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Dear Counsel:

**RE: RESPONSE BY WASTE MANAGEMENT TO MY REPORT DATED JANUARY 12, 2006, RE HUMAN HEALTH RISK ASSESSMENT (RICHMOND LANDFILL)**

The following are my responses to comments (March 2006) submitted by Waste Management to the Ontario Ministry of the Environment in response to my critique of Waste Management's Richmond Landfill Environmental Assessment (EA). The comments by Waste Management are attached as Appendix A to this opinion letter.

**Introduction**

The Richmond Landfill has been in operation at the same site since 1954. The current landfill may serve as a potential source of contaminants, and should therefore be considered as an integral part of the evaluation of baseline conditions in relation to the proposed expansion. In fact, the approved Terms of Reference (ToR) for the Richmond Landfill EA specifically required Waste Management to identify and evaluate baseline conditions:

> The baseline conditions will take into account the existing landfill site. The overall impact assessment for the expansion will consider both the baseline conditions and the impacts of the expansion over a range of operating periods (ToR, page 7, paragraph 3).

The issue of baseline conditions of the existing landfill site has also been brought forward by the Canadian Environmental Assessment Agency (CEAA) (letter to Waste Management Corporation dated April 13, 2006).

**Response to WM Comments 3.1 and 3.2**

**Landfill Gas**

This reviewer reiterates that, in accordance with the conditions of the ToR, baseline air quality data should have taken "into account the existing landfill site" (ToR, page 7, paragraph 3). Moreover, in ToR Appendix B (Potential Impacts and Study Methods), one of the components is "exposure assessment (to quantify the exposure of receptors to the chemicals of concern" (Table B-1, B-3). Following exposure assessment, the next logical step is "hazard assessment" which is designed "to quantify the toxicity of chemicals of concern" (Table B-1, pg. B-3). It is only in "risk characterization" that the strategy is designed "to predict the likelihood of adverse health effects related to gaseous landfill emissions" (Table B-1, pg. B-3). These are sequential and logical steps for assessment of impacts of exposure to chemical components of landfill gas, and they flow directly from the specific obligation under the ToR to ensure that the impact assessment will include baseline conditions. However, it is my conclusion that this ToR obligation was not satisfied by the EA and supporting documents.

In my professional opinion, the EA predictions should have been based upon actual baseline data obtained under local conditions (i.e. in the area in proximity to Richmond Landfill and in the Tyendinaga Mohawk Territory). Baseline conditions do exist, and therefore it is possible to collect data in the surrounding area that will "take into account the existing landfill site" (ToR, page 7, paragraph 3). It is of interest that in the ToR, the method for the evaluation of the "potential for the release of landfill gas and odours" includes a strategy to "collect and test data from the existing site and measure the quality and physical parameters to predict landfill gas quantity" (ToR, Table B-1, pg. B-2). In summary, substantive data have not been provided in either the HHRA or the EA to support the contention that Richmond Landfill will not have an adverse effect on the health of community residents including the Mohawks of the Bay of Quinte (MBQ). This data deficiency is highly problematic, especially since residents report that they have frequently experienced landfill odours which have eroded the quality of their environment, caused material discomfort, and otherwise disrupted the use and enjoyment of their properties. This situation is underscored by an order (dated March 25, 2003) issued by the MOE to the proponent to mitigate the odours migrating from the landfill to residential properties. Residents report that the odours have not only remained unabated but have increased in intensity**.**

**Response to WM Comment 3.3**

**Landfill Gas and Odours**

Based upon my interviews with local residents and the MBQ, it appears that persons living in the vicinity of Richmond Landfill have no confidence in the proponent's conclusion that there will be minimal adverse health impacts on the communities, especially since the outcome is based on modeling predictions rather than comprehensive baseline data. In accordance with the terms of the ToR, exposure assessment is defined by a requirement "to quantify the exposure of receptors to the chemicals of concern" (ToR, Table B-1, pg. B-3). Data for the "chemicals of concern" are not available to demonstrate that the adverse effects that will be sustained by area residents are indeed minimal. In this regard, many residents currently experience landfill gas and odours virtually on a daily basis. Although a gas collection and flaring system was installed in 2001 (EA, pg. 5-2), the landfill gas odours remain unabated within the community, and migration of the gas out of the landfill site appears to be a common and persistent occurrence.

Another issue that has not been adequately addressed by the proponent is the discomfort caused by the landfill "stench", exacerbation of existing respiratory conditions, and diminished quality of life. In summary, the baseline conditions for landfill gas and odours have not been adequately characterized in either the EA or the HHRA.

**Response to WM Comment 3.4**

**Explosive Hazard**

As reported previously, methane is an odorless and colorless gas that is highly explosive in the presence of air at a volume of 5% to 15%. Methane concentrations within landfill disposal areas are typically at about 50% by volume and therefore explosions are unlikely to occur within the fill boundaries. However, as methane migrates out of the landfill and gets diluted, conditions for explosions become more prevalent.

The MOE Landfill Standards Guideline (Regulation 232/98) sets concentration limits for methane.

*The concentration limits specified in the Regulation are:*

- *less than 2.5 percent methane gas in the subsurface of the property boundary,*
- *less than 1.0 percent methane in an on-site building, or its foundation, and*
- *less than 0.05 percent methane (i.e. not present) in a building, or its foundation, which is located off-site.*

No data have been provided in the EA to demonstrate ongoing monitoring of methane gas levels emanating from the existing site. The presence of landfill odours signifies that methane has migrated out of the landfill. It is not known if there are methane contributions from subsurface soil. The EA has focused on predicted landfill emissions and considered the adverse effects as minimal. However, the EA begs an important question: What are the current baseline concentrations of methane gas?

If the landfill emissions currently emanating from the existing landfill cannot be controlled, area residents have no confidence in assurances by the proponent that there will be minimal effects in the scenario of an expanded landfill. It is further recognized in the EA that there will be increased odour effects during the reclamation phase that will last for ten years. The expectation that area residents will be able or willing to tolerate living under these conditions for a decade is unconscionable and unsupportable.

**Response to WM Comment 3.5**

**Asphyxiation Hazard**

Landfill gas poses an asphyxiation hazard when it accumulates in an enclosed space (e.g. basement or crawl space) in concentrations high enough to displace existing air, resulting in an oxygen-deficient atmosphere. By volume, landfill gas typically contains 45% to 60% methane and 40% to 60% carbon dioxide. Landfill gas also contains small amounts of nitrogen, oxygen, ammonia, non-methane organic compounds (NMOCs), sulfides, hydrogen and carbon monoxide. Ambient air contains approximately 21% oxygen by volume. Any of the gases in landfill gas can, either individually or as a mixture, pose an asphyxiation hazard if the levels are sufficiently high so as to create an oxygen-deficient environment. Carbon dioxide may cause an asphyxiation hazard concern if it migrates from the landfill and collects in a confined space. It is denser than air, is colourless and odourless, and is therefore not readily detectable. Carbon dioxide concentrations of 10% or more can cause unconsciousness or death. Lower concentrations may cause symptoms such as headache, rapid breathing, shortness of breath and dizziness.

In view of the above, measurement of carbon monoxide alone is not sufficient to address the asphyxiation hazard of a landfill. Moreover, the location of the maximum discrete receptor in which the sample was obtained should be identified. How many measurements were taken and over what period of time? Do the measurements span the various seasons in order to capture all weather conditions? These data should have been provided in the EA or HHRA to demonstrate that actual measurements were taken and to confirm that they “were all less than recommended air quality criteria”. If these were merely predicted data, they cannot be regarded as being representative of baseline conditions currently prevalent in the vicinity of Richmond Landfill or in the Tyendinaga Mohawk Territory.

It is recognized that the TOR listed 17 NMOCs that were to be included in the Health Assessment of Air Emissions. However, the US EPA AP-42 provides emission factors for over forty constituents of landfill gas. In this regard, the CEAA has questioned whether “decisions made at the Terms of Reference (ToR) stage regarding contaminants of concern are still relevant” (letter to Waste Management Corporation dated September 12, 2005).

**Response to WM Comment 3.6**

**Landfill Fires**

Although landfill fires are not implicitly mentioned in the ToR, these events should have been included and/or addressed in the EA or HHRA because of the potential health and safety issues that they pose. Landfill fires can burn underground for days or weeks. The heat produced can cause chemicals to volatilize or degrade and enter the environment. The products in a landfill that are the most likely source of chemical releases include paints, solvents, cleaners, pesticides or chemical additives in consumer products. These chemicals may be released in the smoke from the fire. It should be noted that although a single chemical in the smoke may not be present in concentrations high enough to cause health effects, the effects of a mixture of chemicals may produce adverse health reactions. Ambient air sampling and monitoring should be carried out to identify the contaminants being released during the fire. For example, at certain particulate or chemical concentrations, the actions taken might be for people to remain indoors and close windows and doors or it may be appropriate to evacuate people as the concentrations increase. The D & O report for the proposed expansion is currently not available to public or agency reviewers, and hence it is not known what measures are proposed to prevent fires and to prevent adverse effects in the event of a landfill fire.

**Response to WM Comment 3.7**

**Animal and Bird Problems**

The terms of the ToR (Public Health and Safety) specifically requires that "disease transmission via insects or vermin" must be addressed by the proponent. This was not done in the HHRA, and a generalized discussion of bird/vermin populations in the "Natural Environment" component (DP #7) is an inadequate substitute for a detailed analysis of human health impacts related to exposure to disease-carrying species.

**Response to WM Comment 3.8**

**Human Health Risk**

In accordance with the approved ToR, "baseline conditions that will take into account the existing landfill site" should be included in the impact assessment within the EA. In my professional opinion, this does not imply that the Human Health Risk Assessment should limit itself to "predicted landfill emissions", but rather that baseline conditions should have formed an integral part of the assessment.

In this regard, contrary to the proponent's claims, the guidelines promulgated by ATSDR are highly appropriate for impact assessment of the existing landfill and existing baseline conditions, which should have included public exposure as part of the baseline data. The residents who are living in the vicinity of Richmond Landfill and who experience the landfill odours almost on a daily basis do not regard the predicted exposures as having any relevance to them. They know very well what the "baseline conditions" of the existing landfill are, and are convinced that the impact of the landfill on their lives will only get magnified by an expansion.

The U.S. Congress established ATSDR in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as the Superfund Law. This law set up a fund to identify and remediate the hazardous waste sites in the country. The U.S. EPA and individual states regulate the investigation and clean-up of contaminated sites. Under the Superfund Law, ATSDR is charged with assessing the health hazards in communities living near Superfund sites, helping to prevent or reduce harmful exposures and accumulating a knowledge base about the health effects from exposure to hazardous substances. In 1984, amendments to the Resource Conservation and Recovery Act of 1976 (RCRA) authorized ATSDR to conduct public health assessments at hazardous waste sites when requested by the EPA, states, tribes or individuals. ATSDR was also authorized to assist EPA in determining which substances should be regulated and the levels at which substances may pose a threat to human health. The Superfund Amendments and Reauthorization Act of 1986 (SARA) broadened ATSDR's responsibilities in the areas of public health assessments, establishment and maintenance of toxicologic databases, information dissemination and medical education. Thus, ATSDR operates in conjunction with EPA and other regulatory agencies, and as reiterated previously, both agencies use similar data but EPA is focused on site remediation and ATSDR on public health assessment. In my opinion, members of the public should have been informed in this EA process about what chemicals they are being exposed to from landfill gas, at what concentrations, and what the minimum risk levels for individual chemicals are in terms of human health impacts.

**Response to WM Comment 3.9**

**Exposure Evaluation**

Richmond Landfill has been in operation for over fifty years. The ToR was submitted on June 23, 1999. The Human Health Risk Impact Assessment submitted was dated November 2004. Several years were available to collect data from the private wells of the area residents and of the MBQ within the Tyendinaga Mohawk Territory. Instead, drinking water data from the Ontario Drinking Water Surveillance Program at the Napanee Water Treatment Plant were used to represent local drinking water.

In my professional opinion, this represents a flawed approach because private wells are the source of drinking water for the local residents. Moreover, approximately 99% of the private drinking wells within the Tyendinaga Mohawk Territory are classified as potentially GUDI (groundwater under the direct influence of surface water) ("Hydrogeological Study of the Tyendinaga Mohawk Territory", April 30, 2005, XCG Consultants Ltd.). Data from the Napanee Water Treatment Plant can hardly be regarded as being representative of baseline conditions for drinking water for either the residents living in proximity to Richmond Landfill or for the MBQ in the Tyendinaga Mohawk Territory.

**Response to WM Comments 3.9 and 3.10**

**Impacts to surface waters and groundwater**

It should be noted that in contrast to the negative results of hydrogeological analysis presented by Waste Management, the analysis carried out by XCG Consultants Ltd. (dated January 30, 2004) has indicated impacts on groundwater outside the landfill site. This conclusion has been corroborated by additional groundwater sampling (including tritium testing) carried out by XCG at off-site test holes in close proximity to the existing landfill site (XCG report "Groundwater Investigation Vicinity of Richmond Landfill Napanee, Ontario", dated May 24, 2006).

It should also be recognized that because of the fractured limestone bedrock underlying the landfill site, monitoring wells "might easily fail to intersect the deep, narrow, fast-flowing plumes of leachate-contaminated groundwater escaping from the site" (report submitted by Dr. D. M. Carmichael, Department of Geological Sciences and Geological Engineering, Queen's University).

In view of the foregoing, direct analysis of potential contamination of drinking water should have been carried out in the EA or HHRA to assess the public health impact of the landfill on groundwater supplying the drinking water wells. Furthermore, impacts of surface water on the GUDI wells on the Tyendinaga Mohawk Territory should have been assessed by direct analysis of the drinking water wells. Hence, there is a profound lack of sufficient data within the EA or HHRA to demonstrate that there will be no public health impacts via leachate-related exposure routes (i.e. surface water, well water, fish consumption, etc.). In my opinion, this constitutes a significant deficiency within the EA and HHRA.

**Response to WM Comments 3.11 - 3.14**

**Dietary Consumption of MBQ**

The underlying reasons given by the proponent for not carrying out analyses for chemical contaminants in the Tyendinaga Mohawk Territory are that: (1) the reserve "does not fall within the air shed study area"; and (2) "the Hydrogeological assessment indicated that no impacts to surface water was expected".

The MBQ arrived in Ontario in 1784, and occupied the territory that was part of their traditional hunting and fishing grounds. Hence, the area was not unfamiliar territory, and the wild game and fish endogenous to the area formed part of the traditional diet of the MBQ. These species include muskrat, beaver, rabbit, deer, squirrel and waterfowl such as ducks and geese. The animals and waterfowl drink water from the ponds and/or streams, and spend considerable time foraging for food in the water. They can serve as models for confirming whether their environment is contaminated, and whether they have been exposed to potentially toxic chemicals. In this regard, the MBQ are concerned about a recent fish consumption advisory regarding brown bullheads and yellow perch due to elevated levels of dioxins and furans. These are fish species found in the rivers in their territory.

In my opinion, it was inappropriate for the proponent to use data from the U.S. EPA Exposure Factors Handbook (U.S. EPA, 1997) to represent consumption rates of the

MBQ. The environment (geography) and cultural practices of numerous Native American populations are vastly different from those of the MBQ. Local consumption rates are more relevant to the situation in the Tyendinaga Mohawk Territory. Consumption rates are an integral part of determining levels of chemical exposure in the MBQ population. Therefore, utilizing ingestion data from the U.S. EPA Exposure Factors Handbook (U.S. EPA, 1997) serves no relevant purpose in this case.

The proponent states that "an evaluation of several different wild game was completed to determine which of the four wild game species identified would potentially be prone to accumulating the highest concentration of chemicals of concern" (Comment 3.11). The four wild game species evaluated were not identified, and it is not clear whether they are species that reside in the Tyendinaga Mohawk Territory. The method of evaluating lipophilicity was also not identified. Not all chemicals are lipophilic, and therefore a more direct approach would have been to examine the target tissues for chemicals of concern.

Consumption rates of fish of the MBQ were also not determined in the EA or HHRA. Neither was the potential for accumulation of chemicals and metals in different fish species, which may be of relevance because of the differing fat content of various fish and also because the fish may be top-feeders or bottom-feeders. In order to properly delineate baseline conditions, at least fish tissues from the Territory should have been tested. This view is in agreement with that of the CEA Agency, which has reiterated that "information on foods gathered and consumed in the project area such as the tissues of fish species" should be carried out (letter to Waste Management Corporation, dated April 13, 2006).

In addition, the ToR specifically states:

> The assessment criteria, potential impacts and study methods are not intended to be absolute or inflexible. If significant new issues/concerns are identified during the EA which require added studies or criteria, CWS will be flexible in considering their inclusion in the evaluation methodology (ToR, page 7, paragraph 2).

The MBQ have significant concerns about their environment, about the fish and game that have traditionally formed part of their diet, and most of all, about their water quality. These concerns have been repeatedly raised by the MBQ with Waste Management and the Ministry of the Environment. However, in my opinion, the proponent has not carried out adequate studies in or near the MBQ territory to address their concerns, especially in view of the conflicting hydrogeological data produced by MBQ consultants and the proponent.

**Response to WM Comment 3.15**

**Indoor Air**

The proponent's assertion that "predicted ground level air concentrations of contaminants at the maximum receptor location were also assumed to exist indoors" is inaccurate. Indoor air may also receive contributions of contaminants that migrate with soil gas to residential areas and can accumulate in basements or enclosed spaces. Soil gases can move horizontally in the subsurface or vertically into the ambient air at any point where the soil cover is permeable. The landfill gas that can migrate from the existing landfill site into nearby residences may be derived, in part, from subsurface sources. As mentioned previously, indoor air can also receive potential contaminants from the vapour of contaminated water. Indoor air monitoring can measure methane levels for evaluating risks of explosion and chemical concentrations for evaluating potential health risks.

Therefore, a major deficiency in the EA relates to the lack of baseline air quality conditions in residential areas. Predicted ground level air concentrations of contaminants do not provide actual data to identify and determine the levels of contaminants (or lack thereof) in the air that people breathe.

**Response to WM Comment 3.16**

**Chemical Interactions**

It would have been more meaningful to determine chemical interactions if the identities and concentrations of the chemicals are known.

**Response to WM Comment 3.17**

**Landfill Gas**

If Waste Management's interpretation of its EA obligations is correct, then it is surprising and rather disturbing that the proponent was not required to examine any contaminants other than the 17 non-methane organic compounds in the Human Health Risk Assessment. As noted above, the U.S. EPA AP-42 provides emission factors for over forty constituents of landfill gas. In this regard, the CEA Agency has questioned whether "decisions made at the Terms of Reference (ToR) stage regarding contaminants of concern are still relevant" (letter to Waste Management Corporation dated September 12, 2005).

By volume, landfill gas typically contains 45% to 60% methane gas and 40% to 60% carbon dioxide. Methane is implicated as an explosion hazard, and both of the gases are implicated in asphyxiation as they can replace oxygen. This reviewer considers explosion and asphyxiation hazards as dangerous health hazards (see Responses to WM Comments 3.4 and 3.5), and both gases should have been in addressed in the HHRA if the EA truly intended to canvass human health impacts associated with the proposed expansion.

**Response to WM Comment 3.18**

**Chemical Analysis**

Consistent with the terms of the ToR, it is understood that baseline conditions with the inclusion of the existing landfill represent current scenarios. It is also understood that predictions of future scenarios should be based on realistic data from local conditions and in geographical locations, including the area in proximity to Richmond Landfill and the Tyendinaga Mohawk Territory. In my opinion, it is necessary to properly identify and assess current baseline conditions (i.e. impacts from the existing site) in order to generate meaningful and reliable predictions about future impacts under expansion scenarios. Since the EA and HHRA failed to fully describe baseline conditions, the proponent's predictions about impacts from future operating conditions are, in my opinion, incomplete and unreliable.

**Response to WM Comment 3.19**

**Health Effects Evaluation**

As has been emphasized previously (Response to WM Comment 3.8), the U.S. EPA works in conjunction with ATSDR and other regulatory agencies. The U.S. EPA is focused on site remediation and ATSDR on public health assessment. In my opinion, the data from the U.S. EPA should be used for characterization of the site, but in addition, the use of minimum risk levels (MRLs) from ATSDR for health assessment will provide reference levels for chemical compounds that the public (and EA authorities) will find more useful and meaningful. MRLs are an estimate of the daily human exposure to a compound that is likely to be without appreciable risk of adverse health effects for a specified exposure duration. MRLs are set below levels that might cause adverse health effects in most people, including sensitive populations.

**Response to WM Comment 3.20**

**Air Quality**

It is understood from the ToR that the overall impact assessment will include the baseline conditions of the existing landfill site, and the prospective aspects relate to the future scenarios of the proposed expansion. Moreover, under the criteria of the ToR, assessments of residential environments and the effects of the landfill on residential receptors in the vicinity of Richmond Landfill and the Tyendinaga Mohawk Territory are not prospective, but are recognized as current events under baseline conditions. However, adequate data regarding human health baseline conditions were not presented in the EA or HHRA.

**Response to WM Comment 3.21**

**Health Outcome**

Contrary to the claims of Waste Management, health outcome data are not regarded as **statistical epidemiological analysis** but are rather defined as **descriptive epidemiological analysis,** which is carried out to assess whether exposure to site contaminants **could have resulted** in the development or exacerbation of health effects. The landfill has been in operation for more than fifty years, and acquisition of such health outcome data would likely provide important indicators as to whether emissions from Richmond Landfill have produced adverse health outcomes in the surrounding communities and in the MBQ population. Health outcome data are not difficult to acquire and should have formed an important part of the baseline conditions associated with the existing landfill, as required by the ToR.

**Summary and Conclusions**

Having regard for the WM response to my report dated January 12, 2006, it remains my professional opinion that, in the context of human health and safety, the EA and its supporting documents (including the HHRA) remain deficient in relation to the approved ToR and the public interest purpose of the EA Act.

In summary, the EA and its supporting documents do not adequately describe or assess human health baseline conditions, contrary to the ToR. In addition, the EA and supporting documents do not adequately investigate and analyze the full range of potential human health impacts associated with the proposed expansion.

Therefore, on the basis of the information submitted in the EA and supporting documents, it cannot be concluded that the proposed expansion will not pose health risks to area residents and the Mohawks of the Bay of Quinte.

Please contact me if you have further questions about this opinion letter.

Yours truly,

Poh-Gek Forkert, Ph.D.