June 15, 2020 Reference No. 11203549-01

George Georgiou

c/o Pat Schick, A.Sc.T.
Jewell Engineering Inc.
Belleville, Ontario
K8N 4Z5

Re: Addendum Letter – Assessment of Phosphorus Loading
Proposed Residential Development – 5 Lots
Part of Lots 47, 49 & 64 (Rossmore)
Part of Lot 60, Concession 1 (Elm Island)
Township of Ameliasburgh,
Municipality of the County of Prince Edward, Ontario

Dear Mr. Georgiou and Mr. Schick

GHD Limited (GHD) is pleased to provide you (the Client) with the following addendum letter to be read in conjunction with our hydrogeological assessment report for the above noted property (the Site). GHD understands that the Quinte Conservation Authority (QCA) has recommended an assessment of phosphorus on water quality within the Bay of Quinte. Our review of the Bay of Quinte Remedial Action Plan (BQRAP) outlines the issues with phosphorus loading and best management practices to reduce phosphorus loading. The purpose of this addendum letter is to show that the development of five (5) residential lots will have a negligible effect on the adjacent Bay of Quinte. The Site has a total area of about 4.5 ha (10.8 acres) that breaks down into the following: Lot 1 consists of 0.37 ha; Lot 2 consists of 0.37 ha; Lot 3 consists of 2.52 ha; Lot 4 consists of 0.35 ha; and Lot 5 consists of 0.41 ha. The majority of Lot 3 is wetland area. There is also 0.54 ha of parkland. The development will be serviced by municipal water and septic tile beds. All lots have a minimum 15 m setback from the flood line and 30 m setback from the wetland.

The principal anthropogenic source of phosphorus associated with the proposed development is the sewage works. Adherence to minimum setback distances between septic systems and any watercourse (i.e. minimum setback of 15 m plus 2 times the height of a raised tile bed) should preserve the chemical and bacteriological quality of the local surface water.

Studies have indicated (Canter and Knox, 1985) that for surface disposal of sewage effluent, significant chemical and biological activity takes place in the upper 0.3 m soil zone and that up to 2.25 kilograms of phosphorus can be fixed per square metre of soil by adsorption and exchange reactions with aluminum and iron-containing compounds. Conventional leach fields with clear sand or soil (no fines or iron-rich material) can expect to remove 15 – 30% of total phosphorus from septic tank effluent. In general, the finer the soil is, the higher the removal. Soils will remove nutrient constituents adequately from watersheds when sewage does not break out to surface (Jowett *et al.*, 2015).

GHD
347 Pido Road Unit 29 Peterborough Ontario K9J 6X7 Canada
T 705 749 3317 **F** 705 749 9248 **W** www.ghd.com

Zarnett, 1976, carried out experiments to determine the sorption characteristics of phosphorous by soils developing a model that estimated of the rate of movement of phosphorous to be 29 to 88 years to move 15 m. These studies suggest that there will be no significant impact to local water bodies because of the disposal of sewage on the phosphorous content in surface water near the site.

To further assess this issue regarding phosphorus, a phosphorus loading calculation was completed for the Site comparing pre-development contributions of phosphorus and post-development contributions of phosphorus. Based upon the literature reviewed, daily average phosphorus point loadings into the Bay of Quinte have decreased from about 214 kilograms of Phosphorus (P) per day (kg P/day) between 1968 and 1972 to 60 to 68 kg P/day between 1978 and 1986 and seldom exceed 25 kg P/day since 2000 (Kim *et al.*, 2016). Minns *et al.* (2004) indicate that total point loadings were 8.3 kg P / day and total river loadings were 529.2 kg P /day on an annual basis. Using these values, GHD computed the pre- and post-development phosphorus loading into the Bay of Quinte.

The calculations estimate the phosphorus loading to the Bay of Quinte based on the MOE Lakeshore Capacity Model V3. Calculations of the pre- and post-development site using the model and comparing the results to the total Bay of Quinte phosphorus mass export per year yielded the following results:

- Pre-Development phosphorus loading (physical loading + septic effluent loading) = 0.45 kg / year (0.00045 tonnes / year)
- Post-Development phosphorus loading (physical loading + septic effluent loading)= 11.02 kg / year (0.011 tonnes / year)
- Bay of Quinte phosphorus mass rate: 0.011 tonnes / sq. km (Minns *et al*, 2004)

The detailed calculations are provided in Appendix A. The calculations do not include the reduction of phosphorus that will occur within the tile bed material which is expected to be at least 15 to 30%. GHD recommends the use of iron-rich sand for the construction of the sewage disposal systems to remove phosphorus from the septic effluent and further reduce loading into the Bay of Quinte. Based upon the calculations without any reduction, the development of 5 lots increases the potential phosphorus mass by about 25 times the pre-development phosphorus mass.

The pre-development Site contributes about 0.0002% of the phosphorus mass exported via the Bay of Quinte per year. The calculated post-development Site is estimated to contribute about 0.0056% of the phosphorus mass exported via the Bay of Quinte per year. It is GHD's opinion that this is a negligible amount of mass being introduced into the system and phosphorus from this proposed development is not a significant issue.

It is recommended that post-development phosphorus management techniques be applied where possible and home owners should be educated about best practices for the management of phosphorus. The best management practices of the BQRAP should be considered such as the use of phosphorus-free fertilizers and don't over fertilize; the naturalization of areas that are not lawn areas that promote vegetation requiring little or no fertilizer (these include the mandatory 15 to 30 m buffers that will be established for

this development); planting of trees and shrubs; use phosphate free soaps, detergents and cleaners; the inspection and maintenance of grassed swales and ditches to ensure their proper function; pick up after your pets; and the monitoring of runoff water quality as part of the stormwater management program.

With the use of iron-rich sand for the construction of the sewage disposal systems, phosphorus loading into the Bay of Quinte due to septic effluent is further reduced. Improperly constructed septic disposal systems are prone to effluent breakouts that can have runoff quickly flow to adjacent water bodies. Inspection of the tile beds during construction and during the operational phase; and the future maintenance of the systems is critical to minimize phosphorus impacts.

It is our professional opinion that based upon the literature reviewed, the calculations completed and consideration of best management practices, that there will be minimal phosphorus loading and no significant impact of phosphorus content to the Bay of Quinte due to the disposal of sewage from the development of the five (5) homes.

We trust that this response meets with your immediate requirements. Should you have any additional questions, please contact our office.

Sincerely,

GHD

Robert Neck, M.Eng., P.Geo. (Limited)

Nyle McIlveen, P. Eng.
/BN/nmc/01
Appendix A: Phosphorus Loading Calculations

Appendix A
Phosphorus Loading Calculations

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Development area in hectares (ha): 4.5434 ha

PHOSPHORUS LOADING CALCULATIONS - PHYSICAL ENVIRONMENT

PRE-DEVELOPMENT	Area		P Export Coefficients		Total P	
Forested Areas	20900	m2	11	mg/m2/yr	229900	mg/yr
Woodland / scrub	2925	m2	26	mg/m2/yr	76050	mg/yr
Wetlands	21609	m2	6.5	mg/m2/yr	140455.9	mg/yr
Total	45434				446405.9	mg/yr
					0.45	kg/yr

POST-DEVELOPMENT	Area		P Export Coefficients		Total P	
Forested Areas	7030	m2	11	mg/m2/yr	77330	mg/yr
Wetlands	21609	m2	6.5	mg/m2/yr	140455.9	mg/yr
Woodland / scrub	8696	m2	26	mg/m2/yr	226096	mg/yr
Green Urban (lawns)	6120	m2	83	mg/m2/yr	507918.5	mg/yr
Access road	380	m2	350	mg/m2/yr	133000	mg/yr
Low density urban (house, driveway etc)	1601	m2	50	mg/m2/yr	80025	mg/yr
	45435				1164825.40	mg/yr
					1.16	kg/yr

ΔP (post - vs pre-) = 0.718 kg/yr

Phosphorus loading has been reduced compared to pre-development based upon physical environment considerations only.

Wastewater Phosphorus Export - Waterfront Development of all lots on Bay of Quinte

PHOSPHORUS LOADING CALCULATIONS - SEPTIC EFFLUENT (pre-development)
Based upon MOE Lakeshore Capacity Model V3

SHORELINE RESIDENTS (i.e. Bay of Quinte)

Permanent residential units = 2.56 capita
Extended seasonal residential units = 1.27 capita
Seasonal residential units = 0.69 capita
Trailer park units = 0.69 capita

For this model, we know the number of bedrooms (pre- and post-) and can use this value rather than the per capita method outlined above.

MOE's Lakeshore Capacity Model assumes:

Anthropogenic phosphorus loading = 9 mg/L (assumed in model)
Daily water usage of = 200 L/capita/day (assumed in model)
Number of bedrooms = 0 capita (bedrooms assumed to be "units")

Average daily phosphorus loading rate (without treatment) = 0 units * 9 mg/L * 200 L/capita/day
Average daily phosphorus loading rate (without treatment) = 0 mg/day
Average annual phosphorus loading rate (without treatment) = 0.0 kg/year

PHOSPHORUS LOADING CALCULATIONS - SEPTIC EFFLUENT (post-development)

SHORELINE RESIDENTS (i.e. Bay of Quinte)

Permanent residential units = 2.56 capita
Extended seasonal residential units = 1.27 capita
Seasonal residential units = 0.69 capita
Trailer park units = 0.69 capita

MOE's Lakeshore Capacity Model assumes:

Anthropogenic phosphorus loading = 9 mg/L (assumed in model)
Daily water usage of = 200 L/capita/day (assumed in model)
5 lots @ 3 bedrooms per house = 15 capita (bedrooms assumed to be "units")

Average daily phosphorus loading rate (without treatment) = 15 units * 9 mg/L * 200 L/capita/day
Average daily phosphorus loading rate (without treatment) = 27000 mg/day
Average annual phosphorus loading rate (without treatment) = 9.86 kg/year

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PHOSPHORUS LOADING CALCULATIONS - TOTAL

Pre-development phosphorus loading without treatment = 0.45 kg/year (physical loading + septic effluent loading)

Post-development phosphorus loading without treatment = 11.02 kg/year (physical loading + septic effluent loading)

ΔP (post - vs pre-) = 10.57 kg/yr

Phosphorus loading has increased 10.57 kg/yr compared to pre-development.

PHOSPHORUS LOADING TO LAKE ONTARIO via Bay of Quinte

Tonnes of Phosphorus Exported via the Bay of Quinte (pre-development)

Total River and Point Source Loading = 196 tonnes / year (Minns et al, 2004)
Bay of Quinte mass rate / km is = 0.011 tonnes/sq. km
(based upon 196 tonnes and subwatershed area of 18,000 km^2 for the Bay of Quinte watershed region)
0.45 kg/year pre-development phosphorus loading
0.00045 tonne/year pre-development phosphorus loading
Therefore, the pre-development Site comprises
0.0002% of the P mass to the Bay of Quinte

Tonnes of Phosphorus Exported via the Bay of Quinte (post-development)

Total River and Point Source Loading = 196 tonnes / year (Minns et al, 2004)
Bay of Quinte mass rate / km is = 0.011 tonnes/sq. km
(based upon 196 tonnes and subwatershed area of 18,000 km2 for the Bay of Quinte watershed region)
11.02 kg/year post-development phosphorus loading
0.01102 tonne/year post-development phosphorus loading
Therefore, the post-development Site comprises
0.0056% of the P mass to the Bay of Quinte

Thus, the Site is a very small contributor of phosphorus to the Bay of Quinte compared with point source and the watershed region
The mass of phosphorus to the Bay of Quinte from the Site is negligible compared to the total mass exported via the Bay of Quinte to Lake Ontario