December 2021

Final Report of the

EXPERT PANEL for the All-Hazard Investigation of Well Water in Chatham-Kent

Prepared for the Minister of Health

CONTENTS

The Honourable Christine Elliott
Minister of Health
777 Bay St. 5th Floor
Toronto, ON M7A 2J3

Dear Minister Elliott,

As members appointed to the Expert Panel for the All Hazards Investigation of Well Water in Chatham-Kent, we are pleased to submit our findings and final report on the safety and quality of drinking water from private wells in Chatham-Kent.

Sincerely,

Keith Benn, PhD, P. Geo.
Ronald Brecher, PhD, DABT
Mark Chappel, MSc, DABT
Glenn Ferguson, PhD, QP_{RA}
Shelley Harris, PhD

EXECUTIVE SUMMARY

The present document represents a report by the Expert Panel on the All-Hazard Investigation of Well Water from an area within the municipality of Chatham-Kent, in Southwestern Ontario. The area of concern corresponds to the North Kent 1 wind complex (North Kent 1) that was under construction in 2017 and that achieved commercial operation in February, 2018. North Kent 1 consists of 34 wind turbines constructed in an agricultural area that is underlain by an interface aquifer providing the source for domestic water wells. The aquifer is composed mainly of sands and gravels as well as glacial till derived from the underlying bedrock geological formation known as the Kettle Point black shale. Local residents have complained of a perceived impact on the quality of their well water during and following construction of North Kent 1, citing increased turbidity, discoloration and the presence of sediment that might include particles of the Kettle Point black shale.

The Expert Panel was appointed in 2019 to lead an investigation into well water quality and any potential health risks associated with consumption of the well water in the North Kent 1 area. Sampling and analysis of well water took place in 2021 and included 61 wells within the North Kent 1 study area and, for comparison, an additional group of 9 wells in adjacent areas outside of North Kent 1. The analytical results from the 2021 program were also compared with those from a baseline assessment of well water quality that was completed in 2016-2017, prior to wind turbine construction.

Data derived from the 2021 investigation reveal well water in the North Kent 1 area to be of substantially poorer quality in comparison to well water from outside of the North Kent 1 area, especially with reference to several parameters including iron content, turbidity and the concentration of very fine-grained sediment that is present in the water as suspended solids. Comparison of the data from the 2021 study with data from the pre-construction baseline assessment indicates that the general water quality in the North Kent 1 area has deteriorated significantly between 2017 and 2021 with respect to those same parameters. The results of those two comparisons are consistent with well water interference within the North Kent 1 area between 2017 and 2021.

For most chemicals observed exceeding health-based criteria (dissolved bromate, fluoride, arsenic, barium, lead, methylene chloride), typically only one well was determined to have elevated concentrations (elevated fluoride observed in 17.1% of the wells was the exception), and these exceedances appeared to be marginally over the Ontario provincial benchmarks. An additional well with an exceedance of lead is identified according to the slightly lower Health Canada benchmark. This would suggest a lack of wide-spread health concerns related to drinking water quality within the study area, based on the limited set of wells sampled to date. Whether any of the contaminants listed above would pose either or both of a short-term or long-term health risk due to consumption of water from the tested wells or from other wells in the North Kent 1 area remains somewhat uncertain at present due to several factors including the rather sparse sampling that was performed for the 2021 study.

Recommendations for further investigation of well water in the North Kent 1 area include the following.

- Further sampling of well water to provide a larger data set and a more geographically complete data coverage.
- Further statistical analyses of the current data and of any further data collected, including:
  - Spatial statistical analyses of the distribution of concentrations of any contaminants of concern;
  - Multivariate statistical analyses in view of identifying correlations of chemical and aesthetic parameters.
- More detailed studies of the solid fraction in suspension in the water to determine its chemical composition and also to determine if certain contaminants of concern are present within the solid fraction and / or in solution.
- Adoption of some Health Canada guidelines for certain potentially toxic chemical components such as lead and manganese.

INTRODUCTION

Government's Commitment

In May 2019, the government took action to address concerns raised about the quality of private well water in Chatham-Kent in response to concerns raised by local residents and Water Wells First during and following construction of the North Kent 1 wind complex.

The government established the *Expert Panel for the All-Hazard Investigation of Well Water in Chatham-Kent* to determine if the quality of the well water poses a risk to those consuming the water.

The Minister of Health's Expert Panel for the All-Hazard Investigation of Well Water in Chatham-Kent

On May 30, 2019, the government appointed five members to the panel by Order-in-Council. These individual experts—three toxicologists, an epidemiologist, and a geologist—would lead the well water investigation (see Appendix 1).

Mandate and Scope

The mandate and scope of the Expert Panel was to:

- Oversee the investigation of private well water and sediment located in Chatham-Kent to determine if the quality of the water poses a risk to those consuming it.
- Review the current evidence and data, including the methodology, data sources, criteria, and testing parameters; identify data deficiencies to advise on further testing requirements; and analyze additional test results.
- Report back to the Minister of Health on the findings.

BACKGROUND

Study Area and Baseline Assessment

The Study Area for this project is generally bounded by Oldfield Line to the northwest, Bear Line Road to the southwest, Pioneer Line and Pine Line/Darrell Line to the southeast and Centre Side Road and Caledonia Road to the northeast.

In 2016-2017 a water well survey and assessment entitled "North Kent Wind 1 LP, Baseline Well Water Survey Assessment Results" was conducted in the area by AECOM Canada Ltd. (AECOM, 2017). This previous assessment is referred to herein as the Baseline Assessment; the results provide a partially comparable data set for the study area for the current investigation.

Kettle Point Formation and Groundwater Conditions

[principal source: Ministry of Environment, Parks and Conservations, Assessment Of Well Water Quality Concerns - North Kent Wind Project - Construction Phase - May 2018 with additional information provided by the Expert Panel]

Most groundwater wells in the Study Area draw water from the interface aquifer between the Kettle Point black shale bedrock and overburden of likely glacial origin. The aquifer consists of a thin deposit of silt, sand and gravel. The Kettle Point black shale is also known to be present as glacial till on top of the bedrock (Tilsely et al., 1993) and thus would at least locally lie directly at the base of, and potentially constitute part of the aquifer itself.

The geological conditions create challenges in securing adequate groundwater supplies in the Chatham-Kent region. The clay overburden soils and the deeper solid shale bedrock generally do not yield significant quantities of water, and are therefore not typically suitable for water supply.

A review of well records indicates the aquifer is typically less than one metre thick, and supplies roughly 90% of the wells in the region. Wells often produce less than 9 L/min (2 GPM) which is considered to be a very low yield for supplying residences or agricultural operations. Groundwater quality is generally poor, with elevated concentrations of total dissolved solids, iron, sodium and chloride.

Procurement of Services

In March 2020, the Ministry of Health posted a Request for Bids on the Ontario Tenders Portal to procure an independent contractor to carry out the water and sediment sampling and testing based on the Expert Panel's recommended methodology.

In the summer of 2020, the Expert Panel members and two ministry officials completed the evaluation of the submitted bids in compliance with procurement directives and procedures.

Vendor's Profile

By December 2020, the successful vendor, Englobe Corporation, was selected and awarded the contract resulting from the open and competitive procurement process.

Englobe Corporation specializes in applied sciences, particularly in the fields of the environment, hydrogeology, geosciences, and materials engineering. Their project team is experienced in completing potable water, groundwater and surface water sampling, monitoring, and reporting at various sites in Ontario.

Scope of Work

The vendor executed the following aspects of the project:

- Developed and implemented a Public Engagement Plan to inform the public and residents about the sampling and testing of well water and sediment
- Surveyed, interviewed and collected information from well owners who agreed to participate about their wells
- Executed the two-phase water and sediment sampling and testing methodology in the field including quality assurance and control, and installation of sediment filters where necessary and as directed by the Expert Panel
- Provided well owners with well water test results

MAIN FINDINGS

Recruitment and Participation

To implement their Public Engagement Plan, Englobe distributed a total of 309 Water Well Surveys (the Survey) by mail and/or hand delivery to potential participants in the well water sampling and testing program (the Program). A total of 72 responses to the Survey were received by Englobe of which 70 respondents signaled their consent to participate in the Program.

Well Information Survey Results

The Survey invited respondents to self-report information regarding water quality issues experienced by them and the results for the total of 72 respondents are summarized in Table 1.

Table 1. Water quality issues self-reported by Survey Respondents

SELF-REPORTED WATER QUALITY ISSUES	QUANTITY	% OF 72 TOTAL RESPONSES
Discoloration	16	22
Odour	8	12
Taste	14	19
Sediment	25	35
Bacteria	9	13
Hardness	24	33
Other Water Issues	2	3
No water Quality Issues Reported	15	21

Respondents were also invited to self-report water treatment systems in place and results are described on page 9 of Englobe's final report (Englobe, 2021; referred to herein as the Report).

Well Water Sampling, Tests and Results

Based on the responses to the Public Engagement Plan, Englobe identified wells to be included in the two phases of sampling and testing (Phase I and Phase II) that constituted the Program. For Phase I, a total of 49 wells were identified and assigned to 3 Groups as follows:

- Group **“Closest to Wind Turbines”** – 20 wells from within the Study Area that were the shortest linear distances from the nearest wind turbines;
- Group **“Distribution within the Study Area”** – 20 wells that provided further spatial coverage within the Study Area; and,
- Group “Outside the Study Area” or **“Reference Group”** – 9 wells that lie outside of the boundaries of the Study Area. To be selected for the Reference Group, wells had to source water from the same aquifer that serves the Study Area and that lies upon the Kettle Point formation; be located at least 250 metres from major infrastructure; and be located at least 100 metres from a major highway. The Reference Group was intended to include 20 wells; however, Englobe was able to recruit only 9 participants.

Water wells sampled during Phase I were analyzed for a Standard Analytical Suite of parameters that were also included in the Baseline Assessment of well water in the Study Area carried out in 2016-2017, prior to construction of wind turbines in that area, as well as for an Extended Analytical Suite that consisted of 34 parameters including potentially toxic metals that are known to be present in some abundance in the Kettle Point black shale (Armstrong, 1986; Armstrong and Carter, 2010) that is also known to be present as glacial till on top of the bedrock (Tilsely et al., 1993) at the base of the aquifer.

Wells for Phase II sampling and testing were selected to provide further spatial coverage within the Study Area. The Phase II sampling program was originally intended to include around 140 to 150 wells; however, Englobe was able to recruit only 21 participants. Water from all of the Phase II wells was analyzed for the Standard Analytical Suite and water from a subset of 17 of the Phase II wells was analyzed for an Additional Suite of selected parameters that included the metals that were included in the Phase I analyses (Extended Analytical Suite) as well as several inorganic parameters.

All tested parameters of the Standard, Extended and Additional analytical suites are provided in Appendix 2 to the present document.

It was intended that sediment should also be collected from the plumbing systems between wells and domestic water outlets; however, Englobe was unable to gather sufficiently large samples of sediment at any of the properties using the sampling methods that are explained in the Report (i.e., installed sediment filter cartridges). As discussed below, the well water sampled at numerous properties carried a rather large load of suspended solids that were apparently of small enough grain size to not be trapped by the filter systems employed by Englobe. Englobe noted that the small quantities of sediment that were visually identified within 26 filtration systems were “typically black in colour (and) potentially derived from the black shale of the Kettle Point formation”.

Health parameters

Parameters that exceeded Ontario Drinking Water Quality Standards (ODWQS) Reg. 169/03 health-based standards (Maximum Acceptable Concentration; MAC) of Health-related parameters are indicated in Table 2 where for each parameter the number of wells within the Study Area that returned exceedances above the MAC is indicated and followed by the percentage of that sample population represented by the exceedances. The data are taken from the table *Summary of Water Quality Exceedances of ODWQS* presented on page 21 of the Report and that is included at the end of the present document (Table 4) where it can be consulted for further detail such as ODWQS guideline values for each parameter, ranges in results and the total number of wells tested for each parameter.

Table 2. Water Well Test Results from the Study Area; Health-Related Parameters

HEALTH-RELATED PARAMETERS	QUANTITY OF EXCEEDENCES	% OF WELLS ANALYZED
Dissolved Bromate	1	1.5
Fluoride	12	17.1
Arsenic	1	1.5
Barium	1	1.5
Lead	1	1.5
Total Coliforms	5	7.1
Methylene Chloride	1	2.1

Here we add five notes regarding the results listed in Tables 2 and 4.

- If the Health Canada MAC (5 μg/L) for Lead concentration in drinking water were applied rather than the ODWQS MAC (10 μg/L) then the number of exceedances for Lead would increase from 1 to 2.
- For the potentially toxic metals Arsenic and Lead it is validated that all exceedances were returned from wells within the Study Area; i.e., no exceedances for those metals were reported for wells from the Reference Group.
- Also, 2 of 2 (or 2 of 3 if the Health Canada MAC were employed) of the exceedances reported for Arsenic and Lead come from wells assigned to the Group Closest to Wind Turbines.
- Although the absolute number of wells that returned exceedances for Lead and Arsenic is small it represents 5% of the wells analyzed for those parameters within the Study Area if the Health Canada MAC is applied for Lead, or 3.5% of the analyzed wells if the ODWQS MAC is applied for that metal.
- Finally, the exceedance for Barium was returned for a well within the Reference Group.

Aesthetic parameters

The parameters for which Englobe reported exceedances of the aesthetic objectives (AO) that are listed in *Technical Support Document for Ontario Drinking Water Standards, Objective and Guidelines* (as cited by Englobe, 2021) are presented in Table 3 where for each parameter the number of wells from the Study Area that returned exceedances above the AO is indicated and followed by the percentage of that sample population represented by exceedances. The data are taken from the table *Summary of Water Quality Exceedances of ODWQS* presented on page 21 of the Report and that is included at the end of the present document (Table 4) where it can be consulted for further detail such as ODWQS guideline values for each parameter, ranges in results and the total number of wells tested for each parameter.

From the data in Table 3 it can be determined that, in general, the quality of the water from the sampled wells is rather poor based especially on the parameters Total Dissolved Solids, Turbidity, Dissolved Chloride, Iron and Sodium.

Another parameter that was measured but that is not included in the ODWQS, namely Total Suspended Solids (TSS) is quite high in the sampled wells and certainly greater than what was determined for the Baseline Assessment as will be discussed in the following paragraphs.

Table 3. Water Well Test Results from the Study Area; Aesthetic Parameters

AESTHETIC PARAMETERS	QUANTITY OF EXCEEDENCES	% OF WELLS ANALYZED
Colour	2	2.9
Total Dissolved Solids	44	62.9
Dissolved Organic Carbon	1	1.4
Turbidity	15	21.4
Dissolved Chloride	15	21.4
Iron	48	68.6
Manganese	3	4.3
Sodium	42	60.0

Comparison with the Baseline Assessment

In Appendix I to the Report, Englobe has provided a limited number of statistics that allow for comparison of Englobe's results with those reported for the Baseline Assessment that was completed in 2017, prior to wind turbine construction in the Study

Area (AECOM, 2017). The statistics are based on 57 sampled wells from the Baseline Assessment and 68 sampled wells from the Englobe program in 2021. Following is a list of 3 parameters that can be considered proxies for the general quality of drinking water as indicated by Englobe on page 13 in the Report. The percentages indicated represent the increases in mean values of the measured parameters from 2017 to 2021.

- Iron : +66%
- TSS : +51%
- Turbidity : +35%

In the Report a comparison is also made between the results for Iron from the 20 wells assigned to the Group Closest to Wind Turbines by Englobe and results from 19 of the same wells as reported for the Baseline Assessment. In that group the mean values for Iron indicate an increase of 100% from 2017 to 2021.

The parameters that were tested for the Extended Analytical Suite during Phase I and for the Additional Analytical Suite during Phase II of the Englobe study were not tested during the Baseline Assessment thus no comparisons are possible for those parameters.

Comparison of the Study Area with the Reference Group

As mentioned above, Englobe sampled 9 wells (the Reference Group) that are situated outside the Study Area and that source water from the same aquifer that sits atop the Kettle Point black shale bedrock as do the wells inside the Study Area. The Reference Group provides data on well water composition at localities that are outside of the footprint of the North Kent industrial wind complex and that would not be expected to have been affected by construction or operation of the wind turbines. Following are comparisons for 3 parameters that can be considered as proxies for well water quality as stated in the Report. The indicated percentage values represent the differences between mean values determined by Englobe for the 20 wells in the Study Area that are assigned to the Group Closest to Wind Turbines and the 9 wells in the Reference Group; in all cases the positive values indicate higher mean values for the former.

- Iron : +83%
- TSS : +160%
- Turbidity : +300%

Also it should be noted that exceedances in Lead and Arsenic were determined for several wells from with the Study Area and none were identified in the Reference Group.

CONCLUSIONS

In the following paragraphs conclusions are first presented regarding the quality of drinking water sourced from wells in the Study Area. The presence of potential contaminants in the tested water and potential health risks that might be associated with consumption of the well water within the Study Area are then discussed. Finally, several recommendations are presented for future work that would provide for a clearer picture of the overall quality of well water and of any potential health risks associated with its consumption.

Water Quality

Based on the results presented in the Report and comparison to those in the Baseline Assessment, three statements can be made regarding the general water quality within the Study Area.

- The general water quality in the Study Area is rather poor as indicated by numerous exceedances for multiple aesthetic parameters including Turbidity, Total Dissolved Solids, Total Suspended Solids and Iron. The analytical results provided in the Report support the self-reported water quality issues for discoloration, odour, taste and sediment issues that were indicated by residents in response to Englobe's pre-sampling Water Well Survey.
- Comparison of the results generated by Englobe's work with those in the Baseline Assessment strongly suggest a significant deterioration in general well water quality within the Study Area between 2017 and 2021. This result is certainly consistent with well water interference having occurred within the Study area since 2017, potentially due to construction and/or operation of the North Kent wind turbines.
- Comparison of Englobe's results from the Study Area with their results for the Reference Group of wells strongly suggests that well water within the former, i.e., within the footprint of the North Kent wind complex is of significantly lower quality than well water within the latter. This result suggests that well water interference that might have occurred within the Study area since 2017 would not have affected the wells within the Reference Group.

Potential Contaminants and Health Risk

Health risks arising from the consumption of well water could potentially be associated with concentrations of disease-causing organisms or unsafe concentrations of toxic chemicals in the water. Several contaminants of concern are identified in the tested well water from the Study Area including Lead, Arsenic, and Total Coliforms. An exceedance in Barium was determined for one well within the Reference Group. Many of the elevated concentrations that were identified were based on exceedances of provincial aesthetic-based drinking water criteria (protective of appearance, staining, taste, odour, *etc*.), and are not based on health concerns at the current measured concentrations although the results presented by Englobe do indicate that the quality of the water is generally poor, that it has apparently deteriorated since 2017 and that the apparent deterioration seems to have been confined to the Study Area.

For most chemicals observed exceeding health-based criteria (*i.e.*, dissolved bromate, fluoride, arsenic, barium, lead, and methylene chloride), typically only one well was determined to have elevated concentrations (elevated fluoride observed in 17.1% of the wells was the exception), and these exceedances appeared to be marginally over the provincial benchmark. This would suggest a lack of wide-spread health concerns related to drinking water quality within the study area, based on the limited set of wells sampled to date.

Whether any of the contaminants listed above would pose either or both of a short-term (acute) or longer-term (chronic) health risk due to consumption of water from the tested wells or from other wells in the Study Area remains somewhat uncertain at present due to several factors, including the following.

- **Bioavailability** – At present there is a lack of knowledge regarding the general bioavailability of the contaminants. For example, assuming that the source of the metals such as Lead and Arsenic is not in the residential plumbing systems but rather in the aquifer then it seems most likely that they would be derived from particles of the black shale that were visibly identified on filtration systems by Englobe and that is known to be enriched in several potentially toxic chemical components, including Lead and Arsenic. If these contaminants are tightly bound to particles within the drinking water, then there is less chance for them to be absorbed into the body following consumption (*i.e.*, they will largely pass through an individual's gastrointestinal tract unchanged and be excreted). Understanding the bioavailability of the metal contaminants would therefore require, at least, an understanding of whether the metals are contained within black shale fragments or if they might be, in whole or in part, in solution. Additional bioaccessibility analyses might provide further clarification as to the potential toxicity and ultimately health risk associated with ingestion of the drinking water containing any contaminants.
- **Sparse Sampling** – The total number of wells sampled and tested by Englobe within the Study Area is rather limited. For instance, 189 wells from the Study Area were sampled and tested for the Baseline Assessment (AECOM, 2017) whereas 61 wells were sampled and tested by Englobe with 57 of those wells having been tested for the Extended Analytical Suite (Phase I) or the Additional Analytical Suite (Phase II). Hence the absolute number of wells studied as well as the spatial coverage of the Study Area does not allow for generalization of potential health risks with a high level of confidence. Also, although the absolute number of wells that returned exceedances for Lead and Arsenic is small it does represent 3.5% of the wells analyzed for those parameters (or 5% if the Health Canada MAC for Lead were accepted) and there is a potential for a larger number of wells in the study area to also have exceedances in those metals.

Recommendations

The Expert Panel provides the following recommendations for further study with a focus on expanding the available data set for water wells in the Study Area, application of statistical analyses and detailed investigation of bioavailability of contaminants in the well water and in solids that are in suspension within the water.

- Further sampling of well water should be carried out to provide a larger data set and a more geographically complete data coverage. The more complete data set and coverage would lead to more robust statistical analyses than are possible at present and could allow for a better understanding of the spatial distributions of contaminants and potential health risks. For instance, the current sparse data set suggests that poorer water quality and also metals exceedances might be associated more strongly with the Group Closest to Wind Turbines although the data set is insufficient for that relationship to be confirmed.

- Spatial statistics generated for maps prepared on a Geographical Information System (GIS) platform would allow to document the spatial distributions of values for all parameters analyzed. Such maps and spatial statistics could allow to identify potential “problem” areas where water quality and/or health risks might be prominent and would also allow for identification of any obvious correlations between concentrations of various parameters in the well water. It is suggested that this work could be started soon using the existing data. New data from further sampling and testing could then be easily added to the spatial database.
- Following the previous point, plotting the data in map format might also confirm or disprove a potential relationship between certain exceedances and geological structures in the underlying bedrock. For example, simple visual inspection of a map of the sampled wells reveals the 2 wells that returned exceedances for Lead (according to Health Canada guidelines) and the one well that returned an exceedance for Arsenic appear to define a roughly East-West lineament that would be approximately parallel to and possibly spatially associated with a known fault structure that crosses the Study Area, namely the Electric Fault (Easton and Carter, 1995) or some associated fault. Such bedrock structures could potentially focus the flow of groundwater and would also be the loci of comminuted (finely ground) black shale that is enriched in several potentially toxic metals. It is stressed that a relationship between geological structures and water quality in the Study Area remains for now very speculative.
- Multivariate statistics should be used to test for correlations of different parameters. As an example, for 2 wells that returned exceedances for Lead (according to Health Canada guidelines) there are corresponding anomalously high values (not in exceedance of guidelines) for Arsenic. Understanding if such potential correlations between parameters might exist at the scale of the Study Area could offer a guide to better understand the potential health risks associated with consumption of well water.
- An effort should be made to capture solid particles that are in suspension in well water potentially by filtering water samples at the analytical laboratory. Then, filtered water and solid fraction could be analyzed separately to determine if one, the other or both might be enriched in contaminants. The resulting information might be of use in determining bioavailability of contaminants.
- Following the previous point, samples of the captured solid fraction might also be analyzed in detail for grain size and mineralogy, both of which could have an influence on bioavailability.
- Should elevated concentrations of metals be identified in the solid fraction, bioaccessibility testing could be considered to determine the leachability of these chemicals with an individual’s gastrointestinal tract to determine whether these chemicals are actually sufficiently absorbed within the body after ingestion so as to pose a potential health concern.

- Five wells were identified with elevated total coliform levels. Total coliforms are a group of bacteria that are naturally found on plants and in soils, water, and in the intestines of humans and warm-blooded animals. These are likely indicative of contaminated surface waters impacting that individual's well (typically after a large rainfall or precipitation event). The presence of elevated total coliforms should trigger follow-up actions to investigate the cause of the positive results, and mitigate the potential health risk for that particular drinking water well.
- Representatives of local municipality or health unit should contact those home owners with wells showing elevated metal or total coliform concentrations to help facilitate follow-up confirmatory sampling and potential mitigative action, if necessary.
- Finally, consideration might be given to the use of some Health Canada guidelines for maximum allowable concentrations (MAC) of potential contaminants. For instance, as mentioned above the Health Canada MAC guideline for Lead is established to be 5 μg/L whereas the ODWQS guideline is 10 μg/L. Also, Health Canada considers Manganese to be a health-related parameter with a MAC of 120 μg/L in drinking water whereas the ODWQS has adopted only an AO and considers Manganese to be an aesthetic parameter for drinking water quality. At least one of the wells that was sampled and tested by Englobe would have exceeded the Health Canada MAC for Manganese.

Table 4 – Summary of Water Quality Exceedances of Ontario Drinking Water Quality Standards; taken from page 21 of the Englobe report : *Private Well Water and Sediment Sampling and Testing, Scientific Findings Report, Chatham-Kent, Ontario*, dated October 25, 2021.

Parameter	Parameter Type	Standard	Critical Value	Quantity of Wells Sampled	Range in Water Quality Results	Quantity of Water Well Exceedances
Dissolved Bromate[1]	Inorganic	Reg. 169/03	0.01 mg/L	66	<0.0095 – 1.0 mg/L	1 (1.5%)
Colour	Inorganic	AO[2]	5 TCU	70	<2 – 7 TCU	2 (2.9%)
Total Dissolved Solids	Inorganic	AO[2]	500 mg/L	70	30 – 1,730 mg/L	44 (62.9%)
Fluoride[1]	Inorganic	Reg. 169/03	1.5 mg/L	66	<0.1 – 2.2 mg/L	12 (17.1%)
Dissolved Organic Carbon	Inorganic	AO[2]	5 mg/L	70	0.19 – 8.6 mg/L	1 (1.4%)
Turbidity	Inorganic	AO[2]	5 NTU	70	<0.1 – 210 NTU	15 (21,4%)
Dissolved Chloride	Inorganic	AO[2]	250 mg/L	70	4.4 – 880 mg/L	15 (21,4%)
Arsenic[1]	Metals	Reg. 169/03	10 µg/L	66	<1.0 – 14 µg/L	1 (1.5%)

[1] Health-related parameter regulated under the Ontario Drinking Water Quality Standards (Ontario Regulation 169/03)

[2] Aesthetic objective for parameters that may impair taste, odour or colour of water, or which may interfere with good water quality control practices.

Parameter	Parameter Type	Standard	Critical Value	Quantity of Wells Sampled	Range in Water Quality Results	Quantity of Water Well Exceedances
Barium1	Metals	Reg. 169/03	1000 µg/L	66	<1.0 – 1,600 µg/L	1 (1.5%)
Iron	Metals	AO[2]	300 µg/L	70	<0.90 – 11,000 µg/L	48 (68.6%)
Lead[1]	Metals	Reg. 169/03	10 µg/L	66	<0.5 – 41 µg/L	1 (1.5%)
Manganese	Metals	AO[2]	50 µg/L	70	<2.0 – 220 µg/L	3 (4.3%)
Sodium	Metals	AO[2]	200000 µg/L	70	14,000 – 630,000 µg/L	42 (60.0%)
Total Coliforms	Bacteriolog ical	Reg. 169/03	0 CFU/100mL	70	0 – 210 CFU/100mL	5 (7.1%)
Methylene Chloride[1]	Volatile Organic Compound	Reg. 169/03	50 µg/L	49	<0.50 – 94.1 µg/L	1 (2.05%

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APPENDIX 1: BIOGRAPHIES OF THE EXPERT PANEL MEMBERS

Keith Benn, PhD, P. Geo.

- 2008 – present : Professional Geoscientist working internationally in the Minerals Industry in Management and Executive roles (including Kinross Gold; St. Andrew Goldfields; Columbus Gold; Goldcorp) and as an Independent Consultant.
- 1991 – 2008 : Assistant then Associate Professor of Earth Sciences, University of Ottawa
- Local member of the Expert Panel

Ronald Brecher, PhD, DABT

- 2013 – present: Independent Consultant specializing in toxicology, risk assessment and risk communication
- 2012 – 2013: Senior Scientist for Public Health Toxicology and Risk Communication, Public Health Ontario (term position)
- 2009 – 2013: Vice President, Toxicology and Risk Assessment Division, MTE Consultants Inc, a multidisciplinary science and engineering consulting firm based in Kitchener, ON.
- 1992 – 2009: Founder and Principal, GlobalTox International Consultants Inc., a toxicology, pathology and pharmacology-focused consulting firm based in Guelph, Ontario

Mark Chappel, MSc, DABT

- 18 years of experience focused on human health toxicology, risk assessment, exposure modeling, and development of regulatory guidance limits for chemicals and other constituents in air (volatiles, particulates), soil, water, food, consumer products, industrial products and other media.
- 2010–Present: Principal Toxicologist, Vice-President and Co-Founder of NovaTox Inc., Guelph, Ontario.
- 2009–2010: Supervising Health Scientist, ChemRisk Canada Co, Guelph, Ontario.
- 2003–2009: Staff Toxicologist, AMEC Earth and Environmental (now Wood Group), Cambridge, Ontario.
- 1999–2003: Senior Research Toxicologist, Ministry of the Environment, Conservation and Parks, Standards Development Branch, Toronto, Ontario

Glenn Ferguson, PhD, QP_{RA}

- 2001-present - Vice President, Environmental Health Scientist, Intrinsik Corp, Environmental Health Division

- Adjunct in the School of Public Health and Health Systems, University of Waterloo
- 2015 – ongoing - Member of the Ontario Ministry of the Environment, Conservation and Parks (MECP) Toxicity Reference Value (TRV) Expert Review Panel
- 2017 – ongoing - Member of the MECP Excess Soil Standards Working Group
- 1998-2001 Environmental Scientist / Project Manager, Program Director, Brownfield Risk Management, Cantox Environmental Inc., Mississauga, Ontario

Shelley Harris, PhD

- Associate Professor in Epidemiology and Occupational and Environmental Health in the Dalla Lana School of Public Health at the University of Toronto.
- Scientist in Population Health and Prevention at the Occupational Cancer Research Center.
- Active research includes the development of methods to measure and predict exposures for large-scale epidemiologic studies and the estimation of human exposures to environmental contaminants using biological markers.
- Principle Investigator of the Ontario Environment and Health Study, a study of environmental sources of PBDEs and organophosphorus flame retardants and risk of breast cancer in young women.
- Leads the North American Pooled Project (NAPP) in collaboration with the U.S. National Cancer Institute, to study the risks of pesticide exposures on non-Hodgkin lymphoma, Hodgkin Lymphoma and Multiple Myeloma.
- Funded by the WSIB, MOL, CIHR, Health Canada and the Canadian Cancer Society to investigate associations between environmental and occupational exposures and risks of colorectal, bladder, kidney, breast and hematologic cancers.

APPENDIX 2: ANALYTIC TESTS

Table 1: Standard suite of tests

- Alkalinity (as CaCO3)
- Ammonia as N
- Bromide
- Calcium
- Chloride
- Colour
- Dissolved Organic Carbon
- E. Coli (bacteria)
- Electrical Conductivity
- Fluoride
- Iron
- Magnesium
- Manganese
- Nitrate as N
- Nitrite as N
- pH
- Potassium
- Sodium
- Sulphate
- Total Coliforms (bacteria)
- Total Dissolved Solids
- Total Hardness (as CaCO3)
- Total Suspended Solids
- Turbidity

Table 2: Extended suite of tests

- Escherichia coli (E. coli)
- Total coliforms
- Alachlor
- Antimony
- Arsenic
- Atrazine + N-dealkylated metabolites
- Azinphos-methyl
- Barium
- Benzene
- Benzo(a)pyrene
- Boron
- Bromate
- Bromoxynil
- Cadmium
- Carbaryl
- Carbofuran
- Carbon Tetrachloride
- Chloramines
- Chlorate
- Chlorite
- Chlorpyrifos
- Chromium
- Cyanide
- Diazinon
- Dicamba
- 1,2-Dichlorobenzene
- 1,4-Dichlorobenzene
- 1,2-Dichloroethane
- 1,1-Dichloroethylene (vinylidene chloride)
- Dichloromethane
- 2,4-Dichlorophenol
- 2,4-Dichlorophenoxy acetic acid (2,4-D)
- Diclofop-methyl
- Dimethoate
- Dioxin and Furan
- Diquat
- Diuron
- Ethylbenzene
- Fluoride
- Glyphosate
- Lead
- Malathion
- Mercury
- 2-Methyl-4-chlorophenoxyacetic acid
- Metolachlor
- Metribuzin
- Microcystin LR
- Monochlorobenzene
- Nitrate (as nitrogen)
- Nitrilotriacetic Acid (NTA)
- N-Nitrosodimethylamine (NDMA)
- Paraquat
- Pentachlorophenol
- Phorate
- Picloram
- Polychlorinated Biphenyls (PCB)

Prometryne	Trihalomethanes	Lead-210
Selenium	Uranium	Polonium-210
Simazine	Vinyl Chloride	Radium-224
Terbufos	Xylenes	Radium-226
Tetrachloroethylene (perchloroethylene)	Nickel	Radium-228
2,3,4,6-Tetrachlorophenol	Vanadium	Thorium-228
Toluene	Molybdenum	Thorium-230
Triallate	Copper	Thorium-232
Trichloroethylene	Zinc	Thorium-234
2,4,6-Trichlorophenol	Haloacetic acids	Uranium-234
Trifluralin	Beryllium-7	Uranium-235
	Bismuth -210	Uranium-238

Table 3: Parameters used for additional testing in Phase II (17 properties sampled)

Inorganics	**Metals**	
Dissolved Bromate	Antimony	Mercury
Fluoride	Arsenic	Molybdenum
Free (WAD) Cyanide	Barium	Nickel
	Boron	Selenium
	Cadmium	Uranium
	Chromium	Vanadium
	Copper	Zinc
	Lead	