GRCA Hydrogeology Comment Response
Proposed Residential subdivision
3852 Ganaraska Road
Campbellcroft, Ontario

Prepared for:

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Submitted by:

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GRCA Hydrogeology Comment Response
Proposed Residential Subdivision
3852 Ganaraska Road
Campbellcroft, Ontario

Dear Jeff,

We are pleased to submit this response to GRCA comments regarding your proposed residential subdivision in Garden Hill.

Please call us if you have any questions about our response or any areas that require clarification.

Yours very truly,

THE GREER GALLOWAY GROUP INC.
CONSULTING ENGINEERS

Charles Mitz, Ph.D., P.Geo.
Senior Project Manager

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Figures (in-text)

1. Introduction

The Greer Galloway Group has received review comments provided by hydrogeology staff at the Ganaraska River Conservation Authority (GRCA) for the proposed Garden Hill Residential Development. These comments are reproduced below:

1. *As stated previously, the hydrogeological report should speak in more detail to the potential impacts of the development site, including reduction in infiltration potentially leading to reduced interflow and baseflow discharge, raised or lowered water levels in shallow aquifers, changes in shallow groundwater flow direction, and creation of preferential pathways that may increase susceptibility of contamination in the subsurface. A figure or schematic indicating the movement of subsurface water would be beneficial to clearly show the difference between pre- and post development preferential pathways. This is especially important since the site contains a wetland, which is likely linked to the groundwater it receives. It is noted that the groundwater level within an aquifer fluctuates constantly in response to rainfall, evapotranspiration, barometric pressure, groundwater movement, and groundwater pumpage. As such calculating hydraulic gradients and groundwater velocity would quantify those changes. A description and figure of the proposed site alteration that clearly outlines groundwater elevations and change in subsurface drainage patterns should be addressed.*
2. *The report should address the issue of whether the groundwater withdrawals in the proposed development will exceed the long-term safe yield of the aquifer or whether there is a significantly decrease of baseflow that may affect sensitive water features in more detail. Stress levels assessed by Source Water Protection do not represent a site-specific water balance that includes wetlands or individual wells.*
3. *Well interference reduces the available drawdown, it also reduces the maximum yield of a well. Well interference is, therefore, an important matter in the design of well fields where it is desirable for each well to be pumped at the largest possible rate. Since the wells are located on the proposed properties and somewhat resemble a grid pattern considerations should be given to the minimum distance for the well location. Excessive well interference is avoided by increasing the spacing between wells. As pointed out within the report that "meeting regulatory setback distances plus a reserve area will limit the areas where wells can be drilled". GRCA suggests a well field design prior to approval of the number of lots to determine the optimum distance between wells.*
4. *The water balance within the storm water report on page 6 mentions an annual moisture surplus of 372mm. The water balance in appendix O however calculates a surplus of 342mm. Please clarify.*
5. *The second submission says that no adverse effects to water quantity are predicted, however page 39, last paragraph of the Servicing and Stormwater Management Report mentions that over time post development conditions would decrease the infiltration volume as recharge to regional groundwater flow system and interflow within the shallow unsaturated zone would be expected to decrease. Please clarify.*
6. *As much as possible, calculations should estimate the amount of infiltration necessary to maintain pre-development conditions. Detailed information on the proposed mitigation measures should be provided to account the loss of infiltration. These details should include location of enhanced infiltration, the volume/rate and condition of the soils to support water*

being infiltrated. This is especially important as the site contains a wetland – Please demonstrate that there will be no negative impacts on the natural features or their ecological functions due to the development.

Each of these comments is addressed in the following subsections:

2. Reduced interflow and baseflow discharge (Comment 1)

Residential development of the site will include the replacement of previously permeable ground surfaces with impervious paved areas and roof. Development will also alter the pre-development site grading with slopes reduced in some areas and increased in others. The result of these changes will be an alteration of groundwater recharge patterns and, absent offsetting measures to enhance recharge, a net decrease in the amount of recharge received by the shallow unconfined aquifer.

Based on consultation with the GRCA, we attempted to model the magnitude and distribution of the predicted reduction in infiltration giving particular attention to areas of the site that could potentially contribute to baseflow in the intermittent watercourse in the north part of the site or to the two identified wetland areas within the portion of the site proposed for development.

The model was based on a rectangular grid composed of 148 grid cells each approximately 40 m by 40 m in dimension (see Figure 1, below).

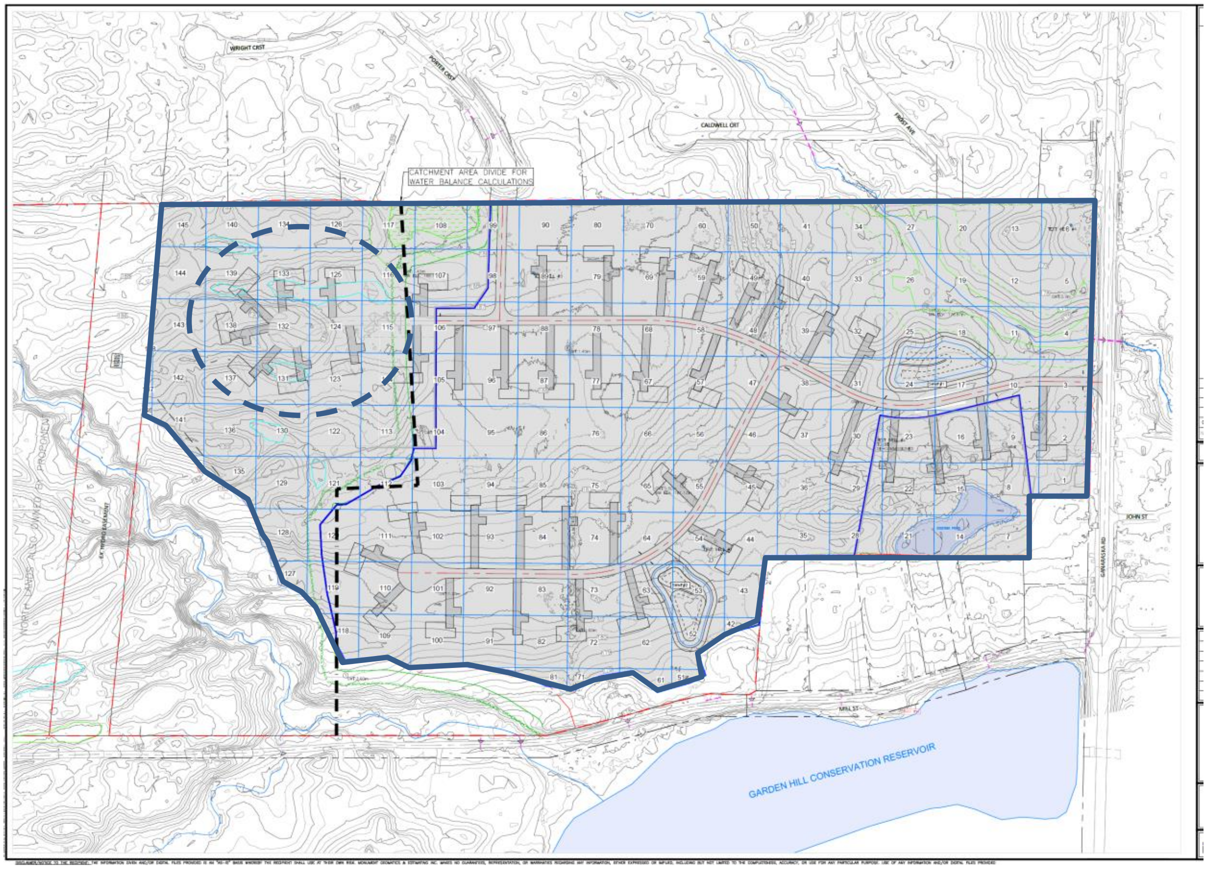

Figure 1 – Site Plan showing grid elements. The 9 lots located within the woodland (circled) are not planned for development at this time. However, to review future potential onsite, these lots have been included in the analysis.

Recharge within each of the grid cells was calculated under pre- and post-development conditions using the MECP 1995 guidance document (Hydrogeological Technical Information Requirements for Land Development Applications). Since the topography and soil sub-factors remain the same under both pre- and post-development contidtions, changes in infiltration are the result in changes to the pervious cover and to the slope. Enhanced recharge within the two stormwater management blocks was ignored for our purposes since the stormwater ponds may be lined.

Changes in pervious cover were estimated by Monument Geomatics & Estimating Inc. using the area of the paved roadways and a hypothetical redidential home footprint. Change in slope was estimated for each cell using the maximum relief across the cell under both pre- and post-development conditions. It is understood that this method will somewhat over-estimate the average slope but it is consderably simpler to estimate and considered sufficient for our purposes.

The infitration factor (IF) for each slope (S) was estimated using the slope classes from the Ontario Stormwater Management Planning and Design Manual (2003) and applying a logarithmic regression:

$IF=-0.04Ln(S)+0.1756$

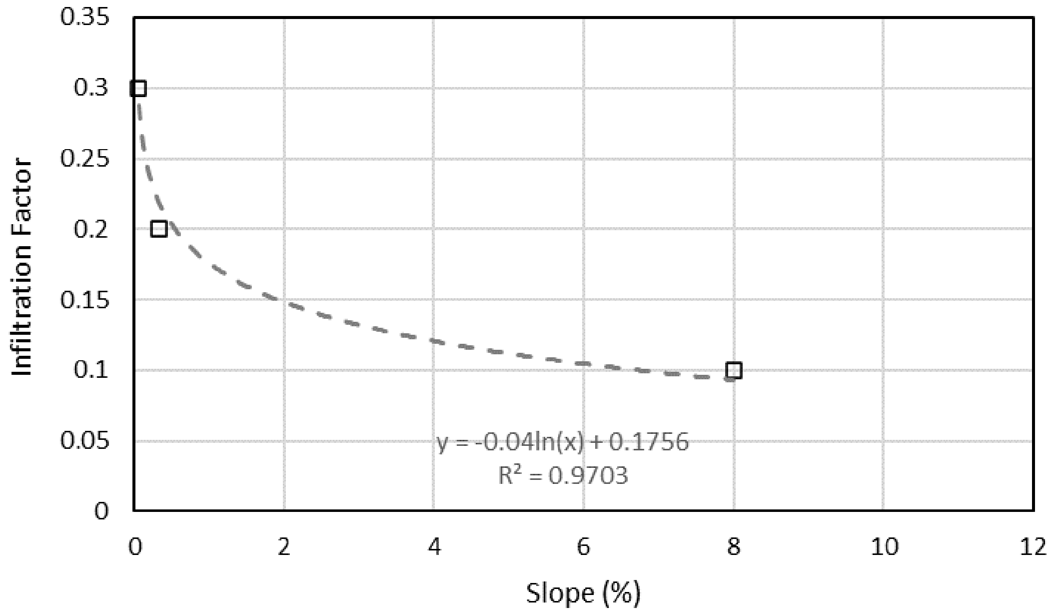

Figure 2 – Relationship between Slope and Infiltration Factor. Rectangles represent discrete points taken from the Ontario Stormwater Management Planning and Design Manual (2003)

The change in slope, post-development, was then determined for each grid cell by subtracting the pre-development maximum slope from the post-development maximum. A negative number means that the site grading reduces the slope for that cell while a positive number represents a post-development slope increase. The change was then kriged and plotted using Surfer (Golden Software Ltd.).

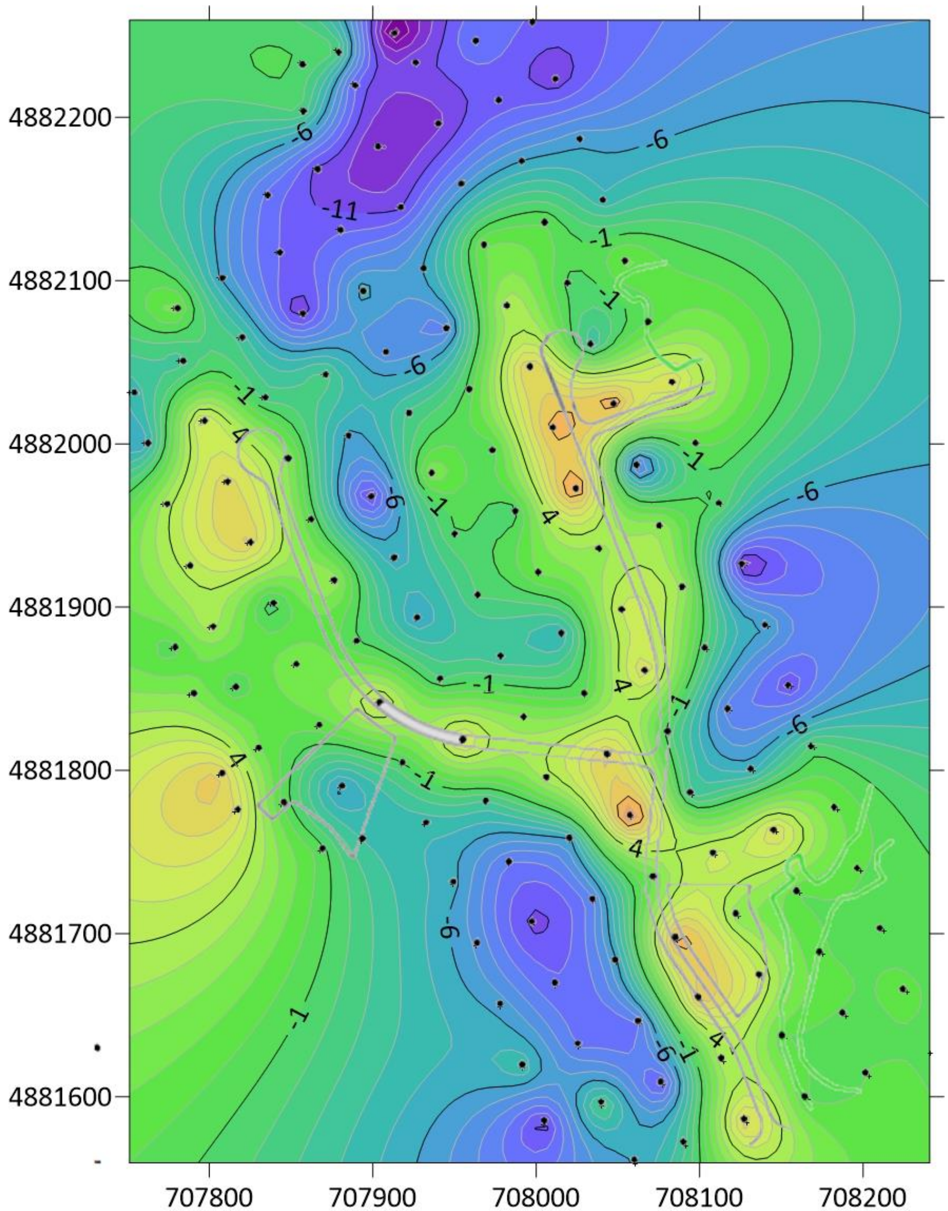

Figure 3 – Modelled change in slope (post-development)

In general, the site grading results in a slight increase (up to 5%) in maximum slope along the two internal roadways and a slight decrease in slope across the balance of the site.

The change in impervious cover was then estimated assuming a roof area of 225 m^2 and that the full paved surface is impervious. The result was processed and graphed in a similar manner to that used for the change in slope:

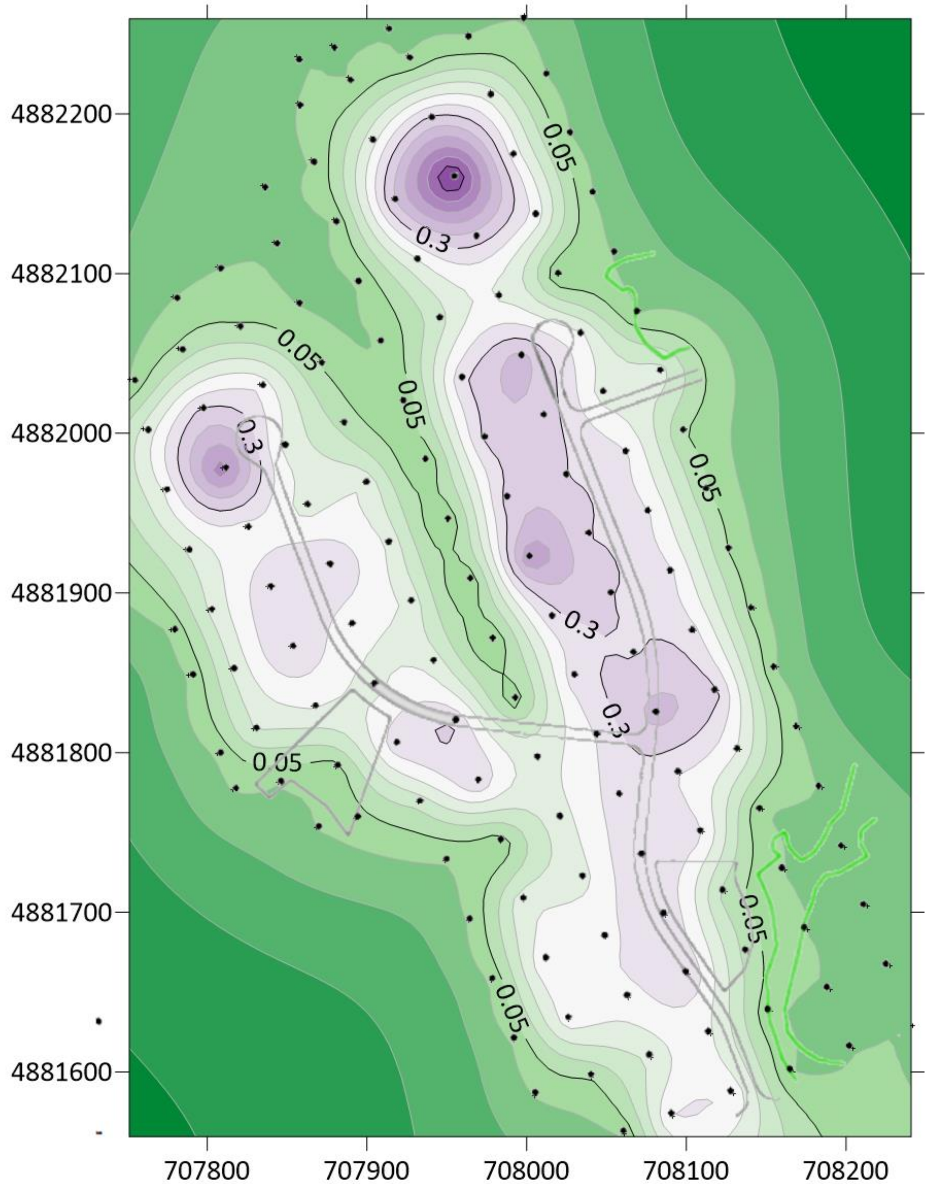

Figure 4 – Fraction of impervious cover (post-development)

As with the change in slope, the fraction of impervious cover is greatest along the internal roadways where the impervious cover represents up to 30% of some of the grid cells. We note that the calculation over-estimates the amount of impervious cover since road-side ditches will allow for some infiltration to occur.

The change in infiltration was then calculated for each grid cell using the revised slope class and ignoring the impervious fraction of the cells. The result (see below) shows an overall decrease in infiltration across the site.

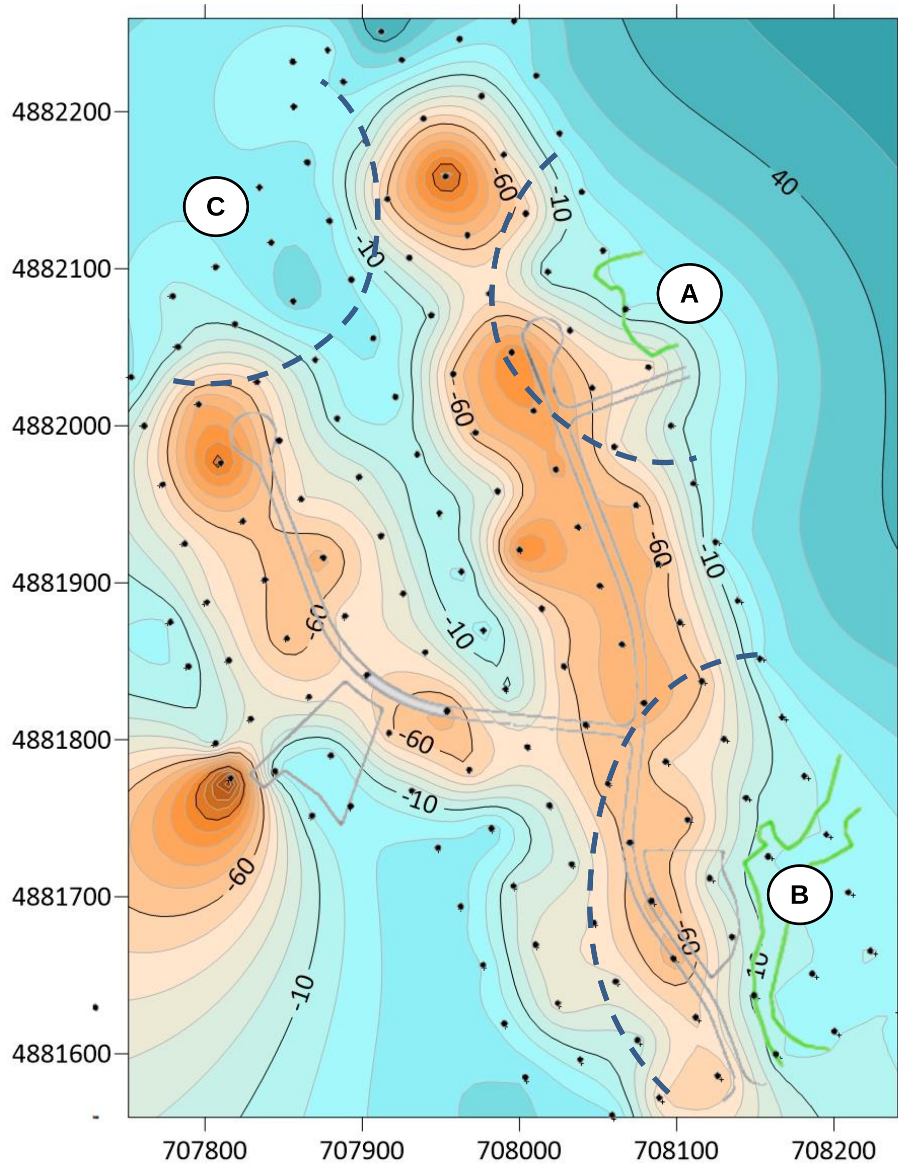

Figure 5 – Predicted change in groundwater recharge (mm/a). The dashed lines represent an approximate zone of influence around on-site wetland features

Overall, reductions in recharge range from 10 to 60 mm/a under the assumed conditions which ignore any lot level enhanced infiltration as well as infiltration in roadside ditches and stormwater ponds. The change is distributed across the site in a roughly even manner which suggests that overall groundwater flow directions are unlikely to be significantly changed although localized increases and decreases in recharge will be reflected in changes in the water table and slight changes in localized flow directions. Such changes are predicted to occur on a scale too fine to be modelled.

The figure shows the approximate locations of two on site wetland areas (A and B) as well as an intermittent water course draining the wooded EP zone in the north part of the property (C). Potential effects of reduced infiltration within the zone of influence surrounding these features warrants closer attention (see Comment 6).

3. Long-term Safe Yield (Comment 2)

As noted by the GRCA, stress levels assessed by Source Water Protection do not represent a site-specific water balance. However, the modelled stress levels do cover the recharge and water balance for the confined aquifer system on the flanks of the Oak Ridges Moraine. The modelled stress levels do not include the potential for local effects on potentially sensitive ecological features such as wetlands.

The planned level of development is equivalent to the residential water demand of about 45 homes within a 16-ha property. Average residential water demand in Ontario is approximately 675 L/day/home so the scale of development represents a total taking of about 30,000 L/day the most of which will be returned to the subsurface. This amount represents a water removal of a little under 2,000 L/day per ha: equivalent to a recharge rate of 73 mm even if we exclude recharge coming from upgradient areas (the main recharge area). We conclude that the long term safe yield for the confined aquifer system is greater than the proposed water takings either within the subject site or in the larger area.

The potential for water takings to affect potentially sensitive ecological receptors is low because of the thick confining strata between the water table aquifer and wetlands and water courses. Potential effects to these features would result from alterations to the site water balance (see Comments 1 and 6).

4. Wellfield Design (Comment 3)

The recommendation to prepare a conceptual wellfield layout is one that we agree with and one which will be helpful during the drilling of supply wells across the site. Such a layout should include both a preferred and an alternate well location for each lot in areas that meet OBC setback requirements from septic systems and which maximize the separation between wells.

5. Moisture Surplus Discrepancy (Comment 4)

The hydrogeology study presented a water balance carried out in accordance with the Ministry of the Environment, Conservation and Parks (MECP) Procedure D-5-4 (Individual On-Site Sewage Systems). The water surplus was estimated to be 367 mm/a which was calculated by subtracting the actual evapotranspiration (AET) of 498 mm/a from the precipitation of 865 mm/a. Both these numbers were taken from the Trent Conservation Coalition Source Protection Committee (TCCSPC, 2018) report. The 372 mm/a number is an error, and it should read 367 mm/a.

As we noted in our report, the water balance methodology used for the hydrogeology study was taken from MECP 1995 guidance and for the purposes of nitrate mass balance calculations. The methodology is crude and should not be used for stormwater management design. We therefore defer to the stormwater report for this purpose.

6. Water Quantity Effects (Comment 5)

Our second submission stated that no adverse effects to water quantity are predicted. This statement was made in reference to the water supply aquifer and there is no contradiction with the Servicing and Stormwater Management Report which notes that changes in the site grading and the increase in impervious cover would decrease the infiltration volume and interflow within the shallow unsaturated zone would be expected to decrease. We note that the regional confined aquifer obtains most of its recharge from lands to the north of the site where permeable aquifer strata daylight at surface. Proximal recharge is dependent on the maintenance of saturated conditions in the base of the shallow overburden overlying the confining layers and would not be affected by development-related changes to infiltration. The potential impacts from such changes to local ecological features is discussed under Comments 1 and 6.

7. Infiltration Maintenance (Comment 6)

Simplified modelling of post-development changes in infiltration suggests a modest net loss of infiltration across the site. Groundwater flow directions are not predicted to change significantly however the reduction in recharge within lands that contribute to water levels in the two wetland areas could affect these features. In the absence of detailed information regarding the sensitivity of the wetland vegetation to such changes, we recommend following the precautionary principle and implementing at-source infiltration to match, as closely as possible the pre-development recharge.

Portions of the site that should be prioritized (i.e., those within the assumed zone of influence of the wetlands and intermittent water course) are shown below. The slight reduction of recharge over the balance of the site would not have any adverse ecological effects since the shallow flow enters the North Ganaraska River which is impounded by a dam in the area adjacent to the site and does not provide suitable spawning habitat for sensitive cold water species such as brook trout (Salvelinus fontinalis) which require upwelling groundwater flow through streambed gravels for spawning.

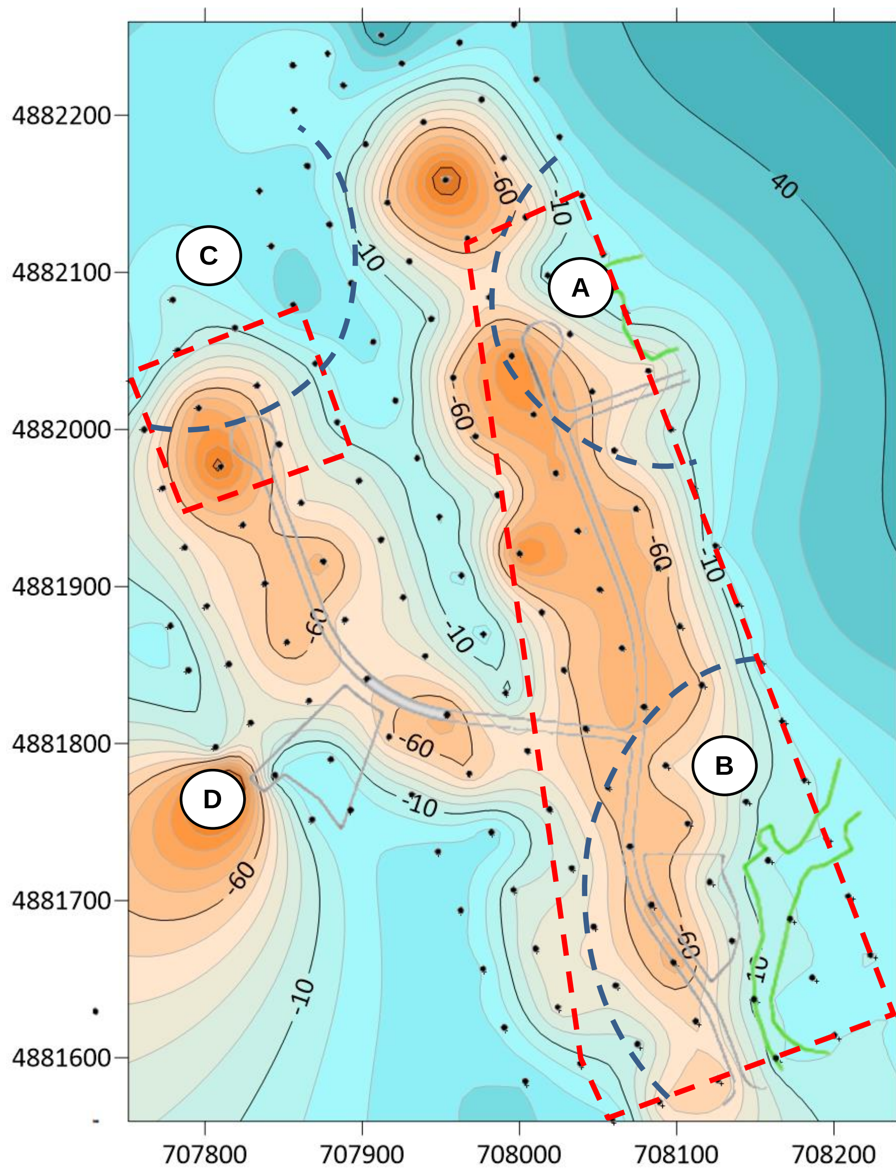

Figure 6 – Predicted change in groundwater recharge showing priority areas for enhanced infiltration

We note that the modelled change in infiltration at Location D is largely an artifact of the kriging algorithm used to generate the contours.

Within the identified areas we recommend the use of enhanced infiltration measures to infiltrate clean roof runoff for each lot. Direct infiltration avoids water losses to evapotranspiration and runoff and it is possible, in principle, for lot level infiltration to offset infiltration losses resulting from impervious paved areas. Direct infiltration of roof water would always be predicted to have its maximum benefit during the summer months when evapotraspiration losses are at their highest and when wetlands would be under the greatest stress.

The percolation rates of the subsoil types have been estimated to range from 25 to 30 min/cm for silty sand and sandy silt soil types and 40 min/cm for silt with sand. At source infiltration of clean roof runoff is considered feasible for the silty sand and sandy silt soil types.

Soakaway pits may be constructed of clear stone (50 mm diameter) placed on the surface of the subsoil. Non-woven filter cloth should be used to line the trench on all sides to prevent the pore spaces between the stones from being infilled by the surrounding native material. The size of the pits may be estimated using the following equation:

$$A = \frac{V}{Pn\Delta t} \qquad [1]$$

Where,

A is the basal area in m^2

V is the volume of water to be infiltrated

P is the infiltration rate (m/h)

n is the porosity of the storage media (1.0 for fabricated storage chamber, 0.4 for 50 mm diameter clear stone)

Δt is the design retention time (typically 24 hours)

8. Summary and Recommendations

The following points summarize the key elements of this response along with recommendations:

1. The deep confined aquifer system is able to yield sufficient quantities of potable water to meet anticipated residential water demands for the proposed residential lots.
2. A modest net loss of groundwater recharge is predicted to occur under developed conditions absent the implementation of enhanced infiltration measures.
3. The predicted change in infiltration is relatively evenly distributed across the site and no significant alterations in groundwater flow directions are anticipated.
4. Enhanced infiltration measures are recommended within portions of the site that occur within the likely zone of influence surrounding potentially sensitive ecological features.
5. A revised water balance should be developed for the identified priority areas. This should include the effects of enhanced infiltration measures and a more detailed treatment of changes in grading and impervious covers. The resulting water balance should match pre-development recharge rates during the summer months.
6. Any utility trenches proposed for the site should be provided with closely spaced cutoffs (say ever 50 m) where the trench bedding material occurs below the seasonal high water table.

All of which is respectfully submitted.

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