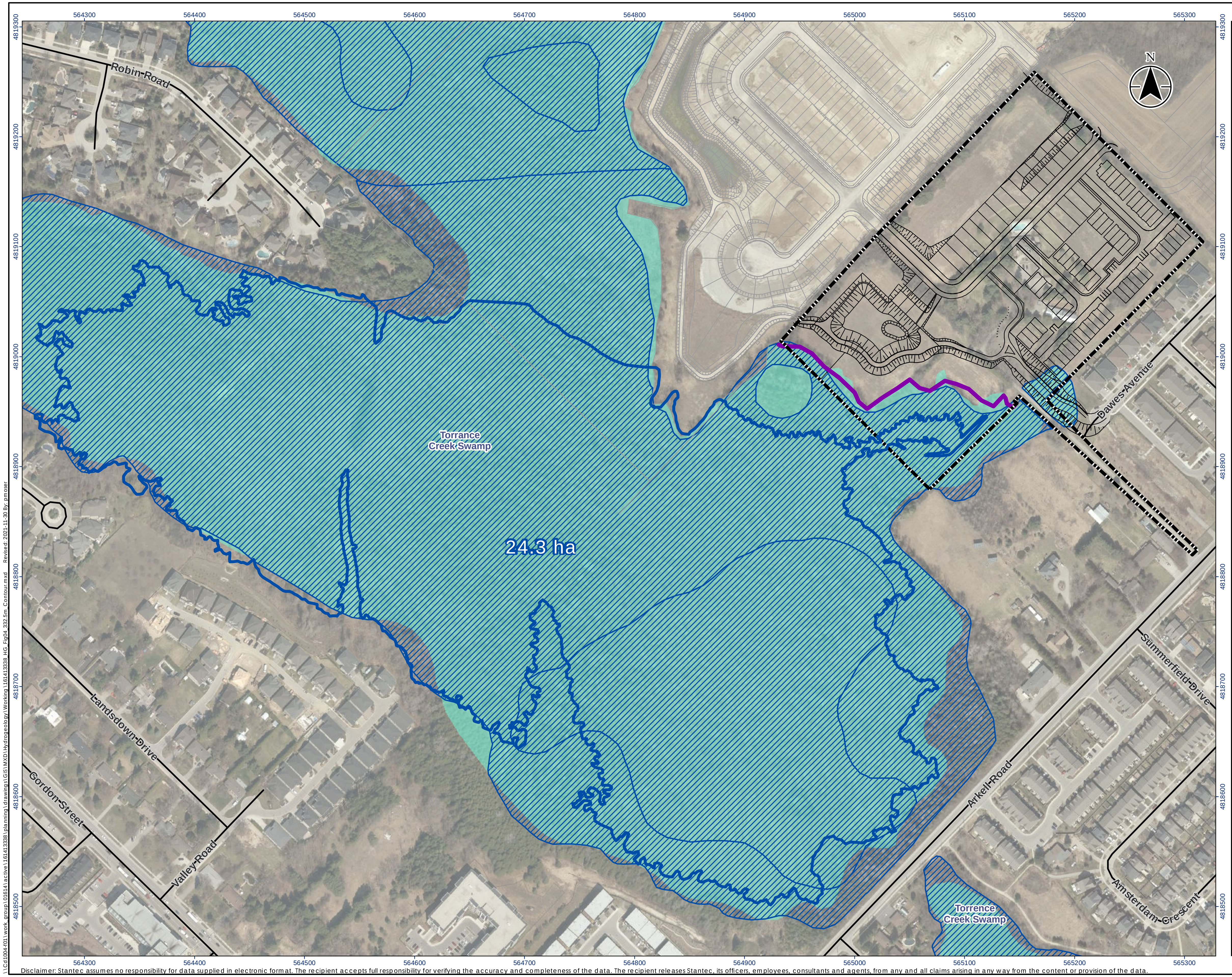
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PRE	1,059	954	1,353	959	300	203	236	256	246	185	1,451	1,459
POST (No Mitigation)	2,048	1,845	2,619	2,405	1,872	1,710	1,991	2,158	2,072	1,557	3,056	2,822
POST (With Mitigation)	1,726	1,555	2,207	1,080	730	650	757	820	787	592	1,453	2,378

Stantec

Project: HYDROGEOLOGICAL ASSESSMENT
220 ARKELL ROAD, GUELPH, ONTARIO

Figure: 7

Title: **Hydrograph - Monthly Pre- and Post-Development Runoff Flows Westward to Torrance Creek Swamp**



Stantec

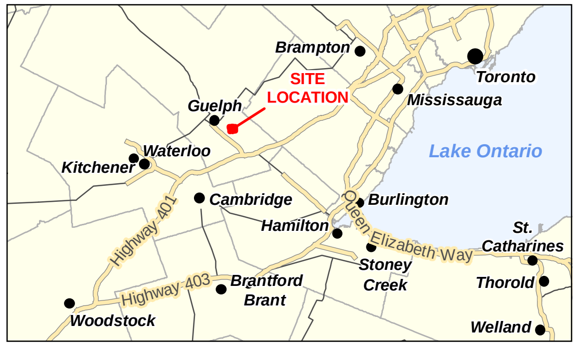
- Site Boundary
- Proposed Subdivision
- Topographic Contour (5 meter Interval)
- Topographic Contour (1 meter Interval)
- Wetland Boundary (Stantec, June 2017)
- Wetland - Evaluated (Provincial)
- Wetland Boundary (GRCA)
- 332.5m Contour

0 50 100 metres

1:3,500 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2017.
3. Imagery © Firstbase Solutions 2021, Imagery date 2021.



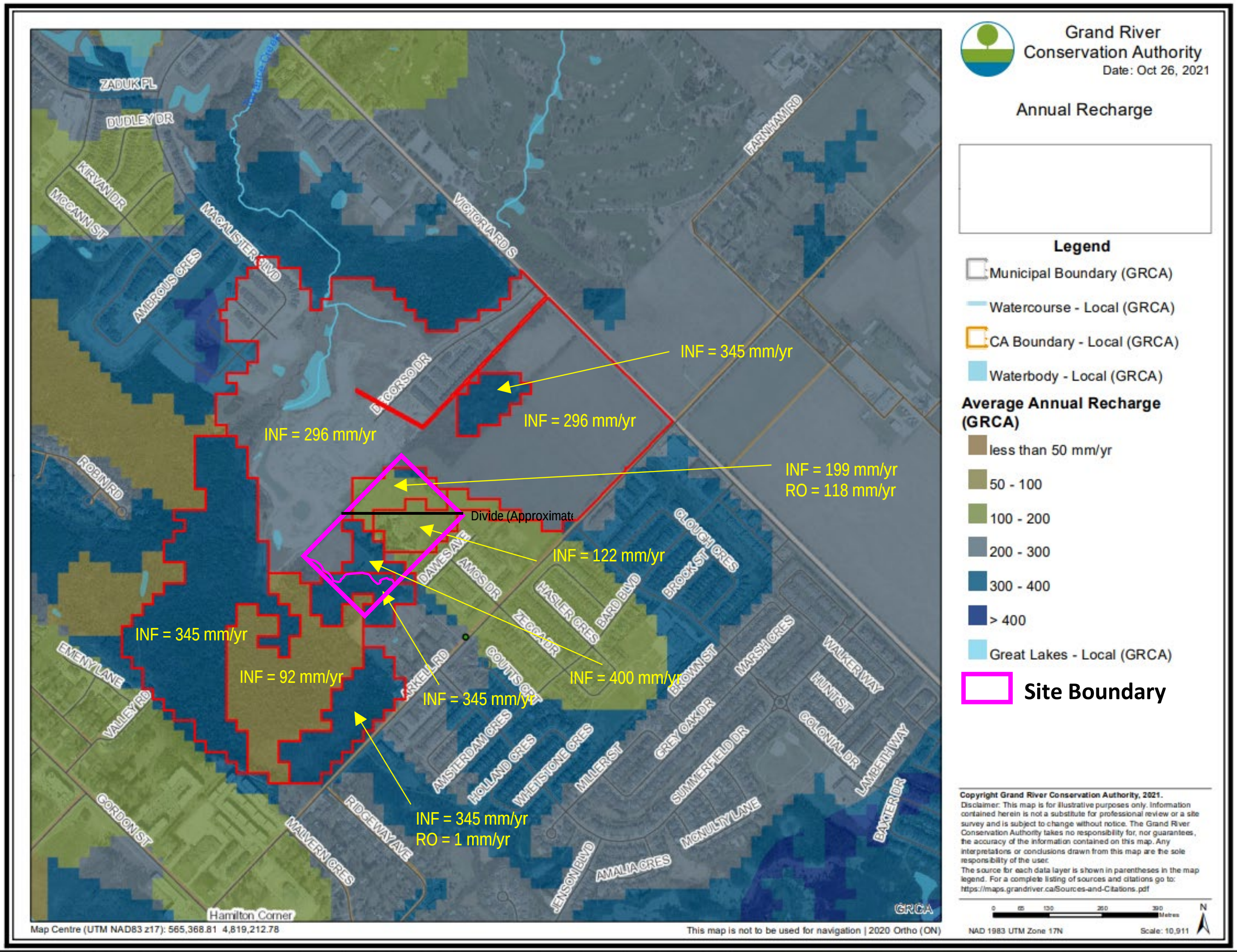
Project Location
Guelph, Ontario

161413338 REVA
Prepared by PRM on 2021-11-30
Technical Review by BW on 2021-11-30

Client/Project
ROCKPOINT PROPERTIES INC.
HYDROGEOLOGICAL ASSESSMENT
220 ARKELL ROAD, GUELPH, ONTARIO

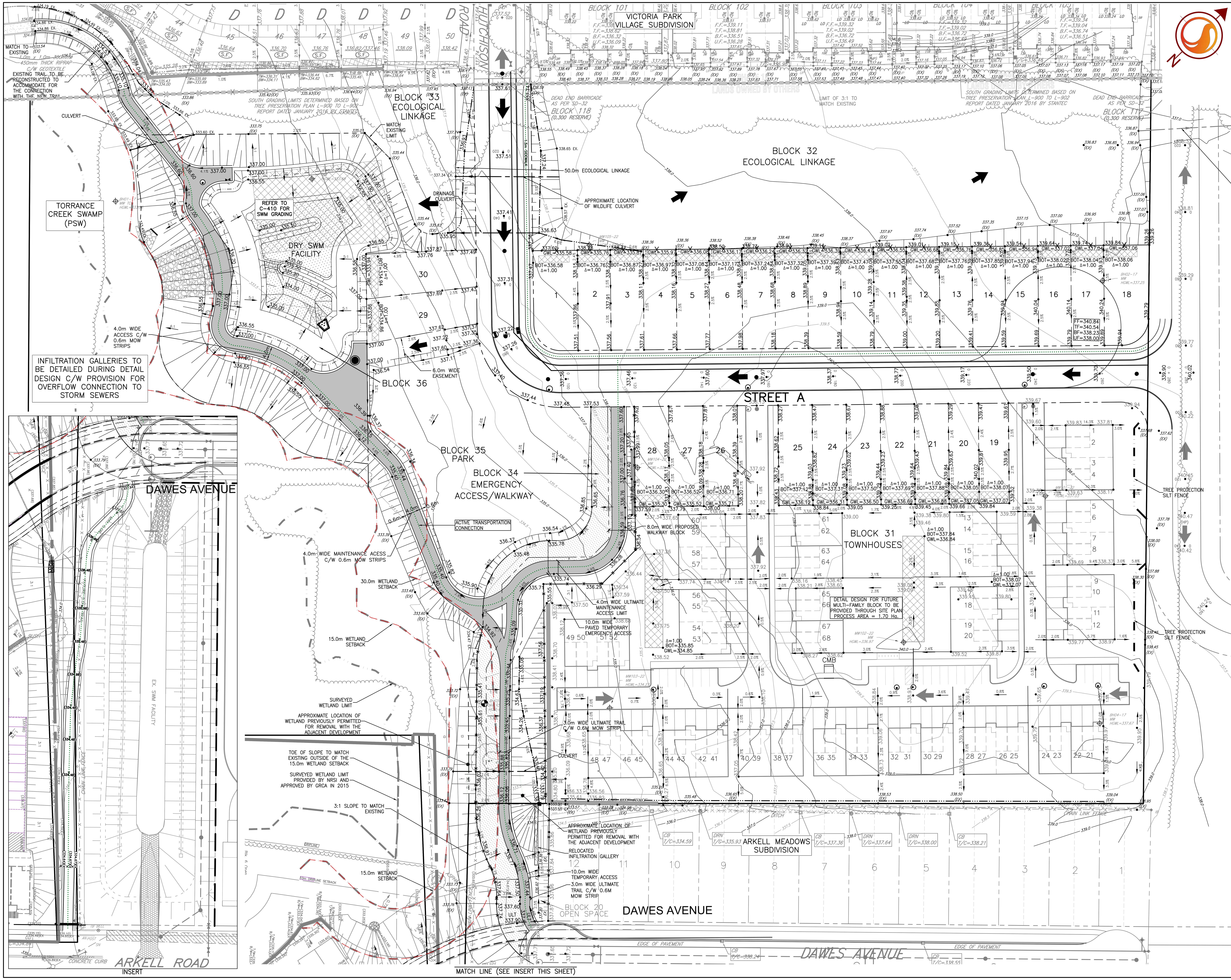
Figure No.
8

Title
Torrance Creek Swamp Runoff Receiving Basin



Stantec

Project:	HYDROGEOLOGICAL ASSESSMENT 220 ARKELL ROAD, GUELPH, ONTARIO
Figure:	**9**
Title:	**Annual Recharge Rates (GRCA)**



Stantec

300 Hagey Blvd. Suite 100
Waterloo, ON, N2L 0A4
Tel. 519.579.4410
www.stantec.com

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Notes

1. BENCHMARK:
   ND-27 RMW376 3
   GUELPH BENCHMARK #392. BENCHMARK PLATE ON TRAFFIC CONTROL BOX LOCATED ON SOUTH WEST CORNER OF THE INTERSECTION OF ARKELL ROAD AND VICTORIA ROAD.
   ELEVATION: 336.245m
2. TOPOGRAPHICAL SURVEY BY STANTEC CONSULTING LTD. DATED JULY 2017.
3. LEGAL PLAN PROVIDED BY BLACK, SHOEMAKER, ROBINSON & DONALDSON LIMITED. DATED MARCH 2019.
4. DRAFT PLAN BY J.D. BARNES LIMITED JAN., 2023.

Revision

Revision	By	Appd.	YY.MM.DD
1. SECOND SUBMISSION	MALM	KRB	23.03.03
0. FIRST SUBMISSION	MHH	KRB	19.05.30

File Name: 161413338_C-GP.dwg	Dwn.	Chkd.	Dsgn.	YY.MM.DD
				23.02.17

Permit-Seal

Professional Engineers Ontario

Licensed Engineering Technologist
Name: J. R. K. BROUSSEAU
Number: 100227228
Limitations: Preparation of municipal servicing design and specifications for gravity sanitary sewer, storm sewer watermain layout, site grading, development erosion control and development of local roads.
Association of Professional Engineers of Ontario

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

Client/Project

ROCKPOINT PROPERTIES INC.

220 ARKELL ROAD

Guelph, ON

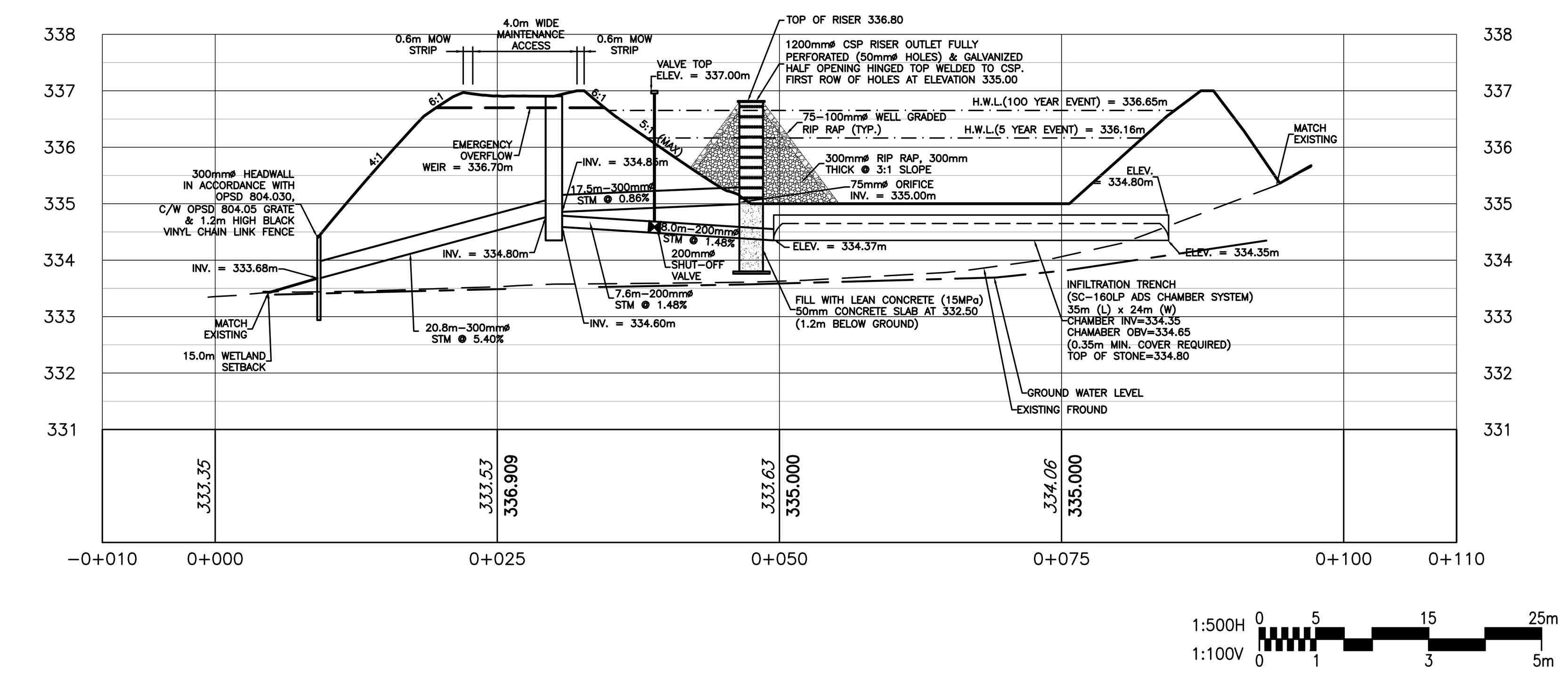
Title

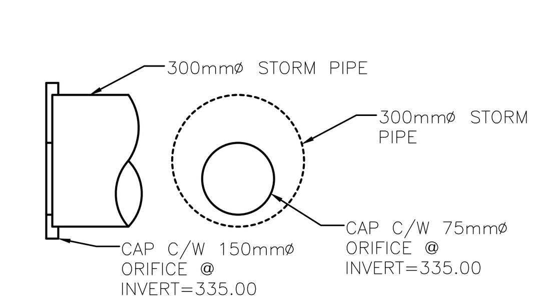
CONCEPTUAL GRADING PLAN

Project No.	Scale
161413338	1:500

Drawing No.	Sheet	Revision
C-400		1

ORIGINAL SHEET - ARCH D



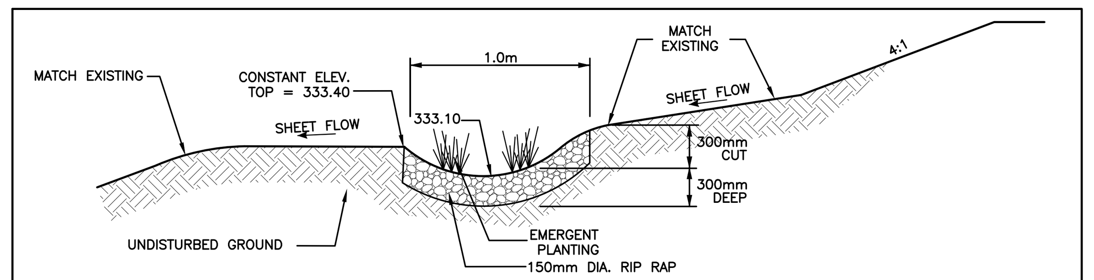


75mmø CAP DETAIL
NTS

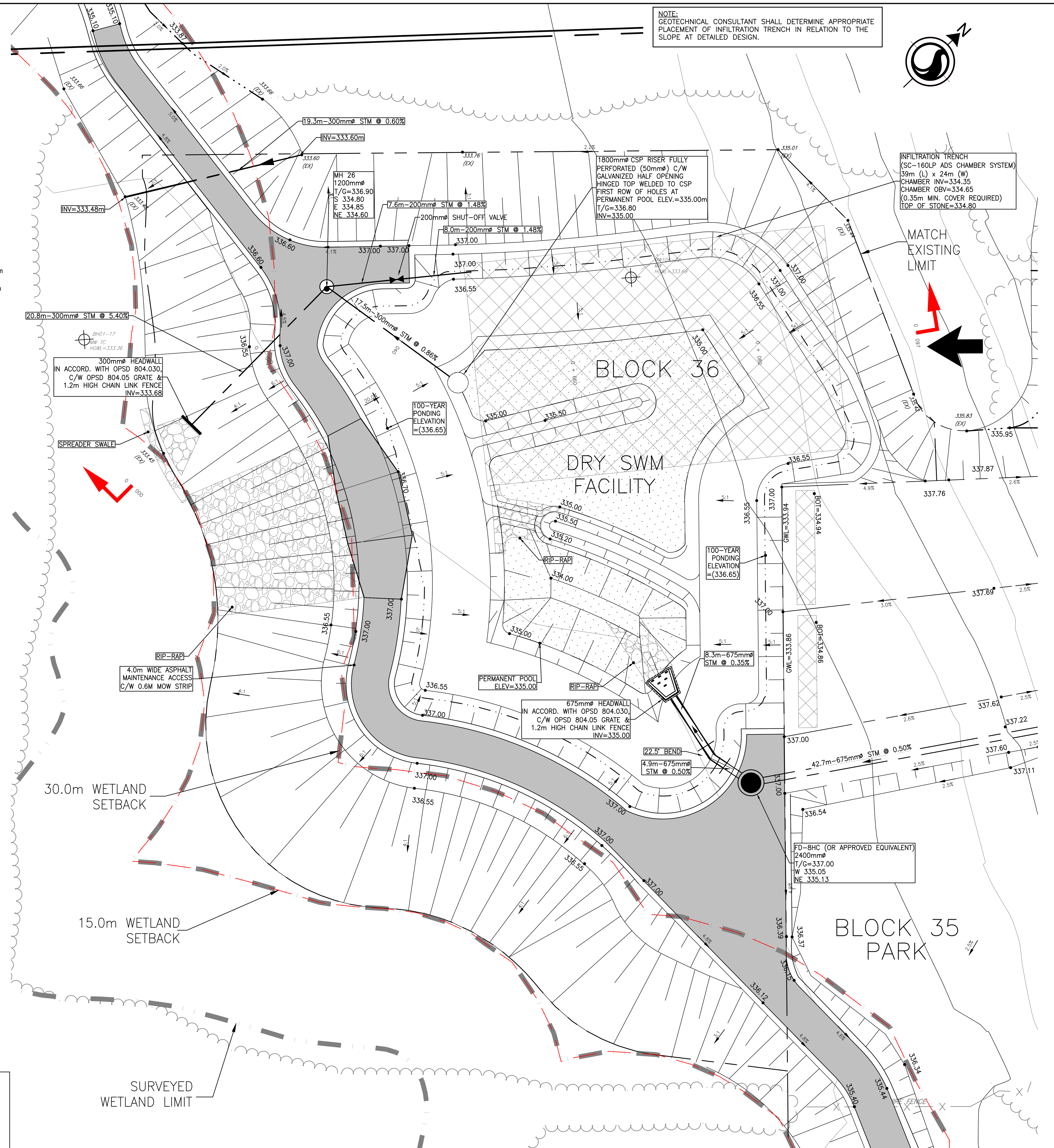
RIP-RAP GRADATION TABLE
100mm RIP-RAP 175mm THICK (MTO)
100% SMALLER THAN 150mm
AT LEAST 20% LARGER THAN 120mm
AT LEAST 50% LARGER THAN 100mm
AT LEAST 80% LARGER THAN 60mm

RIP-RAP GRADATION TABLE
300mm RIP-RAP 525mm THICK (MTO)
100% SMALLER THAN 500mm
AT LEAST 20% LARGER THAN 350mm
AT LEAST 50% LARGER THAN 300mm
AT LEAST 80% LARGER THAN 200mm

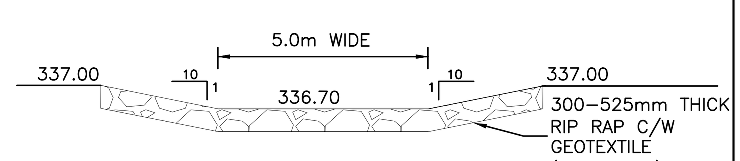
RIP-RAP DETAIL
NTS



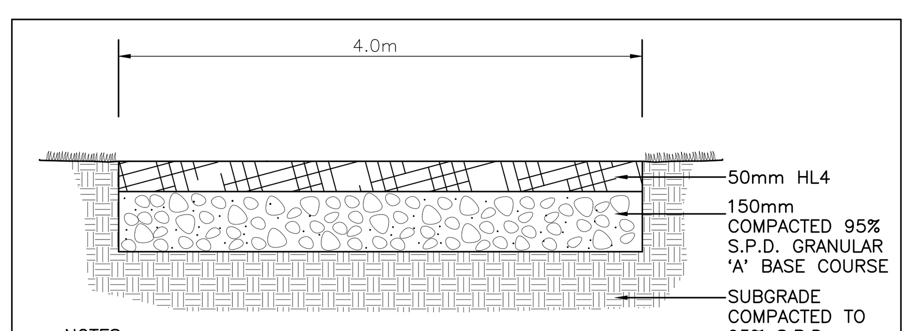
DETAIL OF SPREADER SWALE
NTS



NOTE:
POND SLOPES AND BOTTOM, FROM POND BOTTOM (334.00) TO 0.5m ABOVE PERMANENT POOL (335.00) TO ELEVATION 335.50 WITHIN THE FOREBAY LINED WITH 0.45m THICK ANTI SEEPAGE LINER. FINAL THICKNESS CONFIRMED FOLLOWING SOURCING AND TESTING OF MATERIAL BY GEOTECHNICAL CONSULTANT. ANY LOCALIZED SAND LAYERS CONTACTED ABOVE THE PERMANENT POOL WERE ALSO TO BE LINED.



EMERGENCY WEIR DETAIL
NTS



NOTES:
1. COMPACT ASPHALT TO 97% MARSHALL MIX DESIGN BULK DENSITY.
2. TRAIL TO MATCH PROPOSED GRADES.
3. TRAIL SURFACE TO BE SMOOTH AND EVEN THROUGHOUT.
4. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.
5. DISTURBED AREAS ARE TO BE RESTORED C/W TOPSOIL AND SEED (TOWN AND COUNTRY PICKSEED). TOPSOIL IS TO BE FINE GRADED AND BOX SCRAPPED WITH ALL AREAS HAVING POSITIVE DRAINAGE.

ASPHALT MAINTENANCE ACCESS/WALKWAY DETAIL
NTS

Stantec
300 Hagey Blvd. Suite 100
Waterloo, ON, N2L 0A4
Tel. 519.579.4410
www.stantec.com

Notes
1. BENCHMARK:
ND-27 RMW376 3
GUELPH BENCHMARK #392. BENCHMARK PLATE ON TRAFFIC CONTROL BOX LOCATED ON SOUTH WEST CORNER OF THE INTERSECTION OF ARKELL ROAD AND VICTORIA ROAD. ELEVATION: 336.245m
2. TOPOGRAPHICAL SURVEY BY STANTEC CONSULTING LTD. DATED JULY 2017.
3. LEGAL PLAN PROVIDED BY BLACK, SHOEMAKER, ROBINSON & DONALDSON LIMITED. DATED MARCH 2019.
4. DRAFT PLAN BY J.D. BARNES LIMITED JAN., 2023.

Legend

Revision	By	Appd.	YY.MM.DD
0. SECOND SUBMISSION	MALM	KRB	23.03.03

File Name: 161413338_C-SWM.dwg — Dwn. — Chkd. — Dsgn. — YY.MM.DD 23.02.17

Permit-Seal

Professional Engineers Ontario
Licensed Engineering Technologist
Name: J. R. K. BROUSSEAU
Number: 100227228
Limitations: Preparation of municipal servicing design and specifications for gravity sanitary sewer, storm sewer watermain layout, site grading, development erosion control and development of local roads.
Association of Professional Engineers of Ontario

PRELIMINARY NOT FOR CONSTRUCTION
Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

Client/Project
ROCKPOINT PROPERTIES INC.
220 ARKELL ROAD
Guelph, ON

Title
CONCEPTUAL STORMWATER MANAGEMENT PLAN

Project No. 161413338
Scale 1:250 (0, 2.5, 7.5, 12.5m)
Drawing No. C-410
Sheet
Revision 0

ATTACHMENT 2:
Tables

TABLE 1: PRE-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENTS 106, 208-1, AND 208-2 (LANDS DRAINING TO TORRANCE CREEK SWAMP)

Pre-Development

Model Type: Thornthwaite and Mather (1955)
Client: Rockpoint Properties Inc.
Location 220 Arkell Road, Guelph, ON - Catchments 106, 208-1, and 208-2 (Lands Draining to Torrance Creek Swamp)
Total Site Area (ha) 4.52

Land Description Factors (Sub-area descriptions provided below)	**Sub-Area A**	**Sub-Area B**	**Sub-Area C**	**Sub-Area F**	**Sub-Area G**	**Total**
Topography	0.15	0.15	0.15	0.20	0.20	
Soils	0.25	0.25	0.40	0.25	0.40	
Cover	0.15	0.05	0.15	0.05	0.05	
Sum (Infiltration Factor / IF)†	0.55	0.45	0.70	0.50	0.65	
Soil Moisture Capacity (mm)	150	75	100	75	50	
Site area (ha)	0.79	0.63	2.43	0.45	0.22	4.51
Imperviousness Coefficient	0.00	0.00	0.00	0.40	0.40	
Impervious Area (ha)	0.00	0.00	0.00	0.18	0.09	0.27
Percentage of Total Site Area	0.0%	0.0%	0.0%	4.0%	2.0%	6%
Remaining Pervious Area (ha)	0.79	0.63	2.43	0.27	0.13	4.25
Total Pervious Site Area (ha)	0.79	0.63	2.43	0.27	0.13	4.25
Percentage of Total Site Area	17.6%	13.86%	53.8%	5.9%	2.9%	94%

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Climate Data (Guelph Arboretum Climate Normals, 1971 - 2000)‡													
Average Daily Temperature (°C)	-7.6	-6.9	-1.3	5.9	12.3	16.9	19.7	18.6	14.1	7.9	2.4	-4	**6.5**
Precipitation (mm)	56.4	50.8	72.1	78.3	79.9	76	88.5	95.9	92.1	69.2	86.3	77.7	**923**

Potential Evapotranspiration Analysis for Site	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Heat Index	0.0	0.0	0.0	1.3	3.9	6.3	8.0	7.3	4.8	2.0	0.3	0.0	**34**
Unadjusted Potential Evapotranspiration (mm)	0.0	0.0	0.0	28.4	60.7	84.3	98.8	93.1	69.9	38.4	11.2	0.0	**485**
Potential Evapotranspiration Adjusting Factor for Latitude*	0.77	0.87	0.99	1.12	1.23	1.29	1.26	1.16	1.04	0.92	0.81	0.75	
Adjusted Potential Evapotranspiration (PET)(mm)	0	0	0	32	75	108	124	108	73	35	9	0	**564**
Precipitation - PET (mm)	56	51	72	47	5	-32	-36	-12	19	34	77	78	**359**

Evapotranspiration Analysis													
Sub-Area A	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-51	-9	0	0	
Storage (S)	150	150	150	150	150	121	95	88	107	141	150	150	
Change in Storage	0	0	0	0	0	-29	-26	-8	19	34	9	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	105	114	104	73	35	9	0	**546**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	68	78	**377**
Potential Infiltration (I)	31	28	40	26	3	0	0	0	0	0	37	43	207
Potential Direct Surface Water Runoff (R)	25	23	32	21	2	0	0	0	0	0	31	35	170
Potential Infiltration (mm)	0	0	0	167	3	0	0	0	0	0	37	0	207
Pervious Evapotranspiration (m^3)	0	0	0	252	592	835	907	822	579	280	72	0	4,339
Pervious Runoff (m^3)	202	182	258	167	19	0	0	0	0	0	244	278	**1,348**
Pervious Infiltration (m^3)	0	0	0	1327	23	0	0	0	0	0	298	0	**1,648**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**

TABLE 1: PRE-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENTS 106, 208-1, AND 208-2 (LANDS DRAINING TO TORRANCE CREEK SWAMP)

Evapotranspiration Analysis													
Sub-Area B	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-39	4	0	0	
Storage (S)	75	75	75	75	75	49	30	26	45	79	75	75	
Change in Storage	0	0	0	0	0	-26	-18	-5	19	34	-4	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	102	107	101	73	35	9	0	**533**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	81	78	**390**
Potential Infiltration (I)	25	23	32	21	2	0	0	0	0	0	37	35	176
Potential Direct Surface Water Runoff (R)	31	28	40	26	3	0	0	0	0	0	45	43	215
Potential Infiltration (mm)	0	0	0	137	2	0	0	0	0	0	37	0	176
Pervious Evapotranspiration (m^3)	0	0	0	199	466	640	669	629	456	220	56	0	3,336
Pervious Runoff (m^3)	194	175	248	160	18	0	0	0	0	0	279	267	**1,342**
Pervious Infiltration (m^3)	0	0	0	855	15	0	0	0	0	0	228	0	**1,098**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**

Evapotranspiration Analysis													
Sub-Area C	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-45	-2	0	0	
Storage (S)	100	100	100	100	100	72	51	45	64	98	100	100	
Change in Storage	0	0	0	0	0	-28	-22	-6	19	34	2	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	104	110	102	73	35	9	0	**539**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	75	78	**384**
Potential Infiltration (I)	39	36	50	33	4	0	0	0	0	0	53	54	269
Potential Direct Surface Water Runoff (R)	17	15	22	14	2	0	0	0	0	0	23	23	115
Potential Infiltration (mm)	0	0	0	212	4	0	0	0	0	0	53	0	269
Pervious Evapotranspiration (m^3)	0	0	0	770	1809	2515	2676	2472	1767	855	219	0	13,084
Pervious Runoff (m^3)	411	370	525	339	39	0	0	0	0	0	547	566	**2,797**
Pervious Infiltration (m^3)	0	0	0	5157	91	0	0	0	0	0	1277	0	**6,526**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**

Evapotranspiration Analysis													
Sub-Area F	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-39	4	0	0	
Storage (S)	75	75	75	75	75	49	30	26	45	79	75	75	
Change in Storage	0	0	0	0	0	-26	-18	-5	19	34	-4	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	102	107	101	73	35	9	0	**533**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	81	78	**390**
Potential Infiltration (I)	28	25	36	23	3	0	0	0	0	0	41	39	195
Potential Direct Surface Water Runoff (R)	28	25	36	23	3	0	0	0	0	0	41	39	195
Potential Infiltration (mm)	0	0	0	152	3	0	0	0	0	0	41	0	195
Pervious Evapotranspiration (m^3)	0	0	0	85	200	274	287	269	195	94	24	0	1,429
Pervious Runoff (m^3)	76	68	97	62	7	0	0	0	0	0	109	104	**523**
Pervious Infiltration (m^3)	0	0	0	407	7	0	0	0	0	0	109	0	**523**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	101	91	129	140	143	136	158	171	165	124	154	139	**1,649**

TABLE 1: PRE-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENTS 106, 208-1, AND 208-2 (LANDS DRAINING TO TORRANCE CREEK SWAMP)

Evapotranspiration Analysis													
Sub-Area G	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-27	12	0	0	
Storage (S)	50	50	50	50	50	26	13	10	29	63	50	50	
Change in Storage	0	0	0	0	0	-24	-13	-3	19	34	-13	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	100	102	99	73	35	9	0	**524**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	90	78	**399**
Potential Infiltration (I)	37	33	47	30	3	0	0	0	0	0	59	51	260
Potential Direct Surface Water Runoff (R)	20	18	25	16	2	0	0	0	0	0	32	27	140
Potential Infiltration (mm)	0	0	0	197	3	0	0	0	0	0	59	0	260
Pervious Evapotranspiration (m^3)	0	0	0	42	99	132	135	131	97	47	12	0	694
Pervious Runoff (m^3)	26	24	33	22	2	0	0	0	0	0	42	36	**185**
Pervious Infiltration (m^3)	0	0	0	262	5	0	0	0	0	0	78	0	**344**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	50	45	64	69	71	67	78	85	81	61	76	69	**816**

Pre-Development Infiltration (INF)	10,139	m^3/yr	225	mm/yr	0.3	L/s
Pre-Development Runoff (R)	8,660	m^3/yr	192	mm/yr	0.3	L/s
Pre-Development Evapotranspiration (ET)	22,882	m^3/yr	507	mm/yr	0.7	L/s
Total = INF + R + ET	41,681	m^3/yr	923	mm/yr	1.3	L/s
Precipitation	41,681	m^3/yr	923	mm/yr	1.3	L/s

Sub-Area Descriptions (topography, soils, cover)	
Sub-Area A	Rolling to Hilly, Silty Sand to Sand Till, Pasture and Shrubs
Sub-Area B	Rolling to Hilly, Silty Sand to Sand Till, Urban Lawn
Sub-Area C	Rolling to Hilly, Sand, Pasture and Shrubs
Sub-Area F	Rolling, Silty Sand to Sand Till, Urban Lawn, 40% Impervious
Sub-Area G	Rolling, Sand, Urban Lawn, 40% Impervious

Notes:

† Infiltration factors after Ontario Ministry of the Environment, 2003. Stormwater Management Planning and Design Manual. March 2003.; and Ontario Ministry of Environment and Energy (MOEE). 1995. MOEE Hydrogeological Technical Information Requirements for Land Development Applications. April 1995.

* PET adjustment factors after Thornthwaite, C.W., and J.R. Mather, 1957. Instructions and Tables for Computing Potential Evapotranspiration and the water balance. Drexel Institute of Technology, Laboratory of Climatology, Publications in Climatology, Volume X, No. 3. Centerton, New Jersey.

‡ Climate Data after Environment Canada, 2021. Canadian Climate Normals 1971-2000, Guelph Arboretum, Climate ID 6143069. [Online] http://climate.weather.gc.ca/climate_normals/index_e.html. Accessed July 2021.

Assumptions:
[1] The monthly average precipitation collected at the Guelph Arboretum climate station is reflective of the precipitation trends that have historically occurred at the Site.
[2] Surplus water is not available for runoff and recharge during months where water losses from actual evapotranspiration exceed precipitation inputs.
[3] Runoff, infiltration and evapotranspiration do not occur in months where the average daily temperature is below 0°C, which is the case for the months of December through March at the Site.
[4] Precipitation during freezing months (i.e., December to March) is assumed to accumulate as snow and result in additional precipitation in the first month thereafter where the average temperature is greater than 0°C (i.e., April).
[5] Soil moisture capacity is at a maximum in April.

TABLE 2: PRE-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENT 110 (LANDS DRAINING EASTWARD TO WOODLOT)

Pre-Development

Model Type: Thornthwaite and Mather (1955)
Client: Rockpoint Properties Inc.
Location 220 Arkell Road, Guelph, ON - Catchment 110 (Lands Draining Eastward to Woodlot)
Total Site Area (ha) 2.47

Land Description Factors (Sub-area descriptions provided below)	**Sub-Area A**	Sub-Area B	**Sub-Area C**	Sub-Area D	Sub-Area E								**Total**
Topography	0.15	0.15	0.15	0.00	0.00								
Soils	0.25	0.30	0.40	0.00	0.00								
Cover	0.15	0.05	0.15	0.00	0.00								
Sum (Infiltration Factor / IF)†	0.55	0.50	0.70	0.00	0.00								
Soil Moisture Capacity (mm)	150	75	100	0	0								
Site area (ha)	2.19	0.00	0.28	0.00	0.00								2.47
Imperviousness Coefficient	0.00	0.00	0.00	0.00	0.00								
Impervious Area (ha)	0.00	0.00	0.00	0.00	0.00								0.00
Percentage of Total Site Area	0.0%	0.0%	0.0%	0.0%	0.0%								0%
Remaining Pervious Area (ha)	2.19	0.00	0.28	0.00	0.00								2.47
Total Pervious Site Area (ha)	2.19	0.00	0.28	0.00	0.00								2.47
Percentage of Total Site Area	88.5%	0.00%	11.5%	0.0%	0.0%								100%

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Climate Data (Guelph Arboretum Climate Normals, 1971 - 2000)‡													
Average Daily Temperature (°C)	-7.6	-6.9	-1.3	5.9	12.3	16.9	19.7	18.6	14.1	7.9	2.4	-4	**6.5**
Precipitation (mm)	56.4	50.8	72.1	78.3	79.9	76	88.5	95.9	92.1	69.2	86.3	77.7	**923**

Potential Evapotranspiration Analysis for Site	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Heat Index	0.0	0.0	0.0	1.3	3.9	6.3	8.0	7.3	4.8	2.0	0.3	0.0	**34**
Unadjusted Potential Evapotranspiration (mm)	0.0	0.0	0.0	28.4	60.7	84.3	98.8	93.1	69.9	38.4	11.2	0.0	**485**
Potential Evapotranspiration Adjusting Factor for Latitude*	0.77	0.87	0.99	1.12	1.23	1.29	1.26	1.16	1.04	0.92	0.81	0.75	
Adjusted Potential Evapotranspiration (PET)(mm)	0	0	0	32	75	108	124	108	73	35	9	0	**564**
Precipitation - PET (mm)	56	51	72	47	5	-32	-36	-12	19	34	77	78	**359**

Evapotranspiration Analysis													
Sub-Area A	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-51	-9	0	0	
Storage (S)	150	150	150	150	150	121	95	88	107	141	150	150	
Change in Storage	0	0	0	0	0	-29	-26	-8	19	34	9	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	105	114	104	73	35	9	0	**546**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	68	78	**377**
Potential Infiltration (I)	31	28	40	26	3	0	0	0	0	0	37	43	207
Potential Direct Surface Water Runoff (R)	25	23	32	21	2	0	0	0	0	0	31	35	170
Potential Infiltration (mm)	0	0	0	167	3	0	0	0	0	0	37	0	207
Pervious Evapotranspiration (m^3)	0	0	0	694	1629	2297	2496	2263	1592	770	197	0	11,938
Pervious Runoff (m^3)	555	500	709	458	53	0	0	0	0	0	670	764	**3,709**
Pervious Infiltration (m^3)	0	0	0	3650	65	0	0	0	0	0	819	0	**4,534**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**

TABLE 2: PRE-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENT 110 (LANDS DRAINING EASTWARD TO WOODLOT)

Evapotranspiration Analysis													
Sub-Area B	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-39	4	0	0	
Storage (S)	75	75	75	75	75	49	30	26	45	79	75	75	
Change in Storage	0	0	0	0	0	-26	-18	-5	19	34	-4	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	102	107	101	73	35	9	0	**533**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	81	78	**390**
Potential Infiltration (I)	28	25	36	23	3	0	0	0	0	0	41	39	195
Potential Direct Surface Water Runoff (R)	28	25	36	23	3	0	0	0	0	0	41	39	195
Potential Infiltration (mm)	0	0	0	152	3	0	0	0	0	0	41	0	195
Pervious Evapotranspiration (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	0
Pervious Runoff (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Pervious Infiltration (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**

Evapotranspiration Analysis													
Sub-Area C	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-45	-2	0	0	
Storage (S)	100	100	100	100	100	72	51	45	64	98	100	100	
Change in Storage	0	0	0	0	0	-28	-22	-6	19	34	2	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	104	110	102	73	35	9	0	**539**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	75	78	**384**
Potential Infiltration (I)	39	36	50	33	4	0	0	0	0	0	53	54	269
Potential Direct Surface Water Runoff (R)	17	15	22	14	2	0	0	0	0	0	23	23	115
Potential Infiltration (mm)	0	0	0	212	4	0	0	0	0	0	53	0	269
Pervious Evapotranspiration (m^3)	0	0	0	90	211	293	312	288	206	100	26	0	1,525
Pervious Runoff (m^3)	48	43	61	40	5	0	0	0	0	0	64	66	**326**
Pervious Infiltration (m^3)	0	0	0	601	11	0	0	0	0	0	149	0	**761**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**

Pre-Development Infiltration (INF)	5,294	m^3/yr	214	mm/yr	0.2	L/s
Pre-Development Runoff (R)	4,035	m^3/yr	163	mm/yr	0.1	L/s
Pre-Development Evapotranspiration (ET)	13,463	m^3/yr	545	mm/yr	0.4	L/s
Total = INF + R + ET	22,793	m^3/yr	923	mm/yr	0.7	L/s
Precipitation	22,793	m^3/yr	923	mm/yr	0.7	L/s
Error	0.000	(m^3/yr)	-0.411	mm/yr	0.000	L/s

Sub-Area Descriptions (topography, soils, cover)	
Sub-Area A	Rolling to Hilly, Silty Sand to Sand Till, Pasture and Shrubs
Sub-Area B	Rolling to Hilly, Silty Sand to Sand Till, Urban Lawn
Sub-Area C	Rolling to Hilly, Sand, Pasture and Shrubs

Notes:

† Infiltration factors after Ontario Ministry of the Environment, 2003. Stormwater Management Planning and Design Manual. March 2003.; and Ontario Ministry of Environment and Energy (MOEE). 1995. MOEE Hydrogeological Technical Information Requirements for Land Development Applications. April 1995.

* PET adjustment factors after Thornthwaite, C.W., and J.R. Mather, 1957. Instructions and Tables for Computing Potential Evapotranspiration and the water balance. Drexel Institute of Technology, Laboratory of Climatology, Publications in Climatology, Volume X, No. 3. Centerton, New Jersey.

‡ Climate Data after Environment Canada, 2021. Canadian Climate Normals 1971-2000, Guelph Arboretum, Climate ID 6143069. [Online] http://climate.weather.gc.ca/climate_normals/index_e.html. Accessed July 2021.

Assumptions:
[1] The monthly average precipitation collected at the Guelph Arboretum climate station is reflective of the precipitation trends that have historically occurred at the Site.
[2] Surplus water is not available for runoff and recharge during months where water losses from actual evapotranspiration exceed precipitation inputs.
[3] Runoff, infiltration and evapotranspiration do not occur in months where the average daily temperature is below 0°C, which is the case for the months of December through March at the Site.
[4] Precipitation during freezing months (i.e., December to March) is assumed to accumulate as snow and result in additional precipitation in the first month thereafter where the average temperature is greater than 0°C (i.e., April).
[5] Soil moisture capacity is at a maximum in April.

TABLE 3: POST-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENTS 200 and 202 to 208 (LANDS DRAINING WESTWARD TO TORRANCE CREEK SWAMP)

Post-Development
Model Type: Thornthwaite and Mather (1955)
Client: Rockpoint Properties Inc.
Location 220 Arkell Road - Former Catchment 106
Post-Development Catchments 200 and 202 to 208 (Lands Draining Westward to Torrance Creek Swamp)

Total Site Area (ha) 5.86

Land Description Factors (Sub-area descriptions provided below)	**Sub-Area A**	**Sub-Area C**	**Sub-Area D**	**Sub-Area E**	**Sub-Area F**	**Sub-Area G**	**Sub-Area H**	**Sub-Area I**	**Sub-Area J**	**Sub-Area K**			**Total**
Topography	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20			
Soils	0.25	0.40	0.25	0.40	0.25	0.40	0.25	0.25	0.40	0.40			
Cover	0.15	0.15	0.05	0.05	0.05	0.05	0.15	0.05	0.05	0.05			
Sum (Infiltration Factor)†	0.60	0.75	0.50	0.65	0.50	0.65	0.60	0.50	0.65	0.65			
Soil Moisture Capacity (mm)	150	100	75	50	75	50	100	75	50	50			
Site area (ha)	0.02	1.08	2.34	0.34	0.52	0.22	0.58	0.27	0.18	0.30			5.86
Imperviousness Coefficient	0.00	0.00	0.65	0.65	0.40	0.40	0.15	0.20	0.20	0.10			
Impervious Area (ha)	0.00	0.00	1.52	0.22	0.21	0.09	0.09	0.05	0.04	0.03			2.25
Percentage of Total Site Area	0.0%	0.0%	26.0%	3.8%	3.6%	1.5%	1.5%	0.9%	0.6%	0.5%			38.4%
Remaining Pervious Area (ha)	0.02	1.08	0.82	0.12	0.31	0.13	0.49	0.22	0.15	0.27			3.61
Total Pervious Site Area (ha)	0.02	1.08	0.82	0.12	0.31	0.13	0.49	0.22	0.15	0.27			3.61
Percentage of Total Site Area	0.3%	18.4%	14.0%	2.1%	5.4%	2.3%	8.4%	3.7%	2.5%	4.6%			61.5%
Single-Family Rooftop Area (ha)			0.34	0.04									0.37 (1)
Multiblock-Residential Rooftop Area (ha)			0.34										0.34 (2)
% of Sub-Area Runoff (non-rooftop) directed to SWMF	0.0%	0.0%	94.3%	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%			

Notes:
[1] Total projected rooftop area in single-family lots (i.e., 31 units * 120 m^2 rooftop area per unit = 3,720 m^2 / 10,000 = 0.37 ha)
[2] Total projected rooftop area in multi-residential block (i.e., 38 units * 90 m^2 rooftop area per unit = 3,420 m^2 / 10,000 = 0.34 ha)

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Climate Data (Guelph Arboretum Climate Normals, 1971 - 2000)‡													
Average Daily Temperature (°C)	-7.6	-6.9	-1.3	5.9	12.3	16.9	19.7	18.6	14.1	7.9	2.4	-4	**6.5**
Precipitation (mm)	56.4	50.8	72.1	78.3	79.9	76	88.5	95.9	92.1	69.2	86.3	77.7	**923**

Potential Evapotranspiration Analysis for Site	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Heat Index	0.0	0.0	0.0	1.3	3.9	6.3	8.0	7.3	4.8	2.0	0.3	0.0	**34**
Unadjusted Potential Evapotranspiration (mm)	0.0	0.0	0.0	28.4	60.7	84.3	98.8	93.1	69.9	38.4	11.2	0.0	**485**
Potential Evapotranspiration Adjusting Factor for Latitude*	0.77	0.87	0.99	1.12	1.23	1.29	1.26	1.16	1.04	0.92	0.81	0.75	
Adjusted Potential Evapotranspiration (PET)(mm)	0	0	0	32	75	108	124	108	73	35	9	0	**564**
Precipitation - PET (mm)	56	51	72	47	5	-32	-36	-12	19	34	77	78	**359**

Evapotranspiration Analysis													
Sub-Area A	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-51	-9	0	0	
Storage (S)	150	150	150	150	150	121	95	88	107	141	150	150	
Change in Storage	0	0	0	0	0	-29	-26	-8	19	34	9	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	105	114	104	73	35	9	0	**546**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	68	78	**377**
Potential Infiltration (I)	34	30	43	28	3	0	0	0	0	0	41	47	226
Potential Direct Surface Water Runoff (R)	23	20	29	19	2	0	0	0	0	0	27	31	151
Potential Infiltration (mm)	0	0	0	182	3	0	0	0	0	0	41	0	226
Pervious Evapotranspiration (m^3)	0	0	0	6	15	21	23	20	14	7	2	0	108
Pervious Runoff (m^3)	4	4	6	4	0	0	0	0	0	0	5	6	**30**
Pervious Infiltration (m^3)	0	0	0	36	1	0	0	0	0	0	8	0	**45**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**

TABLE 3: POST-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENTS 200 and 202 to 208 (LANDS DRAINING WESTWARD TO TORRANCE CREEK SWAMP)

Evapotranspiration Analysis													
Sub-Area C	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-45	-2	0	0	
Storage (S)	100	100	100	100	100	72	51	45	64	98	100	100	
Change in Storage	0	0	0	0	0	-28	-22	-6	19	34	2	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	104	110	102	73	35	9	0	**539**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	75	78	**384**
Potential Infiltration (I)	42	38	54	35	4	0	0	0	0	0	56	58	288
Potential Direct Surface Water Runoff (R)	14	13	18	12	1	0	0	0	0	0	19	19	96
Potential Infiltration (mm)	0	0	0	228	4	0	0	0	0	0	56	0	288
Pervious Evapotranspiration (m^3)	0	0	0	343	805	1119	1190	1099	786	380	97	0	5,819
Pervious Runoff (m^3)	152	137	195	126	14	0	0	0	0	0	203	210	**1,037**
Pervious Infiltration (m^3)	0	0	0	2458	43	0	0	0	0	0	609	0	**3,110**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**

Evapotranspiration Analysis													
Sub-Area D	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-39	4	0	0	
Storage (S)	75	75	75	75	75	49	30	26	45	79	75	75	
Change in Storage	0	0	0	0	0	-26	-18	-5	19	34	-4	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	102	107	101	73	35	9	0	**533**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	81	78	**390**
Potential Infiltration (I)	28	25	36	23	3	0	0	0	0	0	41	39	195
Potential Direct Surface Water Runoff (R)	28	25	36	23	3	0	0	0	0	0	41	39	195
Potential Infiltration (mm)	0	0	0	152	3	0	0	0	0	0	41	0	195
Pervious Evapotranspiration (m^3)	0	0	0	260	611	838	877	824	597	289	74	0	4,368
Pervious Runoff (m^3)	231	208	295	191	22	0	0	0	0	0	332	318	**1,598**
Pervious Infiltration (m^3)	0	0	0	1244	22	0	0	0	0	0	332	0	**1,598**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	858	773	1097	1191	1216	1156	1347	1459	1401	1053	1313	1182	**14,046**

Evapotranspiration Analysis													
Sub-Area E	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-27	12	0	0	
Storage (S)	50	50	50	50	50	26	13	10	29	63	50	50	
Change in Storage	0	0	0	0	0	-24	-13	-3	19	34	-13	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	100	102	99	73	35	9	0	**524**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	90	78	**399**
Potential Infiltration (I)	37	33	47	30	3	0	0	0	0	0	59	51	260
Potential Direct Surface Water Runoff (R)	20	18	25	16	2	0	0	0	0	0	32	27	140
Potential Infiltration (mm)	0	0	0	197	3	0	0	0	0	0	59	0	260
Pervious Evapotranspiration (m^3)	0	0	0	38	90	120	123	119	88	42	11	0	630
Pervious Runoff (m^3)	24	21	30	20	2	0	0	0	0	0	38	33	**168**
Pervious Infiltration (m^3)	0	0	0	237	4	0	0	0	0	0	71	0	**312**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	126	114	161	175	179	170	198	214	206	155	193	174	**2,063**

TABLE 3: POST-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENTS 200 and 202 to 208 (LANDS DRAINING WESTWARD TO TORRANCE CREEK SWAMP)

Evapotranspiration Analysis													
Sub-Area F	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-39	4	0	0	
Storage (S)	75	75	75	75	75	49	30	26	45	79	75	75	
Change in Storage	0	0	0	0	0	-26	-18	-5	19	34	-4	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	102	107	101	73	35	9	0	**533**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	81	78	**390**
Potential Infiltration (I)	28	25	36	23	3	0	0	0	0	0	41	39	195
Potential Direct Surface Water Runoff (R)	28	25	36	23	3	0	0	0	0	0	41	39	195
Potential Infiltration (mm)	0	0	0	152	3	0	0	0	0	0	41	0	195
Pervious Evapotranspiration (m^3)	0	0	0	100	235	322	337	317	229	111	28	0	1,679
Pervious Runoff (m^3)	89	80	114	73	8	0	0	0	0	0	128	122	**614**
Pervious Infiltration (m^3)	0	0	0	478	8	0	0	0	0	0	128	0	**614**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	118	107	151	164	168	160	186	201	193	145	181	163	**1,938**

Evapotranspiration Analysis													
Sub-Area G	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-27	12	0	0	
Storage (S)	50	50	50	50	50	26	13	10	29	63	50	50	
Change in Storage	0	0	0	0	0	-24	-13	-3	19	34	-13	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	100	102	99	73	35	9	0	**524**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	90	78	**399**
Potential Infiltration (I)	37	33	47	30	3	0	0	0	0	0	59	51	260
Potential Direct Surface Water Runoff (R)	20	18	25	16	2	0	0	0	0	0	32	27	140
Potential Infiltration (mm)	0	0	0	197	3	0	0	0	0	0	59	0	260
Pervious Evapotranspiration (m^3)	0	0	0	42	99	132	135	131	97	47	12	0	694
Pervious Runoff (m^3)	26	24	33	22	2	0	0	0	0	0	42	36	**185**
Pervious Infiltration (m^3)	0	0	0	262	5	0	0	0	0	0	78	0	**344**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	50	45	64	69	71	67	78	85	81	61	76	69	**816**

Evapotranspiration Analysis													
Sub-Area H	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-45	-2	0	0	
Storage (S)	100	100	100	100	100	72	51	45	64	98	100	100	
Change in Storage	0	0	0	0	0	-28	-22	-6	19	34	2	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	104	110	102	73	35	9	0	**539**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	75	78	**384**
Potential Infiltration (I)	34	30	43	28	3	0	0	0	0	0	45	47	230
Potential Direct Surface Water Runoff (R)	23	20	29	19	2	0	0	0	0	0	30	31	154
Potential Infiltration (mm)	0	0	0	182	3	0	0	0	0	0	45	0	230
Pervious Evapotranspiration (m^3)	0	0	0	155	365	507	540	499	357	173	44	0	2,640
Pervious Runoff (m^3)	110	100	141	91	11	0	0	0	0	0	147	152	**752**
Pervious Infiltration (m^3)	0	0	0	892	16	0	0	0	0	0	221	0	**1,129**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	49	44	62	68	69	66	76	83	80	60	75	67	**798**

TABLE 3: POST-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENTS 200 and 202 to 208 (LANDS DRAINING WESTWARD TO TORRANCE CREEK SWAMP)

Evapotranspiration Analysis													
Sub-Area I	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-39	4	0	0	
Storage (S)	75	75	75	75	75	49	30	26	45	79	75	75	
Change in Storage	0	0	0	0	0	-26	-18	-5	19	34	-4	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	102	107	101	73	35	9	0	**533**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	81	78	**390**
Potential Infiltration (I)	28	25	36	23	3	0	0	0	0	0	41	39	195
Potential Direct Surface Water Runoff (R)	28	25	36	23	3	0	0	0	0	0	41	39	195
Potential Infiltration (mm)	0	0	0	152	3	0	0	0	0	0	41	0	195
Pervious Evapotranspiration (m^3)	0	0	0	68	161	221	231	217	157	76	19	0	1,150
Pervious Runoff (m^3)	61	55	78	50	6	0	0	0	0	0	88	84	**421**
Pervious Infiltration (m^3)	0	0	0	328	6	0	0	0	0	0	88	0	**421**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	30	27	39	42	43	41	48	52	50	37	47	42	**498**

Evapotranspiration Analysis													
Sub-Area J	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-27	12	0	0	
Storage (S)	50	50	50	50	50	26	13	10	29	63	50	50	
Change in Storage	0	0	0	0	0	-24	-13	-3	19	34	-13	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	100	102	99	73	35	9	0	**524**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	90	78	**399**
Potential Infiltration (I)	37	33	47	30	3	0	0	0	0	0	59	51	260
Potential Direct Surface Water Runoff (R)	20	18	25	16	2	0	0	0	0	0	32	27	140
Potential Infiltration (mm)	0	0	0	197	3	0	0	0	0	0	59	0	260
Pervious Evapotranspiration (m^3)	0	0	0	46	109	146	149	144	106	51	13	0	764
Pervious Runoff (m^3)	29	26	37	24	3	0	0	0	0	0	46	40	**204**
Pervious Infiltration (m^3)	0	0	0	288	5	0	0	0	0	0	86	0	**379**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	21	19	26	29	29	28	32	35	34	25	31	28	**337**

Evapotranspiration Analysis													
Sub-Area K	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-27	12	0	0	
Storage (S)	50	50	50	50	50	26	13	10	29	63	50	50	
Change in Storage	0	0	0	0	0	-24	-13	-3	19	34	-13	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	100	102	99	73	35	9	0	**524**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	90	78	**399**
Potential Infiltration (I)	37	33	47	30	3	0	0	0	0	0	59	51	260
Potential Direct Surface Water Runoff (R)	20	18	25	16	2	0	0	0	0	0	32	27	140
Potential Infiltration (mm)	0	0	0	197	3	0	0	0	0	0	59	0	260
Pervious Evapotranspiration (m^3)	0	0	0	85	200	268	273	265	195	95	24	0	1,405
Pervious Runoff (m^3)	53	48	68	44	5	0	0	0	0	0	85	73	**375**
Pervious Infiltration (m^3)	0	0	0	529	9	0	0	0	0	0	158	0	**697**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	17	15	21	23	24	23	26	29	27	21	26	23	**275**

TABLE 3: POST-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENTS 200 and 202 to 208 (LANDS DRAINING WESTWARD TO TORRANCE CREEK SWAMP)

POST-DEVELOPMENT - WITH NO INFILTRATION AUGMENTATION / MITIGATION MEASURES

PRE-DEVELOPMENT

Catchments 106, 208-1, and 208-2 (Lands Draining to Torrance Creek Swamp) (1) — **Area = 4.52 ha**

Monthly Summary (m^3) (2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Pre-Development Infiltration (INF)	0	0	0	8,007	142	0	0	0	0	0	1,990	0	10,139
Pre-Development Runoff (R)	1,059	954	1,353	959	300	203	236	256	246	185	1,451	1,459	8,660
Pre-Development Evapotranspiration (ET)	0	0	0	1,348	3,166	4,397	4,675	4,324	3,093	1,497	383	0	22,882
Total = INF + R + ET	1,059	954	1,353	10,314	3,607	4,599	4,911	4,580	3,339	1,682	3,824	1,459	41,681

Notes:

[1] Refer to Figure 1 (Attachment 1) for delineation of catchments and sub-areas.

[2] Monthly pre-development volume sum for each of Infiltration, Runoff, and Evapotranspiration from Sub-Areas A, B, C, F, and G as calculated in Table 1 (Attachment 2).

POST-DEVELOPMENT

Catchments 200 and 202 to 208 (Lands Draining Westward to Torrance Creek Swamp) (3) — **Area = 5.86 ha**

Monthly Summary - No Augmentation (m^3) (4)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Post-Development Infiltration (INF)	0	0	0	6,751	119	0	0	0	0	0	1,777	0	8,648
Post-Development Runoff (R)	2,048	1,845	2,619	2,405	1,872	1,710	1,991	2,158	2,072	1,557	3,056	2,822	26,156
Post-Development Evapotranspiration (ET)	0	0	0	1,144	2,688	3,693	3,877	3,634	2,626	1,271	325	0	19,259
Total = INF + R + ET	2,048	1,845	2,619	10,301	4,679	5,403	5,868	5,792	4,698	2,828	5,159	2,822	54,062

Notes:

[3] Refer to Figure 3 (Attachment 1) for delineation of catchments and sub-areas.

[4] Monthly post-development volume sum for each of Infiltration, Runoff, and Evapotranspiration from Sub-Areas A and C to K as calculated in this table (Table 3, Attachment 2).

SUMMARY - WITH NO INFILTRATION AUGMENTATION / MITIGATION MEASURES

Post-Development Infiltration (INF)	8,648	m^3/yr	148	mm/yr	0.3	L/s
Post-Development Runoff (R)	26,156	m^3/yr	446	mm/yr	0.8	L/s
Post-Development Evapotranspiration (ET)	19,259	m^3/yr	329	mm/yr	0.6	L/s
Total = INF + R + ET	54,062	m^3/yr	923	mm/yr	1.7	L/s
Precipitation	54,062	m^3/yr	923	mm/yr	1.7	L/s

Pre-Development Infiltration	10,139	m^3/yr
Infiltration Deficit	**-1,491**	**m^3/yr**
Pre-Development Runoff	8,660	m^3/yr
Runoff Surplus	**17,495**	**m^3/yr**

Sub-Area Descriptions (topography, soils, cover)	
Sub-Area A	Rolling, Silty Sand to Sand Till, Pasture and Shrubs, No Impervious Cover
Sub-Area C	Rolling, Sand, Pasture and Shrubs, No Impervious Cover
Sub-Area D	Rolling, Silty Sand to Sand Till, Urban Lawn, 65% Impervious
Sub-Area E	Rolling, Sand, Urban Lawn, 65% Impervious
Sub-Area F	Rolling, Silty Sand to Sand Till, Urban Lawn, 40% Impervious
Sub-Area G	Rolling, Sand, Urban Lawn, 40% Impervious
Sub-Area H	Rolling, Sand, Pasture and Shrubs, 15% Impervious
Sub-Area I	Rolling, Silty Sand to Sand Till, Urban Lawn, 20% Impervious
Sub-Area J	Rolling, Sand, Urban Lawn, 20% Impervious Cover
Sub-Area K	Rolling, Sand, Urban Lawn, 10% Impervious Cover

TABLE 3: POST-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENTS 200 and 202 to 208 (LANDS DRAINING WESTWARD TO TORRANCE CREEK SWAMP)

POST-DEVELOPMENT - WITH INFILTRATION AUGMENTATION / MITIGATION MEASURES

Infiltration Augmentation Sources (m^3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rooftop Runoff - Singles (m^3) *(Note A)*	168	151	215	233	238	226	263	285	274	206	257	231	**2,747**
Rooftop Runoff - Multiblock (m^3) *(Note B)*	154	139	197	214	219	208	242	262	252	189	236	213	**2,526**
SWMF Recharge (m^3) *(Note C)*	0	0	0	878	685	626	729	790	759	570	1110	0	**6,147**
												Total Stormwater Volume Directed to Post-Development LID Infiltration Facilities =	**11,420**

Notes:
(A) 80% of precipitation captured by single-family rooftops that is directed to lot infiltration galleries (sized for 25 mm precipitation event).
(B) 80% of precipitation captured by multi-residential block rooftops that is directed to centralized infiltration gallery (sized for 25 mm precipitation event).
(C) Remaining impervious area (minus rooftops) runoff directed to SWMF, sized for 25mm event, which is approximately 80% of annual precipitation events (Dec-Mar shut off using Winter By-pass valve to avoid infiltration of chlorides).

POST-DEVELOPMENT

Catchments 200 and 202 to 208 (Lands Draining Westward to Torrance Creek Swamp) **Area = 5.86 ha**

Monthly Summary - With Augmentation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Post-Development Infiltration (INF) (m^3)													
Remaining Pervious Areas	0	0	0	6,751	119	0	0	0	0	0	1,777	0	8,648
Rooftop Runoff from Single-Family Lots	168	151	215	233	238	226	263	285	274	206	257	231	2,747
Rooftop Runoff from Multiblock-Residential Block	154	139	197	214	219	208	242	262	252	189	236	213	2,526
Remaining Impervious Runoff to SWMF	0	0	0	878	685	626	729	790	759	570	1,110	0	6,147
Total =	**322**	**290**	**412**	**8,076**	**1,261**	**1,060**	**1,235**	**1,338**	**1,285**	**965**	**3,380**	**444**	**20,068**
Post-Development Runoff (R) (m^3)													
In Absence of Infiltration Augmentation Sources	2,048	1,845	2,619	2,405	1,872	1,710	1,991	2,158	2,072	1,557	3,056	2,822	26,156
Runoff Captured by Single-Family Rooftops	*168*	*151*	*215*	*233*	*238*	*226*	*263*	*285*	*274*	*206*	*257*	*231*	*2,747*
Runoff Captured by Multiblock-Residential Rooftops	*154*	*139*	*197*	*214*	*219*	*208*	*242*	*262*	*252*	*189*	*236*	*213*	*2,526*
Runoff Captured by Impervious Surfaces to SWMF	*0*	*0*	*0*	*878*	*685*	*626*	*729*	*790*	*759*	*570*	*1,110*	*0*	*6,147*
Total Adjusted Runoff =	**1,726**	**1,555**	**2,207**	**1,080**	**730**	**650**	**757**	**820**	**787**	**592**	**1,453**	**2,378**	**14,735**
Post-Development Evapotranspiration (ET) (m^3)	0	0	0	1,144	2,688	3,693	3,877	3,634	2,626	1,271	325	0	19,259
Total = INF + R + ET	2,048	1,845	2,619	10,301	4,679	5,403	5,868	5,792	4,698	2,828	5,159	2,822	54,062

SUMMARY - WITH INFILTRATION AUGMENTATION / MITIGATION MEASURES

Post-Development Infiltration (INF)	20,068	m^3/yr	342	mm/yr	0.6	L/s
Post-Development Runoff (R)	14,735	m^3/yr	251	mm/yr	0.5	L/s
Post-Development Evapotranspiration (ET)	19,259	m^3/yr	329	mm/yr	0.6	L/s
Total = INF + R + ET	54,062	m^3/yr	923	mm/yr	1.7	L/s
Precipitation	54,062	m^3/yr	923	mm/yr	1.7	L/s

Pre-Development Infiltration	10,139	m^3/yr
Infiltration Surplus	**9,930**	**m^3/yr**
Pre-Development Runoff	8,660	m^3/yr
Runoff Surplus	**6,075**	**m^3/yr**

Notes:

† Infiltration factors after Ontario Ministry of the Environment, 2003. Stormwater Management Planning and Design Manual. March 2003.; and Ontario Ministry of Environment and Energy (MOEE). 1995. MOEE Hydrogeological Technical Information Requirements for Land Development Applications. April 1995.

* PET adjustment factors after Thornthwaite, C.W., and J.R. Mather, 1957. Instructions and Tables for Computing Potential Evapotranspiration and the water balance. Drexel Institute of Technology, Laboratory of Climatology, Publications in Climatology, Volume X, No. 3. Centerton, New Jersey.

‡ Climate Data after Environment Canada, 2021. Canadian Climate Normals 1971-2000, Guelph Arboretum, Climate ID 6143069. [Online] http://climate.weather.gc.ca/climate_normals/index_e.html. Accessed July 2021.

Assumptions:
[1] The monthly average precipitation collected at the Guelph Arboretum climate station is reflective of the precipitation trends that have historically occurred at the Site.
[2] Surplus water is not available for runoff and recharge during months where water losses from actual evapotranspiration exceed precipitation inputs.
[3] Runoff, infiltration and evapotranspiration do not occur in months where the average daily temperature is below 0°C, which is the case for the months of December through March at the Site.
[4] Precipitation during freezing months (i.e., December to March) is assumed to accumulate as snow and result in additional precipitation in the first month thereafter where the average temperature is greater than 0°C (i.e., April).
[5] Soil moisture capacity is at a maximum in April.
[6] Rooftop and EOP infiltration galleries sized for 25mm rainfall event, which corresponds to approximately 80% of annual precipitation.

TABLE 4: POST-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENT 201A/B (LANDS DRAINING EASTWARD TO WOODLOT)

Post-Development

Model Type: Thornthwaite and Mather (1955)
Client: Rockpoint Properties Inc.
Location 220 Arkell Road - Former Catchment 110
Post-Development Catchment 201A/B (Lands Draining Eastward to Woodlot)
Total Site Area (ha) 1.13

Land Description Factors (Sub-area descriptions provided below)	**Sub-Area A**	**Sub-Area C**	Sub-Area D	Sub-Area E	Sub-Area F	Sub-Area G	Sub-Area H	Sub-Area I	Sub-Area J				**Total**
Topography	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.00	0.00				
Soils	0.25	0.40	0.25	0.40	0.25	0.40	0.25	0.00	0.00				
Cover	0.15	0.15	0.05	0.05	0.05	0.05	0.15	0.00	0.00				
Sum (Infiltration Factor)[†]	0.60	0.75	0.50	0.65	0.50	0.65	0.60	0.00	0.00				
Soil Moisture Capacity (mm)	150	100	75	50	75	50	100	0	0				
Site area (ha)	0.86	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00				1.13
Imperviousness Coefficient	0.00	0.00	0.65	0.65	0.40	0.40	0.15	0.00	0.00				
Impervious Area (ha)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				0.00
Percentage of Total Site Area	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%				0.0%
Remaining Pervious Area (ha)	0.86	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00				1.13
Total Pervious Site Area (ha)	0.86	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00				1.13
Percentage of Total Site Area	76.2%	23.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%				100.0%

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Climate Data (Guelph Arboretum Climate Normals, 1971 - 2000)[‡]													
Average Daily Temperature (°C)	-7.6	-6.9	-1.3	5.9	12.3	16.9	19.7	18.6	14.1	7.9	2.4	-4	**6.5**
Precipitation (mm)	56.4	50.8	72.1	78.3	79.9	76	88.5	95.9	92.1	69.2	86.3	77.7	**923**

Potential Evapotranspiration Analysis for Site	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Heat Index	0.0	0.0	0.0	1.3	3.9	6.3	8.0	7.3	4.8	2.0	0.3	0.0	**34**
Unadjusted Potential Evapotranspiration (mm)	0.0	0.0	0.0	28.4	60.7	84.3	98.8	93.1	69.9	38.4	11.2	0.0	**485**
Potential Evapotranspiration Adjusting Factor for Latitude*	0.77	0.87	0.99	1.12	1.23	1.29	1.26	1.16	1.04	0.92	0.81	0.75	
Adjusted Potential Evapotranspiration (PET)(mm)	0	0	0	32	75	108	124	108	73	35	9	0	**564**
Precipitation - PET (mm)	56	51	72	47	5	-32	-36	-12	19	34	77	78	**359**

Evapotranspiration Analysis													
Sub-Area A	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-51	-9	0	0	
Storage (S)	150	150	150	150	150	121	95	88	107	141	150	150	
Change in Storage	0	0	0	0	0	-29	-26	-8	19	34	9	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	105	114	104	73	35	9	0	**546**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	68	78	**377**
Potential Infiltration (I)	34	30	43	28	3	0	0	0	0	0	41	47	226
Potential Direct Surface Water Runoff (R)	23	20	29	19	2	0	0	0	0	0	27	31	151
Potential Infiltration (mm)	0	0	0	182	3	0	0	0	0	0	41	0	226
Pervious Evapotranspiration (m^3)	0	0	0	273	640	903	981	889	626	303	77	0	4,691
Pervious Runoff (m^3)	194	175	248	160	18	0	0	0	0	0	234	267	**1,296**
Pervious Infiltration (m^3)	0	0	0	1565	28	0	0	0	0	0	351	0	**1,943**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**

TABLE 4: POST-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENT 201A/B (LANDS DRAINING EASTWARD TO WOODLOT)

Evapotranspiration Analysis													
Sub-Area C	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-32	-68	-81	-45	-2	0	0	
Storage (S)	100	100	100	100	100	72	51	45	64	98	100	100	
Change in Storage	0	0	0	0	0	-28	-22	-6	19	34	2	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	104	110	102	73	35	9	0	**539**
Recharge/Runoff Analysis													
Water Surplus (mm)	56	51	72	47	5	0	0	0	0	0	75	78	**384**
Potential Infiltration (I)	42	38	54	35	4	0	0	0	0	0	56	58	288
Potential Direct Surface Water Runoff (R)	14	13	18	12	1	0	0	0	0	0	19	19	96
Potential Infiltration (mm)	0	0	0	228	4	0	0	0	0	0	56	0	288
Pervious Evapotranspiration (m^3)	0	0	0	85	200	279	297	274	196	95	24	0	1,450
Pervious Runoff (m^3)	38	34	48	31	4	0	0	0	0	0	51	52	**258**
Pervious Infiltration (m^3)	0	0	0	612	11	0	0	0	0	0	152	0	**775**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	56	51	72	78	80	76	89	96	92	69	86	78	923
Impervious Runoff (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**

Post-Development Catchment 201A/B (Lands Draining Eastward to Woodlot)

Post-Development Infiltration (INF)	2,718	m^3/yr	241	mm/yr	0.1	L/s
Post-Development Runoff (R)	1,554	m^3/yr	138	mm/yr	0.0	L/s
Post-Development Evapotranspiration (ET)	6,141	m^3/yr	544	mm/yr	0.2	L/s
Total = INF + R + ET	10,413	m^3/yr	923	mm/yr	0.3	L/s
Precipitation	10,413	m^3/yr	923	mm/yr	0.3	L/s

Pre-Development Infiltration	5,294	m^3/yr
Infiltration Deficit	**-2,576**	**m^3/yr**
Pre-Development Runoff	4,035	m^3/yr
Runoff Deficit	**-2,481**	**m^3/yr**

Sub-Area Descriptions (topography, soils, cover)	
Sub-Area A	Rolling, Silty Sand to Sand Till, Pasture and Shrubs, No Impervious Cover
Sub-Area C	Rolling, Sand, Pasture and Shrubs, No Impervious Cover

Notes:

† Infiltration factors after Ontario Ministry of the Environment, 2003. Stormwater Management Planning and Design Manual. March 2003.; and Ontario Ministry of Environment and Energy (MOEE). 1995. MOEE Hydrogeological Technical Information Requirements for Land Development Applications. April 1995.

* PET adjustment factors after Thornthwaite, C.W., and J.R. Mather, 1957. Instructions and Tables for Computing Potential Evapotranspiration and the water balance. Drexel Institute of Technology, Laboratory of Climatology, Publications in Climatology, Volume X, No. 3. Centerton, New Jersey.

‡ Climate Data after Environment Canada, 2021. Canadian Climate Normals 1971-2000, Guelph Arboretum, Climate ID 6143069. [Online] http://climate.weather.gc.ca/climate_normals/index_e.html. Accessed August 2022.

Assumptions:

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[5] Soil moisture capacity is at a maximum in April.