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[THE DIFFERENCE IS OUR PEOPLE]

April 27, 2015

Via: Email

Ms. Lori Riviere-Doersam, Principal Planner (Acting)
Planning & Economic Development
Regional Municipality of Durham
605 Rossland Road East
Whitby ON L1N 6A3

Dear Ms. Riviere-Doersom:

Re: QSRP Developments Inc.
Proposed Residential Subdivision
309 Zephyr Road, Township of Uxbridge
Response to Peer Review
Project No.: 300034602.0000

A plan of subdivision consisting of seven lots on 2.96 hectares has been proposed for Part Lot 25, Concession 3, Uxbridge Township. The proposed lots are to be serviced by individual drilled wells and individual onsite sewage disposal systems. Grace & Associates Inc. prepared a report entitled "Hydrogeological Assessment and Private Servicing Report" dated August 7, 2012.

Genivar (now WSP) was retained by the Region of Durham to review the report, and subsequently additional information was supplied by Grace & Associates in a technical report entitled "Hydrogeological Assessment Response to Peer Review Comments" dated August 19, 2013. WSP reviewed the August 19, 2013 report and indicated that several of the items raised in the initial peer review had been addressed. However, there were nine outstanding items. R.J. Burnside is now assisting with this project and we have grouped the items into four points:

1. Nitrate attenuation for the on-site septic systems;
2. Impermeable surfaces and pre and post-development water balance;
3. Water demand and other water requirements; and
4. Water quality and treatability for the water supply wells.

This letter addresses the first three items. Addressing the water quality and treatability will require disinfecting and pumping the onsite wells before collecting additional water samples. It was felt that this cost could be deferred until the other items were resolved. Nitrate dilution in particular is the main controlling issue in determining if the development is viable.

1.0 Nitrate Attenuation

The guidance documents used for residential subdivisions or severances to be serviced with onsite sewage systems are the:

- Ontario Ministry of the Environment Procedure D-5-4, Technical Guideline for Individual On-Site Sewage Systems: Water Quality Impact Risk Assessment, and the
- Ontario Building Code Part 8 Sewage Systems.

Procedure D-5-4 prevents nitrate contamination of an aquifer by controlling the overall density of small onsite sewage systems in an area. The potential impact of individual residential systems on individual wells and surface water features is controlled by the OBC separation distances.

The Procedure D-5-4 assessment normally involves three steps:

1. Lot size,
2. System isolation, and
3. Contaminant dilution.

Previous work by Grace & Associates examined the three steps and showed that:

1. the lots in the proposed subdivision do not meet the lot sizing criteria (average of 1 ha),
2. there is a shallow aquifer in the area and the sewage systems would not be hydraulically isolated from the aquifer, therefore,
3. nitrates from the systems must be diluted.

Procedure D-5-4 recognizes that the sewage effluent introduced into the water table is attenuated as a result of several processes, including dilution by infiltration, dilution by groundwater flow, denitrification, and biodegradation. However, the consideration of only infiltration for contamination dilution by D-5-4 is a conservative predictive approach that provides a margin of safety.

Procedure D-5-4 also establishes input parameters. The nitrate concentration of domestic sewage effluent is set at 40 mg/L and the effluent volume at 1,000 L/day per lot. The objective of the predictive model is to reduce the nitrate concentration from 40 mg/L to 10 mg/L or less by precipitation infiltration. The volume of infiltrating precipitation is a site specific estimation based on the water balance and the runoff factors of the site.

A dilution calculation was completed in previous hydrogeology reports, however a pre and post-development water balance was not provided to support the infiltration value used. This water balance is calculated below in Section 2.0. The pre-development average infiltration rate is estimated at 200 mm per year. The stormwater management report recommended that post-development infiltration be increased by directing all roof drains to infiltration trenches. Post-development infiltration will match pre-development infiltration by infiltrating 50% of the roof drainage.

Using the inputs outlined above, the dilution for the seven lots is as follows:

C = QeCe / (Qe + Qp)

Where:

C = concentration of nitrate after dilution

Qe = volume of effluent from the leaching beds = 7,000 L/day

Ce = nitrate concentration in the sewage effluent = 40 mg/L

Qp = volume of precipitation infiltration = 200 mm/year over 2.96 ha

C = 12 mg/L

The predicted nitrate concentration exceeds the objective limit of 10 mg/L. The previous reports by Grace & Associates also predicted nitrate concentrations above the criteria, and subsequently proposed increasing the dilution area to the east and south of the subdivision. The proposed subdivision is currently part of a larger property that includes a golf course and a wetland area (see Figure 1 attached).

However, to include this additional area in the overall density/dilution calculations, there must be a mechanism for ensuring that this additional dilution area is not developed in the future. Other similar developments have included dilution from areas that would eventually come under the control of a municipal government (i.e., stormwater management features or parkland). This is not the case at this property, as the golf course will be a separate property once the residential lots are sold to individual owners. The contamination attenuation zone (CAZ) concept utilized for Reasonable Use is also not available; again because each lot will have an independent owner.

Legal consultation suggests that a mechanism can be placed on a portion of the existing golf course/wetland property that will exclude future development. The excluded future development would be sewage systems that require onsite disposal.

The previous report noted that shallow groundwater flow was predominantly in an easterly to northeasterly direction. This coincides with the overall ground topography and surface drainage (see Figure 1). The proposed development is on the northeast side of an elevational high with the ground sloping down to the north and east. Drainage will also be primarily toward the wetland as a likely local groundwater discharge feature. An additional drainage area is outlined on Figure 1, from the eastern boundary of the subdivision to the low point in the wetland. No development will occur in this area. This additional area covers 6.91 ha and including it in the dilution calculation results in a nitrate concentration of 4.6 mg/L. This is well below the 10 mg/L criteria. Even if the additional area only included the portion of the golf course west of the linear water feature visible on Figure 1, a nitrate concentration of 8.2 mg/L would still be achieved.

As noted above, the nitrate calculation does not take into account other forms of attenuation. The presence of vegetation, in particular deeper rooted shrubs and trees in the natural areas will provide additional attenuation. If development is controlled on the golf course east of the subdivision, there will be more than sufficient nitrate attenuation for the subdivision.

2.0 Impermeable Surfaces and Water Balance

Other outstanding items from the peer review comments included an assessment of impermeable surfaces under post-development conditions and a site specific water balance. The dilution of nitrogen, as calculated above, depends on the water balance to determine the moisture available for infiltration.

Infiltration depends on a number of factors including precipitation, temperature, topography, soil type and vegetation cover. Table 1, attached, calculates the potential evapotranspiration based on precipitation, latitude and temperature, and then calculates the actual evapotranspiration and water surplus based on the monthly precipitation and soil moisture conditions. The water balance uses monthly soil moisture balance calculations to determine the pre-development infiltration (based on existing land use). A soil moisture balance approach assumes that soils do not release water as potential recharge while a soil moisture deficit exists. During wetter periods, excess of precipitation over evapotranspiration first goes to restore soil moisture. Once the soil moisture deficit is overcome, any further excess water can then pass through the soil as infiltration.

The water balance can be estimated from the following equation:

$$P = S + ET + I + R$$

Where:

P = precipitation

S = change in groundwater storage

ET = evapotranspiration/evaporation

I = infiltration

R = surface water runoff

Precipitation (P): The thirty year climate normals for annual precipitation and average temperature were provided by the Environment Canada Udora Station (Station 6119055, 44°15'45.00" N, 79°09'41.004" W, elevation 262.0 masl). The average precipitation for the period between 1981 and 2010 was 886 mm per year.

Storage (S): Although there are groundwater storage gains and losses on a short term basis, the net change in groundwater storage on a long term basis is assumed to be zero so this term is dropped from the equation.

Evapotranspiration (ET): Evapotranspiration and evaporation vary based on the characteristics of the land cover (i.e., type of vegetation, soil moisture conditions, perviousness of surfaces, etc.). Potential evapotranspiration (PET) refers to the water loss from a vegetated surface to the atmosphere under conditions of an unlimited water supply. The actual rate of evapotranspiration (AET) is generally less than the PET under dry conditions (i.e., during the summer when there is a soil moisture deficit). A soil moisture storage capacity of 75 mm was used for the study area based on shallow rooted vegetation in the fields and grassed areas, and a fine sandy loam soil. The borehole logs in the 2012 Hydrogeological Assessment reported silty sand and silty sand till soils at surface. The AET was calculated to be 547 mm/year.

Water Surplus (I + R): The difference between the mean annual P and the mean annual AET is the water surplus (338 mm/year). Part of the water surplus infiltrates into the soil (I). The remainder of the water surplus travels across the ground surface to storm drainage features as runoff (R). The MOE SWM Planning and Design Manual (2003) methodology for calculating the infiltration portion of the water surplus uses topography, soil type and land cover. An infiltration factor of 0.65 for the study site was estimated based on rolling to hilly topography, silty sand soil and grassed/open space vegetation.

Table 1: Water Balance

Soil Type	Average Precipitation	Actual Evapotranspiration	Water Surplus	Total Infiltration	Direct Runoff
Silty Sand Till	886	547	338	220	118

All values in mm/year

Pre-Development Water Budget (Existing Conditions)

The total area of the property is 29,585 m^2, as summarized in Table 2, attached. The existing land use is primarily agricultural land, but also includes some impermeable surface as farm buildings and a gravel driveway that have a combined area of 2,713 m^2. The infiltration over the agricultural land was calculated through the water balance to be 220 mm/year. It is assumed that the infiltration over the impermeable surface area is nil. Therefore, the total annual infiltration across the site is estimated to be 5,912 m^3/year. The infiltration is likely higher as the ratio of impermeable to permeable surfaces is small. It is expected that much of the runoff from the buildings and the driveway ends up in the adjacent field or open area.

Post-Development Water Budget

The development will create additional impervious surfaces such as an asphalt access road, driveways and house roof tops. Impervious surfaces prevent infiltration, but also reduce evapotranspiration because of the removal of the vegetation. Evaporation from impervious surfaces is relatively minor (estimated to be 10% to 20% of precipitation) compared to the evapotranspiration that occurs with vegetation (62% of precipitation at this site). The net effect of development is that most of the precipitation that falls onto impervious surfaces becomes surplus water and runoff.

Water surplus calculations for impervious areas are shown at the bottom of Table 1. The evaporation from impervious surfaces is estimated to be 15% of precipitation. The remaining 85% of the precipitation on impervious surfaces is assumed to be runoff. Therefore, water surplus/runoff from impervious areas is calculated to be 753 mm/year.

The increases in surface water runoff that will occur with urban development are typically addressed through the use of stormwater management techniques and best management practices to reduce the runoff volumes. Based on the proposed land use, the total post-development recharge across the property, with no mitigation, is estimated to be about 5,345 m^3/year (Table 2). This would be a decrease in the post-development recharge of about 10%.

In order to minimize the impacts of development on the water budget, the use of low impact development (LID) measures for stormwater management are recommended. LID measures are aimed at ensuring that the post-development groundwater recharge volume is maintained as close to the pre-development recharge volume as possible. Based on the water budget calculations presented above, the difference between the pre and post-development recharge volumes is estimated to be 567 m^3/year. The Stormwater Management Report (Grace & Associates Inc. August 12, 2013) recommended that all roof drains should be directed to infiltration trenches. Infiltrating 50% of the roof drain runoff will bring pre and post-development recharge within 1% (see Table 2) and result in an average infiltration rate over the site of 200 mm/year. This is the infiltration rate used in the nitrate dilution calculations.

3.0 Water Demand and Other Water Requirements

The daily water demand was calculated by Grace & Associates to be 1,800 L/day with a peak flow rate of 15 L/min. This was noted by the reviewer to be incorrect. Durham Region's *Drilled Wells and Lot Sizing Policies* references the MOE Procedure D-5-5 to establish a sufficient quantity of drinking water. Procedure D-5-5 sets the minimum well yield and pumping rate as follows:

> *The per-person requirement shall be 450 litres per day. Peak demand occurs for a period of 120 minutes each day. This is equivalent to a peak demand rate of 3.75 litres/minute for each person. The basic minimum pumping test rate is this rate multiplied by the "likely number of persons per well" which, for a single family residence, shall be the number of bedrooms plus one. Unless it is otherwise established to MOEE's satisfaction, a minimum of four bedrooms shall be used in the calculation. However, regardless of the results of this calculation, this rate shall not be less than 13.7 litres/minute.*

Therefore, wells for the proposed subdivision must be able to supply 2,250 L/day (450 L x 5 occupants) and meet a peak pumping rate of 18.75 L/min (3.75 L/min x 5 occupants). For a development of less than 15 ha, three wells must be tested. Each well must be pumped for a minimum of six hours to incorporate safety factors with respect to seasonal variables.

According to the previous hydrogeological reports, even though the demand was not calculated correctly, the testing was carried out according to the D-5-5 criteria. Three wells were drilled on the proposed subdivision site and six hour pumping tests were conducted. The reported results, compared to the correctly calculated criteria, were as follows:

Well	MOE D-5-5 Criteria	Test Results		
		TW1	TW2	TW3
Daily Yield (L/day)	2,250	10,800	10,800	13,370
Peak Rate (L/min)	18.75	30.2	30.0	37.2

Each of the wells tested surpassed the D-5-5 requirements. The reports also concluded that there was minimal mutual interference between the test wells at the test rates. The calculated water demand in the report did not affect the assessment of the water supply since the test rates exceeded the D-5-5 criteria. The testing indicates there is a sufficient quantity to meet residential water use.

The reviewer also noted that irrigation systems and geothermal heat pumps were not addressed as potential additional water uses. Neither the Region's *Drilled Wells and Lot Sizing Policies* nor Procedure D-5-5 contain a requirement for including an assessment of potential irrigation systems.

Procedure D-5-5 does state that if groundwater open loop heat pumps are being considered, they must be included in the hydrogeological study. The procedure also states that groundwater heat pumps that do not return water to the aquifer of origin are not permitted. Given today's geothermal technology, it is highly unlikely that open loop heat pumps, which pump water from the aquifer and recharge the water back to the aquifer, would be installed. This type of heat pump will not be allowed for the subdivision. Use of closed loop geothermal systems that do not remove water from the aquifer would still be allowed if constructed according to current regulations.

4.0 Water Quality and Treatability for the Water Supply Wells

The remaining review points dealt with the issues of water quality in the three onsite test wells. Water samples from the test wells indicated the presence of total coliforms and elevated iron, manganese, hardness and colour. It will be necessary to chlorinate the wells, then pump them and retest. It is likely that the total coliform was introduced by either the drilling or pumping equipment and should be eliminated by chlorination. Elevated iron, manganese, hardness and colour are aesthetic parameters and can be treated by readily available equipment if the homeowner wishes. As noted above, the retesting will be completed once the other outstanding issues discussed above have been resolved.

We trust that the information provide above is satisfactory to the reviewing agency.

Yours truly,

R.J. Burnside & Associates Limited

PROFESSIONAL GEOSCIENTIST
Apr 27 2015
N. J. RUTHERFORD
PRACTISING MEMBER
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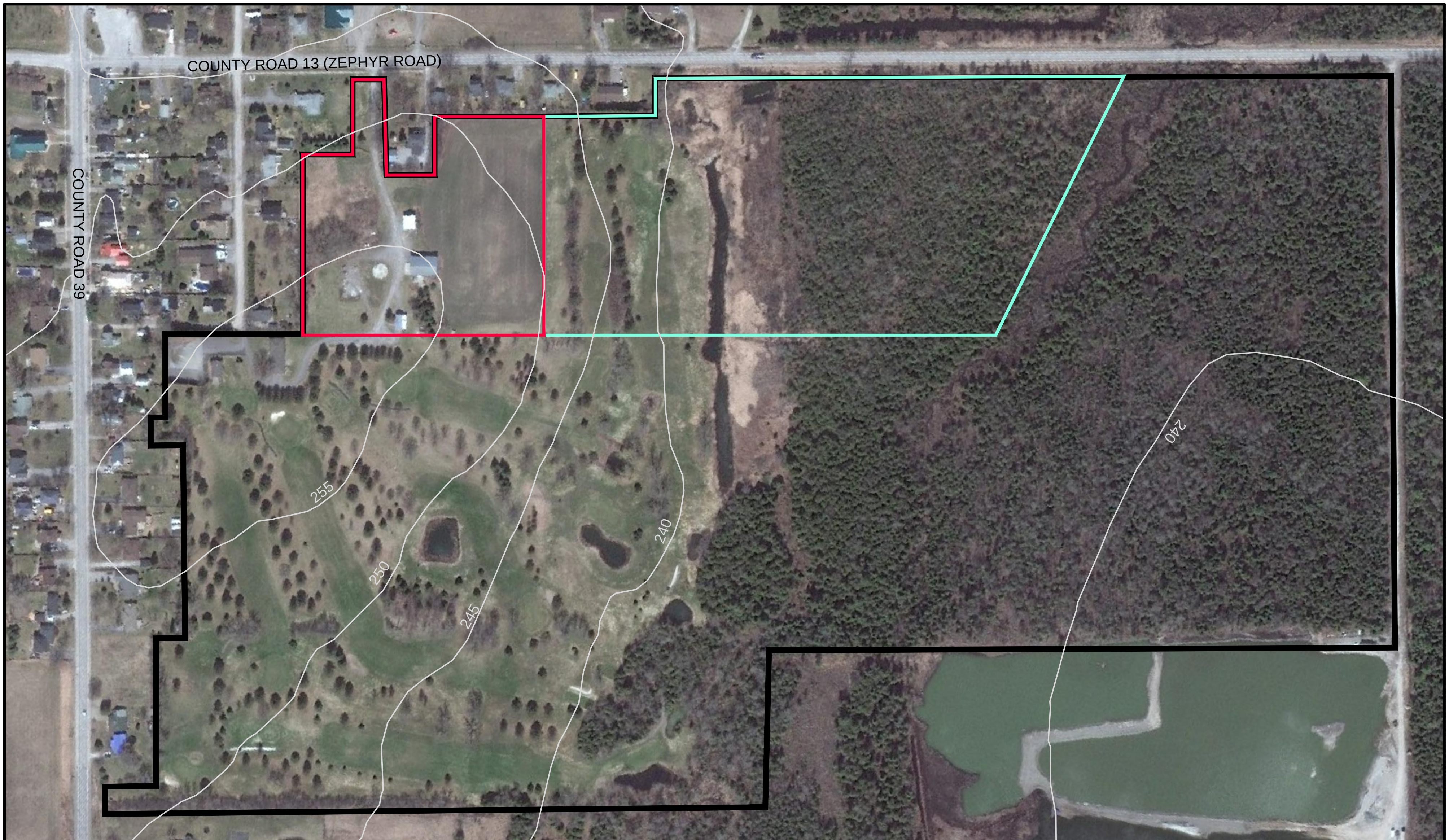
ONTARIO

Joy Rutherford, P.Geo.
Senior Hydrogeologist
JR:js

Enclosure(s) Figure 1 – Dilution Area
Table 1 – Monthly Water Balance
Table 2 – Pre and Post-Development Water Budget

cc: Mark Strangways, QSRP Developments Inc. (enc.) (Via: Email)
Caitlin Robinson, EcoVue Consulting Services Inc. (enc.) (Via: Email)



LEGEND

CURRENT EXTENT OF PROPERTY

PROPOSED SUBDIVSION

ADDITIONAL DILUTION AREA

CONTOUR (5m intervals - masl)

N

0 40 80 160 240

Metres

Client / Report

QRSP DEVELOPMENTS INC.
PROPOSED RESIDENTAL SUBDIVISION
309 ZEPHYR ROAD,
TOWNSHIP OF UXBRIDGE

BURNSIDE

Figure Title

DILUTION AREA

Drawn	Checked	Date	Figure No.
S. K.	J.R.	April 2015	1
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Table 1

QSRP Developments Inc.

Zephyr, Ontario

Monthly Water Balance (Thornthwaite-Mather)

Climate data from Environment Canada - UDORA (1981 - 2010)

Potential Evapotranspiration Calculation		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Average Temperature (Degree C)	T	-7.0	-6.6	-1.3	5.7	12.2	18.0	19.9	19.3	15.1	8.6	2.4	-4.0	6.9
Heat index: $i = (T/5)^{1.514}$	I	0.00	0.00	0.00	1.22	3.86	6.95	8.10	7.73	5.33	2.27	0.33	0.00	**35.79**
Coefficient a ($a=0.49 + 0.0179\ I - 0.0000771\ I^2 + 0.000000675\ I^3$)	a													**1.06**
Adjusting Factor for Latitude (44^o 15' N)	d	0.81	0.82	1.02	1.12	1.26	1.28	1.29	1.20	1.04	0.95	0.81	0.77	
Adjusted Potential Evapotranspiration PET (mm) $PET = 16d(10T / I)^a$	PET	0	0	0	29	74	114	128	115	77	39	8	0	**584**

75	Based on Soil Moisture Retention of 75 mm (shallow rooted crops / fine sandy loam)												
All units in mm	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Precipitation (P)	64.9	45.9	53.1	67.9	82.1	106.6	86.4	73.9	87.3	74.9	83.2	60.0	**886**
Potential Evapotranspiration (PET)	0	0	0	29	74	114	128	115	77	39	8	0	**584**
P - PET	65	46	53	39	8	-7	-41	-41	10	36	75	60	**302**
Accumulated Potential Water Loss						-7	-49	-90					
Soil Moisture Storage (Soil Moisture Retention Tables)	75	75	75	75	**75**	68	38	22	32	68	75	75	
Change in Soil Moisture Storage	0	0	0	0	0	-7	-30	-16	10	36	7	0	**0**
Actual Evapotranspiration (AET)	0	0	0	29	74	114	116	90	77	39	8	0	**547**
Moisture Deficit	0	0	0	0	0	0	11	25	0	0	0	0	**37**
Moisture Surplus (P-PET - Chng in S M Storage)	65	46	53	39	8	0	0	0	0	0	68	60	**338**
Potential Infiltration (mm) (based on MOE metholodogy*; independent of temperature)	42.2	29.8	34.5	25.0	5.1	0.0	0.0	0.0	0.0	0.2	44.0	39.0	**220**
Potential Surface Water Runoff (mm) (independent of temperature)	22.7	16.1	18.6	13.5	2.8	0.0	0.0	0.0	0.0	0.1	23.7	21.0	**118**

POST-DEVELOPMENT WATER BALANCE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Precipitation (P)	64.9	45.9	53.1	67.9	82.1	106.6	86.4	73.9	87.3	74.9	83.2	60.0	**886**
Potential Evaporation (PE) from impervious areas (assume 15%)	9.7	6.9	8.0	10.2	12.3	16.0	13.0	11.1	13.1	11.2	12.5	9.0	**133**
P-PE (surplus available for runoff from impervious areas)	55	39	45	58	70	91	73	63	74	64	71	51	**753**
Water surplus change compared to pre-condition (for areas that change from vegetated open areas to impervious areas)	-10	-7	-8	19	62	91	73	63	74	63	3	-9	**415**

*MOE Storm Water Management Planning and Design Manual, 2003.

topography - rolling to hilly	0.15
soils - silty sand	0.35
cover - grassed / open space	0.15
Infiltration factor	**0.65**

Table 2

QSRP Developments Inc.
Zephyr, Ontario

Pre and Post-Development Water Budget

Land Use Description		Approximate Area [1] (m^2)	Runoff		Infiltration			Mitigation - 50% Roof to Infiltration: Runoff		Infiltration	
			Runoff Rate (m/year)	Runoff Volume (m^3/year)	Infiltration Rate (m/year)	Infiltration Volume (m^3/year)		Runoff Rate (m/year)	Runoff Volume (m^3/year)	Infiltration Rate (m/year)	Infiltration Volume (m^3/year)
Pre Development											
	Grass/ agricultural field	26,872.2	0.118	3,171	0.220	5,912					
	Buildings/ gravel/ asphalt/ concrete	2,712.8	0.753	2,043	0	0					
	Total	**29,585**		**5,214**		**5,912**					
Post Development											
	Landscaped/ grass	24,297	0.118	2,867	0.220	5,345		0.118	2,867	0.220	5,345
	Asphalt	3,888	0.753	2,928	0	0		0.753	2,928	0	0
	Buildings (residential)	1,400	0.753	1,054	0	0		0.377	527	0.377	527
	Total	**29,585**		**6,849**		**5,345**			**6,322**		**5,872**
Change Pre to Post											
	Volume			1,635		-567			1,108		-39
	Percent			31%		-10%			21%		-1%

(1) Grace & Associates Inc., Stormwater Management Report, August 12, 2013