WorleyParsons
resources & energy

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Concerned Citizens of Thorhild County
c/o Betty Kolewaski

Delivered via Email: bkolewaski@shaw.ca

Dear Ms. Kolewaski:

RE: HYDROGEOLOGICAL REVIEW OF PROPOSED LANDFILL FACILITY, THORHILD COUNTY, NW 18 & 19-61-20 W4M

1. INTRODUCTION

Concerned Citizens of Thorhild County (CCTC) have indicated that they require an independent hydrogeological review of the proposed Thorhild Landfill (the "Site"). The proposed location of the Landfill is NW 18 & 19-61-20-W4M. CCTC have hired a second independent consultant to complete the regulatory and design/construction review for the facility. At the request of CCTC, WorleyParsons has completed a preliminary review of selected reports prepared for Waste Management of Canada Corporation (WMCC) in order to provide a preliminary evaluation of the hydrogeological conditions beneath the proposed Landfill.

2. HYDROGEOLOGICAL REVIEW

Based on the review of the reports provided by CCTC and other published reports referenced herein, WorleyParsons provides the following comments in regards to the regional and Site hydrogeology.

2.1.1 Regional Geological and Hydrogeological Conditions

Although a description of the regional geology/hydrogeology is provided in the Millenium EMS Ltd. (MEMS) hydrogeological assessment report (MEMS 2007a), a more thorough understanding on the Site hydrogeology within the regional context would be of benefit in determining potential migration pathways and off-site receptors. For instance, a preliminary review of selected water well drillers' reports for the areas adjacent to the Site (AENV 2009) suggests that varying thickness of sand and sand/gravel deposits within the till unit, as well as coal units within the upper bedrock units, are prevalent throughout the area. It is also noted that AENV Water Well Drilling Report 0153792, the municipal water well completed for the Hamlet of Newbrook, is completed across a sand and gravel unit extending from approximately 41 to 51 metres below ground surface (mbgs). An upper sand unit approximately 4.5 m thick at 28 mbgs was also reported on this driller's report. In addition, a report prepared by Stein et al. (1994) suggests that the Newbrook wells may be capable of a yield of 645 m^3/day (100 igpm), which would make this sand and gravel unit an expectional aquifer, as defined in the Draft Standards for Landfills (AENV 2007). Although Newbrook is approximately 2.5 km north of the Site, the extent of the sand and gravel unit, or the upper sand unit, is unknown.

A preliminary review of AENV's Approvals for the area suggests that are at least 27 Water Act Licences held by private individuals and the County of Thorhild within a 5-km radius of the Site. Although Stein et al. (1994) suggest that some of the surficial material and bedrock aquifers may provide yields that would be considered expectional, as defined in the Draft Standards for Landfills (AENV 2007), apart from a summary table obtained from a 2001 regional groundwater report (Hydrogeological Consultants 2001) there is no information in the MEMS hydrogeological assessment (MEMS 2007a) that indicates that apparent transmissivities or apparent long term yield have been calculated using the surrounding water well data, or that a search of AENV's records was completed to determine if additional studies were conducted as part of the licensing procedures for some of these water wells.

A water well and surface water survey was completed for a 2.4-km radius around the Site by MEMS (2007b). The MEMS report provides summary information on location of the water wells and dugouts, and water quality results surveyed. The map provided with the report indicates that there were a number of locations that MEMS were unable to contact and/or to which access was denied. As well, the information was simply reported in individual forms and not put into a context of how the results of the well survey compare to the regional or Site hydrogeology or the potential interaction that may be expected. The Regulatory disclosure document (Adelantar 2006) indicates that "This assessment will include sampling and testing of landowner water wells within 5.0 km of the Landfill"; however, as indicated, only water wells and dugouts within a 2.4-km radius were tested.

Based on the surficial geology map referenced, a number of meltwater channels are in the area, with one directly adjacent to the east boundary of the Site (Shetson 1990), which coincides with the on-site drainage channel and the headwaters of the Waskatenau Creek (UMA 2007; Figure 4.1 and Figure 1.1, respectively). Typically associated with these meltwater channels are sand and gravel deposits. The MEMS report does not discuss whether the sand and sand/gravel deposits present beneath the Site are connected to these regional meltwater channels. The MEMS report does not discuss the potential effects of isolation, removal, or potential contamination of the Site sand and sand/gravel deposits on the regional meltwater channels or surface waters connected to these channels. Additional assessment is required to determine hydrogeological interaction between the Site, the meltwater channels, and Waskatenau Creek.

As identified in the Draft Standards for Landfills in Alberta (AENV 2007) Section 2.4 (c), "The detailed technical report shall include, at a minimum, all of the following information: (i) a description of the topography, surface drainage patterns, geology, hydrogeology, existing and surrounding land use within 800 metres of the proposed site…." It is WorleyParsons' opinion that the MEMS report is lacking in detailed information beyond the boundary of the Site.

2.1.2 Site Geological Conditions

Based on the information provided, the surficial geology beneath the Site consists of clayey till with saturated silty sand deposits observed in the "till matrix". Extensive bodies of sand were mapped and "may extend off site" (MEMS 2007a; page 9). The total thickness of the surficial material ranges from 8 to 18 m.

Nineteen soil samples representative of the clayey till material were collected from nine of the 108 boreholes installed at the Site and submitted for laboratory testing of Atterburg Limits and soil gradation. The nine boreholes selected are distributed across the Site. The laboratory results suggest that the clayey till material tested was relatively consistent in nature. It is noted, however, that material testing did not include the collection of any undisturbed samples for permeability testing, continuous undisturbed core samples for detailed logging, identification of fractures and photographic record, moisture profiles throughout the geological profile, and laboratory analysis of coarser material or bedrock at the Site. It is realized that material testing is not a specified requirement outlined in the Draft Standards for Landfills in Alberta (AENV 2007); however, it would provide valuable characterization and confirmation of the material properties beneath the Site.

The description of Glacial Till Isopach, Figure 22 of the hydrogeological assessment report (MEMS 2007a; page 10), is incorrect and misleading, since it implies that the total thickness of overburden comprises clayey till, when, in fact, the intertill sand units can reach significant thickness. In other words, this figure represents the total thickness of the surficial material, which includes the sand and sand/gravel units as well as the topsoil, silt, and till units. A more correct title for this Figure should be Surficial Material Isopach.

The inferred extent of the sandy material is shown on Figure 20 as well as the cross-sections present in the hydrogeological assessment report (MEMS 2007a). These deposits are extensive and, as indicated above, extend off site and, therefore, are potential pathways for contaminant migration. The significance of these sandy units to the surrounding environment should be investigated further.

The bedrock consists of "siltstone and shale sequences" with the top of bedrock ranging from 8 to 18 mbgs. Borehole 06-30 was drilled to a depth of 45 mbgs to assess bedrock conditions beneath the Site. The litholog for this borehole indicates that "thin coal layers (<30 cm)" at 20.4 mbgs and a "slight crevasse (0.6 m large)" at 32 mbgs were encountered in this borehole. The "crevasse" suggests that the bedrock is fractured. MEMS indicated that "no significant water bearing zone was encountered"; however, it is not indicated how this conclusion was reached (i.e. were airlift tests conducted throughout the drilling procedure or a test well installed?) The borehole log indicates that an electric log (e-log) was completed for this borehole, but the data were not presented in the report reviewed by WorleyParsons. Based on the borehole log, a monitoring well was not installed, but there is no indication of how this deep borehole was abandoned

There were a number of other boreholes that were drilled and not completed as monitoring wells. These boreholes ranged in depth from approximately 6.1 to 18.25 mbgs, with the deep boreholes terminated in the bedrock. The borehole logs indicate that these were backfilled with drilling cuttings and bentonite. For one borehole, terminated in bedrock at 15.25 mbgs, the method of abandonment was not identified. This abandonment procedure is inconsistent with the statement made on page 5

"The other seventeen boreholes were drilled and backfilled with bentonite to surface" (MEMS 2007a). The method of abandonment is important for boreholes not completed with monitoring wells, since poor abandonment procedures can allow potential contaminants to migrate vertically, thus compromising the hydrogeologic integrity of the site before any development even proceeds. In addition, "slough sand and groundwater entering the borehole" (MEMS 2007a; page 8) can also cause difficulty, not only in well completion, but also in abandonment procedures.

2.1.3 Site Water Level Measurements

Water level data were presented for only two monitoring events completed in October and December 2006. MEMS (2007a) indicated that "Water level measurements from December 2006 may not be representative of equilibrated conditions". In addition, groundwater levels in the fall and winter months typically represent seasonal lows with high water levels measured in the spring and early summer, during snow melt and spring rains. Therefore, it is likely that the reported "surficial groundwater table" of 1.5 to 3.5 mbgs does not represent seasonal highs. Additional groundwater monitoring is required to assess whether all monitoring wells represent "equilibrated conditions" and seasonal groundwater fluctuations across the Site. Equilibrated conditions are required to fully understand the hydrogeology of the Site.

The Wetland Assessment identified 28 ha of wetlands on the Site (MEMS 2007c). It was noted that open water areas were not observed at the time of the Site inspection. Notwithstanding, it is expected that water levels in and around the wetland areas would be close to ground surface and that these wetland areas would act as a zones of groundwater recharge or discharge on the Site. The relationship between the wetlands and the groundwater at the Site is not discussed in the MEMS report.

2.1.4 Site Hydraulic Conductivity Tests and Groundwater Flow Velocity

Hydraulic conductivity tests were conducted on 19 monitoring wells completed in various geological units. The reported hydraulic conductivity values for clayey till (eight tests) ranged from 2.9×10^{-9} to 5.1×10^{-7} m/s. Clayey till with sand pockets (six tests) ranged from 2.0×10^{-8} to 5.1×10^{-7} m/s. Till/sand shale bedrock contact (five tests) ranged from 3.9×10^{-8} to 3.4×10^{-7} m/s. Of the 19 hydraulic conductivity tests completed, only six tests representing the clay till were less than 1×10^{-8} m/s (AENV 2007). Review of the analysis for the hydraulic conductivity test indicates that some of the recovery data have multiple slopes. It is not clear which segment of the slope was used to determine the resulting hydraulic conductivity value, and an explanation of why some of the tests had multiple slopes is not provided. There are no piezometers completed specifically in the sand and or bedrock units and, therefore, the hydraulic conductivities of these units are unknown. More detailed information regarding the tests completed to date, as well as additional hydraulic conductivity testing specifically on the sandy units, which would act as preferential pathways to contaminant migration, is required.

The horizontal groundwater velocity was calculated using the geometric mean hydraulic conductivity of the clayey till material. Using the geometric mean is appropriate to represent the average behaviour for a block of material where sandy and clayey lenses are randomly distributed and water tends to flow along a convoluted pathway. In the case of the Site, however, the evidence suggests that the sandy units are linear and trend to the southeast parallel to groundwater flow. A more appropriate way to average the hydraulic conductivity would be the arithmetic mean, which represents the effective conductivity for flow along (i.e. parallel to) layers. Alternatively, to be conservative, the maximum hydraulic conductivity of the sandy units could be used.

It should also be noted that the large difference in hydraulic conductivities of the clayey till could be attributed to the presence of fractures within the clayey till. Fractures within the upper till to approximately 10 m are common in Alberta, and the fractures can act as preferential pathways (Hendry 1982 and 1988). Additional hydraulic conductivity testing and the collection of continuous cored samples across the Site would be useful in providing more detailed information of the geological material and associated hydraulic parameters.

2.1.5 Site Groundwater Chemistry

Groundwater samples were collected from 19 monitoring wells. Apart from a general statement that the groundwater "is considered representative of background conditions and does not show significant impacts from historical activities on site" (MEMS 2007a), groundwater chemistry has not been put into the context of the groundwater flow system. Based on WorleyParsons' preliminary review, there is more than one hydrochemical facies identified beneath the Site. For instance, the concentrations for total dissolved solids (TDS) range from 650 to 5,350 mg/L and sulphate ranges from 116 to 3,440 mg/L. The lower TDS and sulphate concentrations represent fresher groundwater quality and, therefore, a more active groundwater flow system. A more detailed discussion regarding groundwater chemistry, collected from the Site monitoring wells and neighbouring water wells, and how it relates to the Sites and local hydrogeology, is required. It is also noted that the laboratory reports provided in Appendix F are labelled as "Preliminary Results"; therefore, it needs to be confirmed that the results were not changed at the finalization of the laboratory reports.

3. SITE SUITABILITY FOR LANDFILL DEVELOPMENT

Based on the geological and hydrogeological data presented to date, and the items of concern identified above, the following comments in regards to the suitability of the Site for landfill development are provided.

- It has not been proven that there are no underlying aquifers beneath or adjacent to the Site (Section 2.1 (c) (i); AENV 2007). Given the large number of groundwater users in the area and the reported high yields of both surficial and bedrock aquifers in the area (Stein et al. 1994), a thorough understanding of the bedrock geology, including the distribution of aquifers within the surficial and bedrock material surrounding the Site, is required.
- The upper bedrock has not been characterized to the extent required to assess its hydraulic properties and determine whether it is competent or fractured. Given that bedrock is within 10 m of ground surface in some locations, undisturbed samples for laboratory testing were not collected, and monitoring wells were not installed to isolate the bedrock material for hydraulic conductivity or yield testing.
- The overburden is heterogeneous. Linear sand channels are at shallow depth and likely extend off site, possibly connecting to surface water features. Total overburden thickness ranges from 8 to 18

m, and its hydraulic conductivity ranges from 2.9×10^{-9} to 5.1×10^{-7} m/s. Specific hydraulic conductivity testing of the sandy units beneath the Site is required. Assuming the vertical hydraulic conductivity is one order of magnitude lower than the horizontal value, and using the higher hydraulic conductivity value for conservative estimation purposes, the minimum thickness of clayey till material required to meet the equivalent of 10 m thickness of 1×10^{-8} m/s criteria as identified in Section 2.1 (c) (iii) of the Draft Standards for Landfill (AENV 2007) is 25.5 m.

Based on the information as presented, the site does not appear to meet all requirements of the Draft Standards for Landfills in Alberta. It should be noted that WorleyParsons has not reviewed the proposed layout of the landfill or design and, therefore, has not provided comment in this regard.

4. CLOSURE

We trust that this report satisfies your current requirements and provides suitable documentation for your records. If you have any questions or require further details, please contact the undersigned at any time.

Sincerely,
WorleyParsons

Gregory Haryett, P.Geol.
Senior Hydrogeologist

M.D. Maccagno, M.Sc. P.Geol.
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PERMIT TO PRACTICE
WORLEYPARSONS CANADA LTD.
Signature
Date April 23, 2009
PERMIT NUMBER: P 2306
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

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