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MEMO

To:	Natalie Kotyck
From:	Garry T. Hunter, M.A.Sc., P.Eng.
Date:	September 25, 2024
File:	21-407
Subject	**Sufficiency of Groundwater Monitors Appendices ABCDE Strada Matrix Comment – August 18, 2024**

1.0 Introduction – Insufficiency of Background Information

This memo addresses the insufficiency of the existing Strada groundwater monitor network.

1.1 Strada Team not in Agreement

The August 18, 2024 Matrix includes the following statement:

> ***The Strada Team is not in agreement with the Peer Reviewer and are of the opinion that there is sufficient background to support our assessments.***

This opinion is expressed throughout the Matrix by the Strada consultant team.

1.2 Peer Review Response

In the absence of Groundwater Monitor Screen and related segregated Static Water Level classifications and Geographic Spatial Analysis (GIS) by the broadly accepted Geological Formation / Groundwater Model Layers, this statement is technically unsupported and ill-informed.

Consider:

There is broad agreement by this Peer Review and Strada Groundwater Model and Site Plan consultants with regard to the proposed Geological Formations, Groundwater Model Layers and Aggregate Extraction lifts on the Strada site.

There is now agreement after spatial error trapping analysis by this Peer Review that Strada's single point downhole water level and water quality data collection and related monitor well measuring point geodetic elevations are high quality with an estimated 10 to 20 cm water level vertical accuracy.

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However, unexplained, despite continuing questioning by this Peer Review, the Strada Appendix A/B Hydrogeologist continues to use a now archaic former gravel pit hydrogeologist's ABC gravel pit monitor screen classification to support data interpolation and Spatial Analysis. This classification is not in conformity with the recently determined and agreed Geological Formations, Model Layers (Aquifers) and Quarry Lifts.Furthermore, very little site specific Spatial Analysis has been performed on the high quality site specific downhole water quantity and quality information either by the Strada hydrogeologist or groundwater modellers.

This Peer Review is the only party who has performed Spatial Analysis on Strada's high quality downhole water quantity and quality data initially for error trapping, secondly for evaluation of monitor network distribution sufficiency, thirdly for identification of hydraulic anomalies and finally for interpretation of the site hydraulic and water quality context.

This Peer Review recent interpretation of the 3D Underground Stream location is added to selected example Figures from Strada productions.

These Strada Figures, where groundwater contours and increased hydraulic conductivity zones do not substantially conform to the 3D Underground Stream, are very simply wrong and the monitoring network is insufficient.

This Peer Review notes that this underground stream is apparent from the Gasport Aquifer Model Layer 6 upwards to the Water Table Aquifer (Model Layer 1) under the Strada Melancthon Pit No. 1 Site Plan Floor.

1.3 Monitor Network Sufficiency

After 15 months of review of the Strada site document stack, this Peer Review considers for this site that nested Water Table Epikarst Model Layers, Guelph Eramosa Aquifer Model Layer 4 and Gasport Aquifer Model Layer 6 monitors are required at each one half Township Lot corner or the closest Strada Pit corner (subtotal 10) and in proximity to the flow convergence trough underground stream (subtotal 4, total 14 (42 screens)).

Monitors need to be outside the proposed Quarry Extraction footprint and protected to provide long-term static water levels for future change comparison.

2.0 Spatial Analysis (GIS)

In the 15 months since being engaged on this file, this Peer Reviewer is aware of only the following examples of direct site specific Spatial Analysis (GIS) of real groundwater monitoring water level data by the Strada Team. These examples include:

2.1 Appendix A/B Real Base Line Report

In the August 15, 2024 Appendix A pg A-8 Fig A.5 Monitor Locations (groundwater only but despite the title, no surface water locations identified).

Consider:

Fig A.5 shows the 'smorgasbord' of groundwater monitor locations as summarized in following Table A.1 Groundwater Monitoring Well Network (pg A-1 & pg A-2, Fig H.18.A).

Table A.1 includes Active, Dry Inactive, Pulled (Abandoned) and Destroyed Wells. Only about two thirds of the wells are active.

Unexplained Fig A.5 does not show this 'active' well status and effectively hides the inactive well information from the reader. There are monitor locations missing (OW20) and/or overprinted on Peer Review Figure H.18.A1.

Table A.1 also uses the now archaic former gravel pit hydrogeologist ABC well terminology which is not coincident with the now accepted Strada Quarry Model Layer terminology. Most notable, the significant Gasport Aquifer (Model Layer 6) monitor screens are not differentiated, leading to confusion.

This now archaic ABC well terminology even confused the Strada Team in its inclusion of shallower Guelph / Eramosa Aquifer C monitors in its September 6, 2024 Slide Deck Model Layer 6 Gasport Aquifer description.

This Peer Reviewer has identified this Model Layer monitor screen classification issue continually throughout the Matrix, Strada consultants have ignored this comment throughout.

2.2 2023 Environmental Compliance Report

Strada's Hydrogeologist 2023 Gravel Pit Annual Environmental Compliance Report Fig-2, Fig-4, Fig-5, Fig-8, Fig H18.1 and H18.2 provides the following elementary spatial analysis:

Fig-2 shows the Groundwater and Surface Water Monitoring Locations but does not show (hides) the inactive gravel pit monitors.

Fig-4 shows the Gravel Pit Hydrogeologist classified 'A' monitor groundwater static level contours for April 2023 (Fig H.18.1).

Fig-4 with April 2023 static water level contours far above the pit floor contradicts Strada's Licensed Pit Plans (season high water table + 1.5 m). There is no mandatory self-disclosure of this condition in the Strada 2023 Compliance Report.

Fig-4 and Fig-5, although each showing about '13' active 'A' monitor screens, indicate an absence of 'A' groundwater monitor locations along the 4th Line frontage of Melancthon Pit # 1 and the Prince Property. Although approaching the target number of 14 monitor screens, the monitors are not well distributed.

Fig-8 Groundwater Contours for Gravel Pit Hydrogeologist's 'C' Monitors described as deep elsewhere (mislabeled as Shallow on this Figure) shows only '11' active monitors throughout the Strada Gravel pits. However, the monitoring network wells are poorly distributed with significant gaps on the 4th Line frontages as well as on the mid Township lot line. There are insufficient number of monitor screens to define the 'C' water level contour surfaces in Melancthon Pit # 2, Melancthon Pit # 1 and the Prince Property.

Unexplained, OW19C water level is not included and does not inform this contour plot.

Fig-9 (Fig H.18.2) also shows that 'C' groundwater contours now include '13' monitors including OW19C, OW4C, OW29C but for unknown reasons deletes OW3C. Although approaching the Target number of 14 monitor screens, the monitor wells are poorly distributed.

Fig-9 has fewer data gaps and is beginning to reflect the groundwater flow zone convergence trough (underground stream) but not in the correct location as further defined by this Peer Review Fig H.1 and Fig H.2 and as inferred by Strada groundwater modellers (Fig 11.23.1).

The Strada hydrogeologist flow arrows are mislocated on Fig-9 compare to the groundwater modellers' assumption due to misinterpretation of data and continuing data gaps (Fig H.18.2).

Perhaps the most significant contour feature on Fig-9, apparently unrecognized and unexplained by Strada's Hydrogeologist are the depression water level contours at the now added OW19C monitor (Fig H.18.2).

At face value, this anomalous OW19C water level observation is indicative of a 'window' in the Goat Island Aquitard connecting the upper Model Layer 4 to Model Layer 6. This window is contrary to the Strada groundwater modellers' assumptions of a continuous aquitard across the site.

Additional groundwater monitors are required to define this underground stream location through the Prince Pit to the probable location near Melancthon No. 1 Pit OW16C at the east site boundary (Fig H.18.2).

This Peer Review acknowledges that there may be additional new nested monitor well water level data not included on these Compliance plots. This Peer Review has attempted to patch the Model Layer 4 and Model Layer 6 data gaps with legacy no longer active site groundwater monitoring on its prior draft Fig H.1 and H.2.

Strada's hydrogeologist has refused to cooperate in provision of compiled legacy manual groundwater monitoring water level data to assist in patching the data gaps with synthetic data (perhaps now finally provided after the fact, not downloaded).

3.0 Model Degraded Real Site Water Level Data

Consider:

Strada's hydrogeologist, unexplained, instead of undertaking site spatial analysis of water levels, dumped this high quality 10 to 20 cm accuracy water level data, obtained by Strada at great expense, and degraded the data (25 to 50 x) to about 5 m ± contour accuracy within the poorly calibrated TPA groundwater model environment somehow expecting a miracle spatial analysis (GIS) water level result (Fig H.21.1, H.21.2, H.23.1 and H.23.2). Why?

These degraded virtual 5 m contours with very high residuals (Fig H.22.1 and H.22.2) are not appropriate for incorporation on Site Plans (Fig H.21.1 and H.21.2).

The Strada groundwater modellers (Appendix C Fig 3.29 to Fig 3.34 inclusive) were able to take the on-site geological formation unconformity and interpreted gradational rock picks and spatially contour the bottoms, tops and thicknesses of formations to a 2m contour interval (Fig H.19.1, H.19.2, H.20.1 and H.20.2). This 2 m contour interval is considered by this Peer Review to be appropriate considering the inherent bedrock formation variability. Data gap deficiencies were apparent mainly along the 4th Line and the one half Township lot boundaries where borehole coverage was sparse.

Why did the Strada groundwater modellers not classify by monitor screen (statistically stratify) the high quality 10 to 20 cm downhole single point groundwater monitor static water level data and plot one meter or better groundwater contours by the accepted Model Layer following the same process as followed for the 'geological rock picks'? (Fig H.19.1, H.19.2, H.20.1 and H.20.2).

4.0 Hydraulic Head

Where is the fundamental Spatial Analysis of the hydraulic head across the Goat Island Aquitard? This is not 25 m as oft quoted for the Shelburne Production Well No 7, the Strada site is clearly different than Shelburne.

The groundwater modellers' 5 m contours on Fig H.21.1 and H.21.2 at face value show no difference in Hydraulic Head across Model Layer 5 (Goat Island Aquitard) in the southerly part of the Strada Pit sites. Is there no effective Aquitard on the Boyne / Pine groundwater divide (zero flow) at the south end of the pits? This hydraulic head difference increases from 2 m at the Melancthon Pit No. 1 east boundary to more than 5 m along the Prince Pit 4th Line frontage.

There is insufficient continuous Monitoring Data as supplied by Strada to March 2024 to evaluate Hydraulic Heads in the recent nested Guelph / Gasport Monitor Wells. A more extended record is required.

5.0 Site Plan Importance of Spatial Analysis of Site Water Level Data

Why is this the Spatial Analysis of the groundwater monitor static water levels by Model Layer important?

Consider:

The Strada proposed Quarry Site likely contains a 'radial spoke' bedrock lineament karstic fracture zone extending from the Pine River / Horning's Mills Lake at least to the McTaggart Farm infiltration depression. Other similar radial spokes with streams and swales are apparent emanating from Horning's Mills Valley and crossing 15th Sideroad between the Town Line and 5th Line. South of 15th Sideroad these radial spokes are mainly buried. The unburied lineament swales are usually less than 100 m in width, have headwater bedrock cradled swales active during spring snowmelt runoff with downgradient emergent cold water streams.

The MHBC initial Site Plan proposed Phase 1 Extraction centered on this radial karstic bedrock underground stream ensuring that maximum water management will be required with full depth extraction in Phase 1 Area.

The modellers did not adopt the site data supported natural flow convergence trough (underwater stream) zone for re-infiltration / injection of Quarry water and moved infiltration infrastructure to unnatural (incorrect model supported) proposed quarry site areas where unnatural infiltration trench and pond breakouts to adjacent farm and residential lands may occur (Fig H.23.1 and H.23.2).

The modellers recognized only water quantity pumping from the quarry floor and not quality degradation within the quarry environment.

The groundwater modellers contrived Gasport Vertical Linear Barrier Walls and Guelph Eramosa Setback Glacial Till Berm Wedges along the 4th Line to dam this underground stream to keep the underground stream water out of the Quarry.

The modellers in the first scenario focused entirely on quarry drawdowns and wetland water balances and did not recognize that their underground stream barrier dams would flood the adjacent Duivenvoorden aggregate properties, various farm fields and in some cases residential properties.

In the latest proposal discussed, rather than rethink the first extraction Scenario, the modellers applied 'band aids' including active (perpetual?) pumping of the adjacent Duivenvoorden depressional properties west of the 4th Line. No proposal for disposal of pumped water was provided.

The logic of the groundwater modellers' virtual design escapes this Peer Reviewer. Why dam up the underground stream and then install permanent perpetual pumping to pump down the flooded land areas? Why not let the stream run into the quarry in the first place to reduce Strada's liability or in the alternative, install extraction wells at varying depth as required and pump the 'clean' aquifer water to infiltration /

injection areas in the underwater stream area departing the Strada proposed quarry site (Fig H.3).

Furthermore, this initial poorly calibrated groundwater model version significantly under-estimate the pumped quarry floor water and infiltration quantities.

Strada needs to fill in its groundwater monitoring Model Layer gaps and in particular better define the 3D locations of underground groundwater flow concentrations (underground streams) to inform Site Design, Extraction Sequencing, Excess Water Infiltration and Water Management to minimize unanticipated quarry operating costs, failure risks and impacts.

Site Plan area allocations may be required for temporary or permanent stockpiling of initial excavated waste overburden (till) and / or lower quality waste rock. These area allocations may compete with space for establishing infiltration ponds, and if in the quarry, with groundwater flow.

6.0 Conclusion

The Strada hydrogeologist comments that site monitoring is sufficient to support assessments are not consistent with the Strada Team evidence, is technically unsupported, ill-informed and somewhat frivolous in the light of the document stack made available to this Peer Review over the past 15 months.

In the present Extraction Scenario No. 1 Assessment (Appendix E), the modelling inferred virtual assumptions are controlling the location of the underground stream through the Prince and Melancthon #1 Pit areas (Fig H.23.1 and H23.2), not the site data. This underground stream needs to be further defined with additional groundwater monitors.

In conclusion, this Peer Review cannot place much weight or confidence in Strada's technically unsupported claims that the existing water level monitoring network is sufficient.

In the alternative, Strada could adopt, subject to further editing and update with undisclosed water level and underground stream data, the Peer Review 'patched' together Water Table (Model Layer 1) (to be completed) Guelph / Eramosa Model Layer 4 (Fig H.1) and Gasport Model Layer 6 (Fig H.2). These plots are approaching one meter accuracy. Incorporating these site specific Layers into the Groundwater Model, together with improved calibration, would permit proposed Quarry Site Analysis and Assessment to move forwards without further groundwater monitor construction at this time.

This Peer Reviewer is available to discuss these conclusions.