Overview Assessment of the Potential Public Health, Environmental and Groundwater Resource and Other Impacts of the Proposed Adams Mine Site Landfill

Submitted by

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Executive Summary

Presented in this report is an overall assessment of the potential impacts of the proposed Adams Mine Site Landfill (AMSLF) on public health, groundwater resources, the environment and other interests within the potential sphere of influence of the proposed landfill. A summary of key issues is presented below.

Public Participation in AMSLF Assessment

Metro's public participation proposed landfill impact assessment process did not allow adequate time for peer and public review of many of the key issues that should be reviewed as part of completing the Phase 1 Assessment.

Metro's consultants final reports were made available with inadequate time for review prior to the PLC meeting to which the peer reviewer reported to the PLC on his findings. It should, therefore, not be assumed that Metro's consultants final reports reliably and adequately address the peer reviewers comments on the draft reports.

Potential for Groundwater and Surface Water Pollution by Landfill Leachate

Adequacy of Existing Information. At this time there are significant technical deficiencies in the studies that have been conducted on the geology/hydrogeology and on current groundwater and surface water quality. These deficiencies significantly limit the reliability that Metro and its consultants can justifiably claim regarding the ability of the proposed landfill design, operation, closure and post-closure care to protect off-site pollution of groundwater and possibly surface water by landfill leachate for as long as the wastes in the landfill represent a threat.

While Metro and its consultants state *"The site can be safely designed and operated as a landfill facility."*, this is a premature assessment of the safety of the proposed landfill facility based on what is known today. At this time it can be indicated that it may be possible to develop a "safe" landfill facility at the Adams Mine Site.

Hydraulic Containment Operations. A hydraulic containment mode of operation involving inward groundwater flow into the landfill where the groundwater and leachate are removed from the bottom of the landfill appears to be feasible. Substantial further work needs to be done to demonstrate the reliability of this mode of operation, however.

Gravity Drainage Operations. There are also significant questions about the reliability of the so-called gravity drainage mode of operation that is proposed to be activated at the end of the contaminating lifespan in preventing leachate-derived constituents from polluting groundwaters of the region. Significant additional work needs to be done to demonstrate the reliability of both proposed modes of operation of the landfill.

Service Life of Leachate Removal System. It appears that Metro's consultants may have over-estimated the service life of key components of the leachate removal system. There is a significant potential for blockage of this system by biological growths and chemical precipitation that could impair the ability to maintain an effective hydraulic containment mode of operation that would prevent off-site groundwater pollution by leachate.

Contaminating Lifespan. While Metro's consultants estimate that the contaminating lifespan of the proposed landfill will be on the order of 100 years, there are significant questions about the reliability of this estimate. Insufficient information was presented in the consultants' reports and cited references to justify the 100-year value. It is more likely that the contaminating lifespan of this landfill will be several hundred to a thousand years or more.

If the contaminating lifespan exceeds the expected service life of key components of the leachate removal system, then this landfill may not be granted a license by MOEE based on its current proposed design.

Leachate Generation Rates. Metro's consultants have underestimated the amount of moisture that will enter the landfill through the cover of the closed landfill. This will result in increased leachate production over that estimated. The ramifications of this increased leachate production have not been evaluated.

Leachate Treatment. The proposed leachate treatment system has the potential to provide high degrees of leachate treatment that if properly operated and monitored could protect water quality within the Misema River. The proposed degree of treatment involving the use of a mixing zone for dilution of the hazardous and deleterious chemicals to concentrations below that allowed by MOEE should be increased in order to help protect Misema River water quality from potential adverse impacts of unregulated chemical constituents in the treated leachate.

The leachate treatment system may need to be expanded to include additional treatment beyond that proposed to control potential adverse impacts associated with chronic aquatic life toxicity

and bioaccumulation of treated leachate-derived constituents to and within fish and other aquatic life in the Misema River.

The flows of the Misema River relative to those of the projected leachate are such that a considerable natural safeguard exists from adverse impacts of the unregulated chemicals present in MSW leachate. It will be important to reliably monitor the treated leachate and the river for potential adverse impacts from these chemicals.

Several of the current MOEE water quality standards for protection of aquatic life and human health are not adequate and need to be revised. The leachate should be treated to meet water quality protection standards which reflect the latest in reliable technical information on the impacts of chemicals on public health, aquatic life and wildlife.

Disposal of Pit Dewatering Water. While it appears, at this time, that the water in the AMS pits can be safely discharged to the Misema River without treatment, the studies that have been conducted on the characteristics of these waters by Metro's consultants have not reliably evaluated all potential constituents or conditions that need to be evaluated prior to determining that it is safe to discharge the pit waters to the Misema River without treatment. One of the major problems is that some of the analytical methods used to investigate the characteristics of the pit waters, such as for arsenic, were not sufficiently sensitive to determine whether these waters had concentrations above MOEE standards. Further, no toxicity testing was done on these waters to determine if unregulated chemicals within them could be potentially toxic to aquatic life in the Misema River.

It is possible that further studies could show that very expensive treatment of the pit waters would have to be carried out before discharge to the Misema River.

Surface Water Quality Monitoring. A key component of the leachate treatment system will be the development and implementation of a water quality monitoring program that assesses the potential impacts of the residual regulated and unregulated chemical constituents in the treated leachate. At this time, Metro and its consultants have not proposed an adequate water quality monitoring program to protect aquatic life and other uses of the Misema River from residual chemical constituents in the treated leachate. Attention must be given to the potential impacts of the large number of unregulated organic chemicals in the treated leachate that could impact water quality in the Misema River. This is an area that has been largely ignored by Metro and its consultants thus far that will need to be addressed as part of Phase 2 of this Assessment.

Groundwater Quality Monitoring. The groundwater quality monitoring program developed thus far by Metro and its consultants is deficient compared to the program that will ultimately be needed to try to detect pollution of groundwaters by leachate that could escape from the hydraulic containment system proposed by Metro for preventing groundwater pollution at the proposed Adams Mine Site Landfill. Metro should be required to develop a groundwater monitoring approach that will ensure a known high degree of reliability in detecting leachate-polluted groundwaters under the Adams Mine Site property before they trespass under adjacent properties.

Groundwater Production Well Monitoring. Further, Metro should be required to conduct groundwater monitoring of all production wells within the worst-case potential sphere of influence of leachate-polluted groundwaters that could develop at the Adams Mine Site Landfill for as long as the polluted groundwaters and landfill represent a threat. For planning purposes, this period of time should be considered to be infinite. This off-site production well monitoring should be conducted to detect incipient groundwater pollution by landfill leachate with a sufficient early warning so that this pollution is known before harm to the users of the water occurs.

Third-Party Monitoring. Metro should fund a comprehensive third-party independent monitoring program for the landfill operations and environmental impacts in order to detect problem areas before they become significant. This third-party monitoring should be conducted in such a way as to supplement Metro's and the regulatory agencies' monitoring programs. The results of this monitoring program should be presented directly to a citizens advisory committee responsible for the oversight of the Adams Mine Site Landfill development, operations, closure and post-closure care.

Worst Case Scenario Evaluation. The worst case scenario evaluation for pollution of groundwater by landfill leachate projects that appreciable local surface water pollution could occur in the vicinity of the landfill. Insufficient information is available at this time to be certain that this proposed worst case scenario has been, in fact, reliably developed. There may be other conditions that need to be incorporated into a worst case scenario evaluation.

Remediation of Polluted Groundwaters. At this time, Metro and its consultants have given inadequate attention to defining possible remediation approaches that could be used for off-site as well as on-site groundwater pollution that might develop associated with the Adams Mine Site Landfill. A key part of the development of a "safe" landfill is the development of remediation approaches for polluted groundwaters that might under worst-case conditions develop at the landfill and be transported off-site to pollute adjacent property owners' groundwater supplies.

Metro should as part of the Phase 2 Assessment program, should it proceed with the development of this landfill, define possible remediation approaches for both off-site and on-site groundwaters. These approaches should include a discussion of the remediation approaches that would be implemented if incipient Adams Mine Site Landfill leachate pollution is detected off-site to stop further pollution and to clean up the polluted groundwaters to the maximum extent possible.

Funding of Remediation. A key part of development of the groundwater pollution remediation program will be the definition of the magnitude of the funding that could be needed for the program implementation and how Metro can assure that the funds will, in fact, be available in perpetuity to address contingency needs for possible groundwater pollution that could occur at the Adams Mine Site. These contingency needs could include removal of the wastes from the Adams Mine Site Landfill (landfill mining) if it is not possible to stop off-site pollution of groundwaters from this landfill.

Reasonable Use Policy. It is important in planning for a "safe" landfill to not utilize the MOEE Reasonable Use Policy approach which allows the contamination of groundwaters by leachate up to 25% to 50% of the Ontario Drinking Water Objective for health and non-health related parameters, respectively. This Policy fails to consider the presence of hazardous, unregulated chemical constituents in landfill leachate that could be transported through aquifers off-site.

Any contamination of off-site groundwater by leachate (any presence of a leachate-derived constituent) should for public health and groundwater resource protection, be considered a situation that requires groundwater remediation independent of whether any drinking water objectives are exceeded. This is prudent public health policy and the approach to which the Adams Mine Site community and property owners-users of the region near the landfill should be entitled.

Adequacy of MOEE Landfilling Regulations. The current MOEE landfilling regulations are deficient in several areas in protecting public health and the environment from adverse impacts of landfill derived constituents. In addition to the deficiencies associated with the reasonable use policy and some of the water quality objectives, one of the most important deficiencies is the failure of theses regulations allow to adequate bufferlands between the waste deposition areas and adjacent properties. Metro will likely have to purchase or gain easements from adjacent properties in order to dissipate adverse impacts of the proposed landfill associated with odor, dust and noise.

Impact on Agriculture. While Metro's consultants claim that the proposed landfill will not be adverse to agriculture, thus far they have not presented convincing evidence on this issue. The work of Gartner Lee on the origin of the Temiskaming Little Clay Belt region groundwater shows that based on the information available now, there appears to be little likelihood that leachate polluted groundwaters that could arise in the vicinity of the proposed AMSLF would be transported to the Little Clay Belt region and thereby pollute groundwaters in the region. However, the TFA investigations have revealed that the Munroe esker could potentially be a pathway for transport of leachate polluted groundwaters to the Little Clay Belt region. This is an issue that must be adequately addressed so that the farming interests are confident that there is little likelihood of adverse impacts if this landfill is developed.

Other Impacts

Landfill Gas. There is a significant potential for on-site landfill gas problems associated with vinyl chloride emissions and groundwater pollution by VOC's. These problems could be manifested off-site.

Odor. It is projected that there will be significant off-site odors from this landfill. It is not clear, however, that the projections have reliably estimated the full magnitude of these odors. While Metro's consultants assert that odor is only a nuisance, it is well known that highly offensive odors such as those associated with landfills can be detrimental to an individuals health. Metro will need to develop odor control approaches and acquire additional property for odor dissipation.

Dust. There will be potentially significant dust releases off-site, arising from landfill operations. At this time, inadequate attention has been given to the potential human health hazards associated with PM 10 particles in this dust.

Noise. Metro's consultants discuss the potential for adverse impacts of landfill-derived noise and some other adverse impacts of emissions from the landfill at nearby property residences. It is the reviewers understanding that Metro will have to control adverse impacts at the landfill and adjacent property line. Adjacent properties should not be used to dissipate adverse impacts of releases from the landfill.

Birds. The evaluation of potential bird problems at the proposed AMSLF is highly superficial and in some instances inaccurate. Without highly effective bird control programs, gulls and other birds could possibly become a problem at the proposed landfill through impacts on aviation and possibly through the transport of disease.

On-Site 3R Activities. At this time the on-site 3R activities have not been defined. Of particular concern is the potential for outdoor composting and the control of odors associated with such composting activities.

Potential Operation Issues. There are a number of potential operation problems that have not been adequately addressed. Of particular concern is the unloading of the rail containers during cold weather conditions.

Economic Evaluation. The economic evaluations performed by Metro's consultant does not provide sufficient details to enable the peer reviewers' to evaluate the adequacy and reliability of the projected costs of landfilling at the proposed AMSLF. Of particular concern is the potential that the true cost of operation and especially post-closure care will be substantially higher than those projected. It is possible that these costs may add 10 to several 10's of dollars per ton to the disposal costs associated with the development and use of the proposed AMSLF. Further, the expected revenue associated with developing a landfill gas recovery system may have significantly overestimated the revenue that will in fact be generated by the recovery and use of landfill gas.

Development of the AMSLF as a Waste Treatment System. Metro and its consultants have concluded that the shredding of the waste to enhance the hydraulic characteristics of the landfill and thereby reduce its contaminating lifespan is not justified. It appears, however, that an inappropriate analysis of this situation has been made. Metro needs to reevaluate the potential benefits of shredding the waste placed in the landfill and the addition of moisture to the landfill to enhance the rate of waste stabilization through conversion of many of the organics into landfill gas and the leaching of the waste to remove leachable components in a shorter period of time than will occur under the proposed mode of operation.

Overall Assessment.

Overall, at this time Metro and its consultants have not provided reliable and/or adequate information on the current state of knowledge on the impacts of the proposed Adams Mine Site

Landfill on off-site public health, groundwater resources and the interests of those within the potential sphere on influence of the landfill.

While at this time no potential adverse impacts have been identified that would preclude the development of the Adams Mine Site Landfill so that it would be "safe" and a "good neighbor" to the owners and users of the lands near the landfill, there is need for considerable work to be done in Phase 2 of this Assessment and a high level of commitment by Metro to address contingencies if this landfill is to be developed with a high degree of certainty of full protection of public health, groundwater and the environment.

It is likely that addressing what are now known and what could develop as potentially adverse impacts of the proposed AMSLF could significantly increase the cost of landfilling at this site from that currently projected by Metro and its consultants.

Introduction

Metropolitan Toronto (Metro) has proposed to construct a municipal solid waste (MSW) landfill in the Kirkland Lake, Ontario region that would accept approximately 40 million tonnes of waste over at least 20 years. Metro began conducting studies in 1990 devoted to evaluating the potential public health, groundwater resource, environmental and other impacts of this proposed landfill.

The landfill is proposed to be constructed in three pits of the Adams Mine Site (AMS). Over the past six months Metro and its consultants have developed a set of draft reports covering their current findings on these impacts. A detailed set of comments has been provided by the author on each of these reports. This report provides an overview summary of the key findings, conclusions and recommendations on issues that should be considered by the Public Liaison Committee (PLC) in evaluating the appropriateness of developing Metro's proposed Adams Mine Site Landfill.

The development of this proposed landfill was based on a potential willing host concept in which the host communities of Kirkland Lake, Larder Lake and Englehart entered into an agreement with Metro to support the development of this landfill in exchange for a royalty and other benefits that would be paid to these communities. While councils of these communities signed this agreement in 1990, there is a significant question today about whether such a referendum would be supported by the public.

Some of the apparent public opposition to the development of the proposed AMSLF appears to be the typically-based Not-In-My-Back-Yard (NIMBY) approach. There has been and, in general, continues to be considerable justified NIMBY associated with the development of an MSW landfill in a region. The author has devoted considerable effort to understanding NIMBY as it relates to the development of MSW landfills and, most importantly, developing approaches that can be used to address justified NIMBY. Dr. Jones-Lee and he have published extensively on these issues.

The proposed AMSLF provides a unique opportunity where the host communities and others in the region have the opportunity to recommend to Metro, through the PLC, approaches that can potentially be used to address NIMBY issues. The development of the proposed AMSLF has the potential of being significantly different from most landfill development projects in that a voluntary host community was sought and the landfill owner, Metro, would not just meet but rather, in some instances, would exceed to some extent, the current minimum regulatory requirements for developing an MSW landfill. The author has provided the PLC with a detailed set of comments on some of the significant deficiencies in current Province of Ontario (MOEE) regulatory requirements for MSW landfill siting, operation, closure and post-closure care.

Ordinarily, the public who face the siting of a landfill in their region are not provided with the support necessary to achieve a high degree of understanding of the technical issues associated with the siting, operation, closure and post-closure care of a proposed landfill in their region. However, the people of Ontario and especially in the Kirkland Lake area, have the assistance of qualified technical expertise to critically review Metro's consultants' reports and provide comments on technical deficiencies - inadequacies. The PLC, members of the public and others in the Adams Mine Site area have the potential benefits of Gartner Lee's - Bill Balfour's and his associates' expertise and experience as well as the expertise of Brian Gallaugher and the author in reviewing Metro's proposed approach for developing the AMSLF. Unfortunately, Metro's Phase 1 Assessment process has been conducted in such a way as to not allow adequate time for review of the key issues that should be reviewed before a decision is made about proceeding to Phase 2.

As the author has indicated through the course of the peer review process, while there are many questions about the potential impacts of this proposed landfill, he has not, including to this time, encountered any issues that he feels require abandonment of the development of this proposed landfill based on its potential impacts on public health, groundwater resources, the environment and the interests of those within the potential sphere of influence of the landfill. All of the potential problems that have surfaced thus far can be addressed. It will be up to Metro and the people of Toronto to adopt adequate approaches that address the issues raised by Gartner Lee staff, the author, B. Gallaugher, PLC, and the public.

Specific Comments

Presented below are comments on problems with the approaches used for the development of the Adams Mine Site Landfill.

Public Consultation. There were some significant deficiencies in the public consultation process. Some of Metro's consultants' reports did not provide a balanced, full disclosure discussion of potential environmental, public health and other impacts of the proposed landfill. Further, the overall process that was conducted for review of technical issues was inadequately planned to allow appropriate time for full peer and public review. The work plans that were developed for the various studies conducted by Metro's consultants did not provide sufficient detail to enable the peer reviewers to evaluate the adequacy of the proposed studies. Further, the review process did not include the opportunity for comments by the peer reviewers on the adequacy of the proposed approach.

In general, the consultants' reports were late compared to the timetable that was originally developed. As a result, for a number of these reports the peer reviewers had only a couple of days before their comments had to be submitted to meet the deadline established by Metro. The net result was inadequate time for both peer review and public input on some of the key issues that need to be addressed and resolved before proceeding to Phase 2 of the Assessment process.

It will be important that if this process continues into Phase 2, a more appropriate planning and implementation of consultants' and peer reviewers' activities be developed so that information can be brought to the attention of the PLC and others with adequate time to conduct an in-depth, appropriate review of unresolved issues.

One day before the final PLC meeting on December 10, 1995 at which the author was to present his conclusions on the adequacy of Metro's consultants review of the proposed AMSLF, Metro made available to the author about 2 feet of revised consultants reports. These reports were supposed to address, to some extent, some of the comments made by the peer reviewer and others in the draft reports that they reviewed and commented on. There was, obviously, insufficient time to determine whether Metro's consultants had adequately and reliability incorporated revisions into the final reports that addressed the concerns of the peer reviewer that arose from a review of the draft reports. It should not be assumed that Metro's consultants final reports have adequately and reliably addressed the peer reviewers's comments. A review of these issues will have to be conducted with supplemental funding as part of Phase 2 of the Assessment process, should Metro decide to proceed with further development of this landfill.

Adams Mine Site Investigations. At this time, there are significant deficiencies in the studies that have been conducted regarding the Adams Mine Site geology/hydrogeology and groundwater and surface water quality that will need to be properly addressed in Phase 2 should Metro decide to go ahead with the studies. In some cases, these studies could show that some of the preliminary predictions of net environmental impacts based on Metro's and its consultants' statements of conclusions may be inappropriate.

The peer reviewers found that Metro's consultants' reports frequently contained statements about the "safety" of a proposed approach for development of this landfill that were not supportable based on the information provided by the consultants. There are many instances where significant questions are raised by the peer reviewers about the reliability of the conclusions presented in the consultants' reports. It will be important that if further work is done in this Assessment, that Metro and its consultants provide detailed information on how they developed their conclusions on particular issues. These presentations should be in sufficient detail so the peer reviewers can develop the same conclusions from the information made available by the consultant as were developed by the consultants.

Metro and its consultants asserted, *"The site can be safely designed and operated as a landfill facility."* This is a premature assessment based on what is known today. What can be said is that, from the information available, it appears that it may be possible to design, operate, close and provide post-closure care to protect public health, groundwater resources and the environment from the potential adverse impacts of the proposed landfill. Considerable additional work will need to be done, and the full cooperation of Metro in providing the necessary safeguards will be

required in order to state that the Adams Mine Site can be safely designed and operated as a landfill facility. While the author agrees that this is possible, it will take significantly different approaches on the part of Metro to develop safeguards than are conventionally provided in the design, operation, closure and post-closure care of municipal solid waste landfills. These additional safeguards will likely significantly increase the cost of landfilling at the proposed AMSLF over that projected by Metro and its consultants. As of yet, Metro has not indicated that it is willing to make this level of commitment.

Reliability of Hydraulic Containment. Metro and its consultants have overstated the current understanding of the ability of hydraulic containment - inward groundwater flow at the site to keep leachate from traveling outward into the groundwater. While this appears to be possible, significant additional work will be needed to demonstrate more reliably that hydraulic containment can, in fact, be made to work at this site for as long as the wastes in the landfill remain a threat.

Service Life of Leachate Removal System. There is significant potential that the landfill leachate removal system will plug due to biological fouling and chemical precipitation. This would greatly impair, if not block, the removal of leachate from the landfill due to blockage of the filter layer between the bottom of the wastes and the leachate drainage layer as well as within the leachate drainage layer. If blockage of the leachate removal system occurs, then leachate could build up in the landfill to the point where it could reverse the inward hydraulic gradient which could lead to groundwater pollution by leachate. Metro should reevaluate the possibility of removal of leachate from the landfill by in-waste pumping as a back-up to the proposed method of leachate removal.

Contaminating Lifespan. Metro and its consultants state that the projected contaminating lifespan for the proposed Adams Mine Site Landfill will be on the order of approximately 100 years. They further state that after about 100 years, it will be possible to stop pumping leachate from the landfill leachate removal system and stop operating the leachate treatment system. At that time, the pits would be allowed to fill to a considerable extent with leachate. This leachate is proposed to be collected in a gravity drainage system. It is the author's assessment that at this time, the 100-year contaminating lifespan has not been reliably evaluated. Metro should plan for an indefinite contaminating lifespan, certainly a thousand years or more.

Metro's consultants' calculations as well as what the author concludes on the contaminating lifespan of this landfill show that the leachate at the end of about 100 years could still be a significant threat to pollute groundwaters and surface waters if discharged without treatment.

While perimeter drainage systems of this type are used in dewatering mines, there is a significant difference between dewatering for mining operations and the control of leachate pollution of groundwaters. Small amounts of MSW leachate have high potentials to pollute large amounts of groundwater impairing their use for domestic and other water supply purposes. It is essential in developing an assessment of the reliability of the hydraulic containment pumping and gravity drainage modes of operation, to consider how effectively all leachate will be collected.

Leachate Generation Rates. From the information available, it appears that Metro's consultants have underestimated the amount of leachate that will be generated in this landfill due to increased percolation of water through the cover of the landfill beyond the amount projected in calculating leachate generation rates. It is inappropriate to assume, as has been apparently done by Metro's consultants, that the design characteristics of the cover which determine the amount of moisture that enters the landfill and generates leachate during the contaminating lifespan of the landfill will remain constant as designed over the hundreds to thousand or more years that this landfill could be a threat to public health, groundwater resources and the environment.

The increased moisture that will likely enter the landfill through the cover beyond the amount projected needs to be evaluated with respect to how it would impact the many components of leachate management that are discussed in Metro's consultants' reports. Rather than allowing leachate generation in the landfill to be controlled by unplanned changes in the permeability of the cover due to cracks that develop in the low permeability layer of the cover, Metro may find that installing a leak detectable cover on this landfill and a deliberate moisture addition system could be a significant asset in reducing the contaminating lifespan of the landfill.

Leachate Treatment. Metro proposes to treat the leachate removed from the landfill and discharge the treated leachate to the Misema River. The leachate treatment system proposed is a good start on the approach for leachate treatment that will have to be followed. While it may be adequate for most conditions, there may be situations where additional treatment of the leachate may be necessary to protect public health, aquatic life and wildlife from residual constituents in the leachate. There are questions about whether this treatment system will operate year-round and whether the discharges of treated leachate will occur directly to the Misema River or to tributaries of the river. It is unclear whether the indirect discharge to the river will be on an intermittent basis where the treated leachate would be stored over the winter. These issues need to be resolved in order to determine the treated leachate loading to the river at various times of the year.

The relative flows of the Misema River versus those projected for the treated leachate appear to be such that even under drought conditions there still could be appreciable dilution of the treated leachate by the river water. The proposed leachate management approach, therefore, has a natural safeguard of appreciable dilution built into it. It is important to maintain the magnitude of this safeguard in order to protect the aquatic resources of the river from impacts from the unregulated chemicals that are present in leachate.

At this time, Metro proposes to treat the leachate for most constituents to within five times of the MOEE water quality objective and/or drinking water standard. Metro plans to use a mixing zone of up to one half the width of the Misema River and several hundred meters downstream of the discharge in which the excessive concentrations of constituents in the treated leachate, compared to MOEE objectives, will be diluted to concentrations equal to or less than the objectives. While this approach apparently would be accepted by MOEE, such an approach should not be allowed. There are situations, such as for bioaccumlatable chemicals i.e. mercury, where organisms could accumulate within their body tissue, excessive mercury concentrations within the mixing zone and thereby represent a hazard to those who use these organisms as food.

The primary reason for not allowing a mixing zone for hazardous chemicals in the treated leachate is that MSW leachate, after treatment, still contains a large number of potentially hazardous unregulated chemicals. By requiring that Metro treat the leachate so that it could be discharged to the Misema River without dilution for all regulated chemicals, it would be possible to reduce the hazards by a factor of five associated with the unregulated hazardous chemicals in the treated leachate. This is appropriate for this type of situation where complex mixtures of potentially hazardous chemicals are being discharged into a relatively pristine system - the Misema River. Under such conditions dischargers should be required to provide additional treatment beyond the minimum necessary to satisfy current regulatory approaches.

The proposed approach of not allowing a mixing zone for potentially hazardous chemicals is in accord with the resolution adopted by the PLC at the December 10, 1995 meeting, of zero pollutant discharge from the leachate treatment plant to the Misema River. This resolution is appropriate and should be adopted.

It is also important that Metro not attempt to use the existing MOEE policies - standards as the basis for development of this landfill where the minimum protection that these policies require represents the level of control that Metro will commit to in protection of the health, interests and welfare of those potentially impacted. For example, with respect to existing surface water quality, the current MOEE standard for mercury in water is well-known not to be adequate to protect pregnant women from harm due to eating fish which have been taken from waterbodies that have mercury at the currently allowed concentrations, based on PWQO's.

Although it is not clear at this time that MOEE will require the treatment of the leachate so that it has no chronic toxicity to aquatic life at the point of discharge, Metro should commit to protecting aquatic resources so that there is no aquatic life toxicity as assessed by either acute or chronic toxicity measurements using several sensitive test organisms. In those instances where MOEE standards may not reflect the most current information available on the impacts of chemicals on human health, aquatic life and wildlife, Metro should treat the leachate in accord with the latest generally accepted reliable information for protection of public health, aquatic life and wildlife.

Discharge of Pit Dewatering Waters to the Misema River. Metro's consultants conclude, based on the chemical characteristics in the three AMS pits that are proposed to be used as landfills, that this pit water can be safely discharged to the Misema River without treatment. However, a review of the adequacy of the studies conducted by Metro and its consultant of the characteristics of the pit waters, shows that there were significant deficiencies in some aspects of these studies. For example, the analytical methods used to measure arsenic in the pit waters was not sufficiently sensitive to detect arsenic at concentrations that are potentially adverse to Misema River water quality. Therefore, if the pit waters contained elevated levels of arsenic compared to drinking water standards, there is a potential that the discharge of pitwaters without treatment for the removal of arsenic could be adverse to the Misema River water quality.

Similarly, the studies on the pit waters did not include any assessment of aquatic life toxicity or the bioaccumulation of hazardous chemicals in the fish that were taken from one of the pits.

These pit waters, therefore, could contain chemicals that could be toxic to aquatic life in the Misema River and/or could bioaccumulate within aquatic organisms in the Misema River.

A more comprehensive evaluation of the characteristics of the AMS pit waters must be conducted before it can be concluded that these waters can be safely discharged to the Misema River without treatment and/or significantly altering the rate of dewatering of the pits from that proposed.

Water Quality Monitoring. The groundwater and surface water monitoring systems proposed by Metro are significantly deficient compared to the programs that will be needed to ensure adequate protection of public health, groundwater resources, the environment and the interests of those who own or use properties within the potential sphere of influence of the proposed landfill. Of particular concern for surface water quality protection is the need to conduct chronic bioassays on the treated leachate effluent and the river waters. Also, there is need to conduct bioaccumulation studies on aquatic life within the river to ensure that excessive accumulation of potentially hazardous chemicals which represent a threat to public health and wildlife through the use of river organisms as food does not occur.

The information provided on Metro's proposed approach for groundwater quality monitoring is nebulous and inadequate. Because of the great difficulties in reliably monitoring leachate-polluted groundwaters in fractured rock systems of the type that exist near the proposed Adams Mine Site Landfill, it will be necessary for Metro to develop a groundwater monitoring approach that provides a highly defined degree of reliability of detecting leachate-polluted groundwaters that exist under the Adams Mine Site property. The PLC and the public should be informed as to the reliability that Metro's proposed groundwater monitoring system has in detecting leachate-polluted groundwaters before crossing the Adams Mine Site Landfill property line.

Since it will likely be difficult to develop a groundwater quality monitoring approach that will potentially detect leachate-polluted groundwaters with a greater than 95% probability under the Adams Mine Site Landfill property, it will be essential for Metro to develop an off-site groundwater quality monitoring program for all production wells that exist now or are developed in the future that are within the potential worst-case sphere of influence for leachate-polluted groundwaters to travel from the Adams Mine Site Landfill to an off-site well.

This groundwater quality production well monitoring will need to be conducted for as long as the wastes in the landfill and any polluted groundwaters that may have developed associated with the landfill will be a threat to groundwater quality. For planning purposes, the off-site groundwater quality production well monitoring program should include monitoring of a variety of parameters with sufficient frequency and reliability to detect incipient groundwater pollution by leachate-derived constituents before harm to the users of the well occurs. Because of the uncertainty and sometimes unreliability of both landfill operators' and regulatory agencies' monitoring of releases from landfills, this monitoring program should be conducted by a third-party independent monitoring group that is funded by Metro but reports directly to an Adams Mine Site Landfill citizens advisory committee that oversees the operations of this landfill.

Plausible Worst Case Scenario Evaluation. During the review of the Metro's draft consultant reports, the author suggested that Metro require that its consultants conduct a plausible worst case scenario evaluation for leachate management and then address how this situation would be detected, remediated, the amount of funds needed to control the problem and the source of the funds that would be needed at any time in the future for the remediation. At the December 9, 1995 Temiskaming Federation of Agriculture - PLC workshop, a Metro consultant presented, for the first time, a plausible worst case scenario failure for the hydraulic containment approach. He indicated that under this scenario, leachate that escapes from the landfill would come to the surface as a surface discharge near the landfill. This leachate then would drain to Boston Creek and the Misema River polluting both waterbodies. At this time, no details have been provided on the development of this worst case scenario and its reliability. It will be important, as part of Phase 2, to conduct an in depth review of this proposed worst case scenario to be certain that it is reliable and does in fact represent a true worst case situation.

Also, information will be needed on what Metro would do if this situation did, in fact, develop to prevent significant impairment of the water quality in the Misema River, Boston Creek and downstream waterbodies at any time in the future where this scenario could occur.

Polluted Groundwater Remediation. Metro should develop a well-defined comprehensive set of remediation approaches that can be used to remediate off-site contaminated groundwaters to the maximum extent possible. It should be understood that it may not be possible to remediate off-site MSW leachate-polluted groundwaters so that wells that pump such waters can ever again be considered safe for domestic and some other uses. It will be essential, however, that Metro have well developed contingency plans in place to remediate the polluted groundwaters to the maximum extent possible and, most importantly, to stop further spread of polluted groundwaters off-site from the Adams Mine Site property. These plans should be developed now so they can be reviewed for their adequacy with respect to implementability, reliability and funding.

At the time that Metro finds off-site leachate-polluted groundwaters, Metro will need to begin to develop an effective on-site groundwater remediation program to stop further off-site groundwater pollution. This program may have to include exhumation (removal) of the wastes from the Adams Mine Site Landfill if the on-site remediation programs cannot stop off-site pollution of the groundwaters.

Adequate funding for groundwater remedial activities, including the mining of wastes from this landfill, should be available for both the off-site and on-site polluted groundwater remediation programs. This funding should be established in a dedicated trust fund derived from disposal fees that will be of sufficient magnitude to address all plausible, worst-case failure scenarios and groundwater remediation needs. The planning for the use of these funds should make them available *ad infinitum*. If at some time hundreds to a thousand or more years from now it is found that no groundwater pollution has occurred and the landfill and associated leachate-polluted groundwaters are no longer a threat to cause off-site groundwater pollution, then these funds could be returned to Metro for other uses.

In judging whether off-site groundwater pollution occurs, it will be important that no use be made of the MOEE Reasonable Use Policy which allows contamination of groundwaters by

leachate-derived constituents up to about 25% of the Ontario Drinking Water Objective for health-related parameters and 50% of the Objective for non-health-related parameters. This Policy ignores the potential threat that the unregulated organics present in MSW leachate represent to the health and welfare of those who use such waters contaminated to this level. For the purposes of developing the Adams Mine Site Landfill, the need for remediation of polluted groundwaters should be based on finding any Adams Mine Site MSW Landfill leachate-derived constituents in off-site groundwaters.

Landfill Gas. Metro and its consultants assert in the draft Overview Document that the landfill gas collection and management system will be operated for a period of approximately 30 years after site closure. While the Overview Document provides an extensive glossary of waste management terms, it fails to define closure which is one of the most important terms associated with developing a landfill. In the waste management field, the closure of a landfill means the termination of receipt of waste and the installation of a cover on the landfill. It is the author's understanding that closure will be completed in about 20 years after the site (3 pits) begins operations. There will be closure of some of the pits during this period since they will stop receiving waste earlier than the other pits. If the conventional use of site closure is applicable to the Adams Mine Site Landfill, it is inappropriate for Metro's consultants to claim that it will be possible to stop landfill gas management 30 years after site closure. In fact, this is shorter than the period of landfill gas generation at the Adams Mine Site Landfill projected by Metro's consultants.

The contaminating lifespan is a product of the interaction of water percolating into and through the waste and landfill gas generation rates and duration. Metro's consultants have apparently not adequately considered the problems that will be encountered in having the moisture in the landfill interact with the waste that is contained within the crushed, but not shredded, garbage bags. These bags of waste will become significant impediments to moisture entering the waste and thereby could lead to leachate and gas production.

At this time Metro has not given adequate reliable consideration to the potential benefits associated with the shredding of the MSW landfill waste in shortening the contaminating lifespan for both leachate and landfill gas production. This is an area that Metro needs to reexamine since it could be an important factor in influencing whether this landfill should be developed, especially in light of the MOEE regulations that require that the contaminating lifespan be less than the service life of any non-maintainable structural components for leachate and gas management. As long as the plastic garbage bags are allowed to remain essentially intact, the contaminating lifespan of this landfill will be determined to a considerable extent by the ability of the moisture that enters the waste to interact with the garbage located in these bags. These bags will decompose slowly and could greatly extend the period of time that landfill gas and leachate production occur where they would be threats to groundwater quality and the use of the region near the Adams Mine Site Landfill through gaseous emissions.

At the TFA - PLC workshop on December 9, 1995, Metro's consultants indicated that a change in the proposed design of the landfill has occurred in which the circumferential vertical liner near the upper part of the landfill has been replaced by a granular drainage layer. Rather than trying to block the lateral transport of leachate through this region, Metro's consultants propose to allow

all leachate that enters this area to become part of the leachate collection system and be removed by pumping or collection in the gravity drainage system. While this system could be more effective in preventing leachate migration laterally from the landfill near the ground surface, it could potentially allow for more landfill gas migration laterally which could result in off-site, near surface groundwater pollution by VOC's such as vinyl chloride. It is well known that landfill gas - VOC migration through the vadose zone (above the water table) is a significant cause of groundwater pollution associated with MSW landfills. This issue needs to be addressed as part of the Phase 2 Assessment of the proposed landfill in order to develop an approach to detect landfill gas migration under conditions where the gas collection system does not collect all of the gas that is produced in the landfill. This is not an uncommon situation for MSW landfills, especially with an inadequately maintained gas collection system.

Implementation of Mitigation Approaches. Metro and its consultants claim that numerous mitigation measures have been incorporated into the site design and operations. Such claims are inappropriate. The consultants in their draft reports have discussed possible mitigation measures that could be adopted. There is no commitment, however, on the part of Metro that any consultant's suggested mitigation approach will necessarily be funded and implemented.

Landfill proponents sometimes claim, as Metro has done, that additional design and operations measures as well as off-site impact management measures can be implemented should the operations monitoring program indicate the need. While this statement is appropriate, there are significant questions about how well they will actually be implemented. Metro faces a public which is aware of a long history of landfill owners/operators failing to keep commitments on protecting public health, groundwater resources and the interests of those who own or use properties within the sphere of influence. Metro has some problems of this type at landfills it owns and, for that matter, continues to operate. This situation makes the public justifiably skeptical about whether Metro will, in fact, protect their health and interests associated with the proposed Adams Mine Site Landfill development.

Metro's current staff and management would plan to make the Adams Mine Site Landfill a "good neighbor." As this landfill will be a threat for no less than hundreds and possibly a thousand or more years, there is no assurance that the future Metro staff and management will, in fact, adequately and reliably carry out all needed mitigation measures for as long as this landfill represents a threat. There is need to develop a mechanism to ensure that plausible worst-case scenario failure of the landfill containment systems can be adequately and reliably implemented to detect and remediate any problems that occur at any time in the future. This will likely require a dedicated trust fund of sufficient magnitude to address all plausible worst-case scenario problems that could develop at this landfill.

Worst-Case Evaluation. Metro and its consultants have repeatedly claimed that they have performed a worst-case evaluation of the potential impacts of the proposed landfill. However, some of the so-called worst-case impact evaluations as claimed by Metro's consultants were, in fact, not worst-case. Further, the details of the approach used to estimate the so-called worst-case scenario impacts are not provided in many of the draft reports. It is, therefore, impossible for the author to independently establish that the conclusions presented in the reports are supported by the analytical approach used.

In a number of instances there seem to be significant discrepancies between the impacts anticipated by Metro's consultants and those expected by the author based on his expertise and experience. For example, in the modeling of the contaminating lifespan it is assumed that ammonia, which is one of the key parameters in determining this lifespan, has a relatively short half-life in the landfill environment compared to what would be expected based on the author's experience with the aqueous environmental chemistry of ammonia in such environments. Further, in review of the literature which Metro's consultants claim serve as a basis for the short half-life used in modeling ammonia, it is found that much longer half-lives are reported than the value used in the modeling of the contaminating lifespan of the Adams Mine Site Landfill.

At this time, the technical justification for using the very short half-life for ammonia compared to what would be expected is unclear. This issue needs to be resolved since this is apparently a key factor in determining the estimated 100-year contaminating lifespan as opposed to the several hundred to a thousand or more years that the author feels would be more appropriate for this landfill.

Misema River and Boston Creek as Groundwater Transport Barriers. Metro and its consultants assert that should the hydraulic containment system fail to prevent groundwater pollution in the vicinity of the landfill that the groundwater discharge to the Misema River and Boston Creek would prevent downgradient pollution of groundwaters. There are, however, significant questions about how reliably Metro's consultants have assessed the potential for the Misema River and Boston Creek to serve as discharge points for all potential leachate-polluted groundwaters that could develop at the Adams Mine Site Landfill. At this time, inadequate field studies have been conducted to be certain that there is no underflow of deeper groundwaters under Boston Creek and the Misema River which could transport leachate-polluted groundwaters beyond the location of the river and the creek.

Impact on Agriculture. Metro and its consultants claim that there is little possibility of adverse impacts of the landfill on agricultural interests in the Temiskaming Little Clay Belt area. However, there are still several potential net effects to agriculture that have not been adequately addressed. These include the potential for transmission of disease from the wastes to agricultural interests via birds and the potential for landfill pollution of groundwaters by leachate to be transported to the Little Clay Belt agricultural water supplies.

Agricultural interests in this area are concerned that a major fault or fracture exits near the Adams Mine Site Landfill that could rapidly transport leachate to the groundwaters that are used as a water supply in their area. While Metro's consultants assert that this situation does not exist, thus far they have not presented information that presents convincing evidence on this issue. The author has developed a detailed discussion of the issues that need to be addressed as part of evaluating whether the proposed Adams Mine Site Landfill represents a threat to the groundwater resources in the Temiskaming Little Clay Belt area. Many of the issued raised by the author were addressed, to a considerable extent, by Gartner Lee in their presentation at the TFA - PLC December 9, 1995 workshop. At this workshop it was indicated that the groundwater supplies of the Little Clay Belt region are derived locally and that there is little or no possibility of transport of leachate polluted water from the AMSLF reaching the agricultural water supplies

of the region. While from the information provided, this situation seems to be appropriate, it is important that it be independently evaluated.

The TFA has, through it own investigations, determined that the Munroe esker could be a potential transport mechanism for leachate polluted groundwaters to reach the Little Clay Belt region. It appears that Metro's consultants have not adequately investigated this situation. This is obviously a topic area that needs attention to be certain that when this esker crosses the Misema River it could not transport leachate derived from the landfill side of the river to the other side of the river and then on down to the Little Clay Belt region.

Impact on Residential Users of Nearby Property. Metro and its consultants assert that landfill releases such as odors, dust, noise, litter, etc. only represent nuisance impacts and do not impact public health. Some of Metro's consultants' so-called direct nuisance effects such as odors, dust and noise are, in fact, public health hazards that must be considered and adequately controlled. Further, it is inappropriate for Metro and its consultants to discuss impacts on existing residents when the regulatory requirements are explicit in requiring control of landfill releases at the property line with adjacent properties. Based on MOEE regulations Metro will not have the opportunity to dilute - dissipate emissions from the landfill on adjacent property owners' land without their explicit permission.

Dust and PM-10 Particles. Metro and its consultants project that there will be off-site dust releases from the proposed landfill. Metro will have to initiate reliable dust control programs to prevent such releases from occurring at the property line. This will likely also necessitate Metro acquiring additional property to dissipate such releases.

Metro's consultants' draft report covering dust issues failed to address the potential public health significance of PM-10 particles that are part of the dust that would be generated from this landfill. While Metro's consultants did include a discussion of PM-10 particles in the draft Overview Document, this document did not discuss the public health significance of PM-10 particles and, most importantly, the inadequacies of the current US EPA PM-10 particle standards that were cited in this discussion. Metro should be required to monitor for PM-10 particles at the property line to ensure that no off-site adverse impacts to the health of nearby property owners/users occurs.

Impact of Birds. In previous comments on the impacts of gulls and other birds, the author has indicated that he found that Metro's consultants report on this topic was highly superficial and likely in error. On the morning of December 11, 1995, when the author left Kirkland Lake, he had the opportunity to discuss with the pilots of the airline, the normal flight path for travel from the Kirkland Lake airport. The PLC members may recall that Metro's consultants report on birds flight path for commercial airlines was not near the AMSLF, however, the author reported that in September when he took off from the Kirkland Lake airport that he flew over the AMS. It was found through discussions with the pilots that every flight between Kirkland Land and Earlton flies over the AMS. It is therefore clear that the Metro's consultants assessment of potential bird impacts associated with AMSLF development was not only superficial but in significant error. From the information provided by the Gartner Lee staff, it is now clear that Metro will likely

have to spend substantial funds for control of bird impacts in order to protect commercial and private aviation.

Recycling Facilities. While Metro and its consultants mention that a recycling facility will be constructed at the AMSLF, at this time it is unclear from the information provided what magnitude of recycling will take place at the landfill and how many people will be employed in this facility.

Composting. Metro and its consultants have indicated that outside, windrow mixed waste composting is proposed to be practiced in the vicinity of the AMSLF. This type of compost is contaminated with a variety of hazardous and otherwise deleterious constituents which could severely limit its use. Further and most importantly, Metro has not addressed the control of odors associated with the outdoor composting possibly proposed for the Adams Mine Site.

Economic Impacts. Metro, through its consultants Hemson Consulting Limited, made available to the author Technical Appendix K - Economics dated December 4, 1995 on December 10, 1995. This appendix is indicated as an "Interim Report". A critical review of this report shows that it, like other Metro consultant's reports, does not provide the peer reviewers with the information necessary to assess the reliability of the conclusions presented in this report on the potential economic aspects of the proposed AMSLF.

Metro is requiring that its Council accept the reliability of the conclusions presented in this report without having available independent investigation of the technical validity of these conclusions. It has been stated by Metro staff that whether Metro Council decides to go ahead with the AMSLF Assessment or selects one of the alternative proposals for managing Metro's garbage, would be based primarily on economic considerations. This means that Metro Council must have reliable information on economic issues associated with the AMSLF as well as the alternative proposals.

As is well known, economics is less than a precise science. In order for Metro Council to reliably evaluate the economic aspects of the proposed AMSLF, it is important that they be provided with reliable economic information. At this time, it appears that the Council may not have received such information. While it is impossible to evaluate the reliability of the information provided in the Economics report since insufficient detail is provided to enable such an evaluation, from the authors experience and expertise in evaluating the longterm cost of landfill post-closure care, it appears that Metro and its consultants have significantly underestimated the long term costs associated with the development of the AMSLF. Of particular concern is post-closure costs. As an example, if the contaminating lifespan of the AMSLF is not the projected 100 years, but several hundred years to a thousand years, the cost of post-closure care changes drastically.

Further, the economics of post-closure care seems to be highly dependent upon obtaining revenue from the sale of landfill gas. The economics of landfill gas recovery and use are such that, for many landfills located in a much more desirable location with respect to utilization of landfill gas, that it is uneconomical to recover landfill gas as a source of income. In the AMSLF situation, it is questionable whether it is appropriate to conclude that there will be substantial income derived from the sale of landfill gas during the post-closure care period for the AMSLF.

Before Metro Council decides, based on economic considerations, to proceed to Phase 2 of the Assessment, there is need for reliable, independent assessment of the reliability of the economics of Metro's consultant's economic report. It is my assessment, based on having considered these issues for a number of other sites, that a proper economic analysis could readily show that the cost per ton of developing, operating and closing of the proposed AMSLF could be 10 to several 10's of dollars per ton more than that projected in the consultant's economics interim report. It appears that these issues will have to be addressed as part of Phase 2 Assessment of the proposed AMSLF.

It is important that Metro Council understands that the bid prices for the disposal of Metro Toronto solid waste in US landfills may not necessarily reflect the ultimate cost of such disposal. The author is familiar with the significant economic deficiencies in the approach that was adopted by the US EPA in developing current US landfill regulations. The US Congress and the US EPA, as part of developing these regulations, opted for a short term political resolution of MSW landfilling practices. It is well understood by the technical community in the USA that current US landfills only postpone when groundwater pollution occurs by MSW leachate.

It is also well understood that US landfilling companies are developing massive liabilities associated with landfilling of wastes that will ultimately pollute groundwater for landfills sited in those areas where groundwater pollution is possible. Dr. Jones-Lee and the author have published several papers on these issues. They include: "Municipal Landfill Post-Closure Care Funding: The 30-Year Post-Closure Care Myth" Report G. Fred Lee and Associates (1992), "Landfill Post-Closure Care: Can Owners Guarantee the Money Will Be There?" in Solid Waste and Power 7(4):35-39 (1993), "Landfilling of Solid & Hazardous Waste: Facing Long-Term Liability" IN: Proceedings of the 1994 Federal Environmental Restoration III & Waste Minimization II Conference (1994) and "Overview of Landfill Post Closure Issues" presented at the American Society of Civil Engineers Convention (1995).

Metro Council should not assume that because a US company quotes a price per ton for solid waste disposal that this is the only cost that the people in Toronto will face in that approach for waste management. As discussed in these articles, it is well known that US garbage companies will not be able to meet the long term liabilities that are accumulating with current methods of solid waste management involving disposal in US landfills that meet current minimum regulatory requirements. At some time in the future, essentially all of the owners of current landfills will be subject to having to pay for the massive costs associated with groundwater pollution cleanup. There certainly will be significant attempts to collect part of these funds from those who contributed waste to the landfill. While landfill companies may assert that disposing of waste in their landfill will not result in any long term liability for future remediation of polluted groundwaters, there are significant questions about whether such claims are reliable and will, in fact, be valid for as long as the waste in the landfill represent a threat.

Basically, Metro Council is faced with the situation of trying to make a business economic decision on how best to manage Metro's garbage over the next 20 or so years without having reliable information on the true costs for the various alternative approaches. It is important that Metro and its Council develop a more reliable assessment of not only initial but long term costs

associated with managing Metro's solid waste for developing the AMSLF and the alternative approaches for MSW management.

Overall Assessment

The author concludes that Metro's consultants' draft reports, including the draft Overview Document, generally overstate the current state of knowledge with respect to the ability to develop the Adams Mine Site into a MSW landfill with respect to groundwater quality protection issues. While thus far no data have been generated which show that this site is not a suitable site for a landfill because of its potential to pollute groundwater, the ability of the natural strata to protect groundwater from pollution for as long as the wastes in the landfill will be a threat is still subject to some question. These issues will need to be addressed in Phase 2 of this Assessment.

It is also found in general that the consultants' draft reports and draft Overview Document tend to understate the potential adverse impacts of surface releases from the landfill, including dust, odors, noise, etc. It is clear, however, that there will be sufficient surface off-site impacts to require that mitigation measures be taken to either increase the size of the property associated with the landfill so these adverse impacts can be dissipated on Metro's property and/or initiate control programs at the source to control magnitude and duration of release of constituents so they do not cause off-site impacts.

It is the author's conclusion that the Adams Mine Site can be developed into a landfill that will be protective of public health, the environment and the interests of those within the potential sphere of influence of the landfill. The key to this development is a commitment on the part of Metro to take all necessary steps to prevent problems from developing and to provide for adequate monitoring to detect any problems before they become large-scale and to provide funds and approaches that can be readily implemented into mitigation measures for the control of off-site problems associated with the landfill.

The economic aspects of the proposed development of the AMSLF are, at this time, poorly understood. It is virtually certain that the proposed costs of landfilling at this landfill are significantly less than the actual cost that Metro will ultimately experience. Similarly, the ultimate cost of the disposal of Metro's solid waste at the alternative sites are also likely significantly underestimated. A critical, in depth, reliable estimate of the long term liabilities for the disposal of Metro's solid waste for each of the alternatives available should be conducted as part of the Phase 2 Assessment associated with the development of the proposed AMSLF.

Supplemental Information

Overview Assessment of the Potential Public Health, Environmental and Groundwater Resource and Other Impacts of the Proposed Adams Mine Site Landfill

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Introduction

Subsequent to completion of the overview assessment of the potential impacts of the proposed AMSLF, the author attended a workshop organized by the Temiskaming Federation of Agriculture and PLC on December 9, 1995 and the PLC meeting on December 10, 1995. At these meetings a number of new issues or different aspects of existing issues were raised which have prompted the development of this supplemental information report to the December 7, 1995 Overview Assessment Report. In addition, Metro has made available the interim economics report (Technical Appendix K - Economics) developed by Hemson Consulting Limited dated December 4, 1995. This report has raised a number of highly significant questions about the adequacy of Metro's proposed approach for developing the AMSLF in such a way as to be protective of public health, groundwater resources, the environment and the interests of those within the potential sphere of influence of the proposed landfill.

Because of the importance of this new information, the authors December 7, 1995 overview report to the PLC has been revised and reissued as the Revised December 12, 1995 report. It is this report that was made available to Metro Council in response to requests for the results of the peer reviewers' findings on Metro's consultants reports. Presented below are the sections that have been added to the December 7, 1995 report to the PLC. If PLC members wish to have a complete copy of the December 12, 1995 revised report provided to Metro Council, please contact Heathwood. Please note, however, that much of that report is identical to the report previously provided to PLC members at the December 10, 1995 PLC meeting.

Additions to the Executive Summary

Metro's consultants final reports were made available with inadequate time for review prior to the PLC meeting to which the peer reviewer reported to the PLC on his findings. It should, therefore, not be assumed that Metro's consultants final reports reliably and adequately address the peer reviewers comments on the draft reports.

Contaminating Lifespan. While Metro's consultants estimate that the contaminating lifespan of the proposed landfill will be on the order of 100 years, there are significant questions about the reliability of this estimate. Insufficient information was presented in the consultants' reports and cited references to justify the 100-year value. It is more likely that the contaminating lifespan of this landfill will be several hundred to a thousand years or more.

If the contaminating lifespan exceeds the expected service life of key components of the leachate removal system, then this landfill may not be granted a license by MOEE based on its current proposed design.

Leachate Treatment. The proposed leachate treatment system has the potential to provide high degrees of leachate treatment that if properly operated and monitored could protect water quality within the Misema River. The proposed degree of treatment involving the use of a mixing zone for dilution of the hazardous and deleterious chemicals to concentrations below that allowed by MOEE should be increased in order to help protect Misema River water quality from potential adverse impacts of unregulated chemical constituents in the treated leachate.

The leachate treatment system may need to be expanded to include additional treatment beyond that proposed to control potential adverse impacts associated with chronic aquatic life toxicity and bioaccumulation of treated leachate-derived constituents to and within fish and other aquatic life in the Misema River.

The flows of the Misema River relative to those of the projected leachate are such that a considerable natural safeguard exists from adverse impacts of the unregulated chemicals present in MSW leachate. It will be important to reliably monitor the treated leachate and the river for potential adverse impacts from these chemicals.

Several of the current MOEE water quality standards for protection of aquatic life and human health are not adequate and need to be revised. The leachate should be treated to meet water quality protection standards which reflect the latest in reliable technical information on the impacts of chemicals on public health, aquatic life and wildlife.

Disposal of Pit Dewatering Water. While it appears, at this time, that the water in the AMS pits can be safely discharged to the Misema River without treatment, the studies that have been conducted on the characteristics of these waters by Metro's consultants have not reliably evaluated all potential constituents or conditions that need to be evaluated prior to determining that it is safe to discharge the pit waters to the Misema River without treatment. One of the major problems is that some of the analytical methods used to investigate the characteristics of the pit waters, such as for arsenic, were not sufficiently sensitive to determine whether these waters had

concentrations above MOEE standards. Further, no toxicity testing was done on these waters to determine if unregulated chemicals within them could be potentially toxic to aquatic life in the Misema River.

It is possible that further studies could show that very expensive treatment of the pit waters would have to be carried out before discharge to the Misema River.

Worst Case Scenario Evaluation. The worst case scenario evaluation for pollution of groundwater by landfill leachate shows that appreciable local surface water pollution could occur in the vicinity of the landfill. Insufficient information is available at this time to be certain that this proposed worst case scenario has been, in fact, reliably developed. There may be other conditions that need to be incorporated into a worst case scenario evaluation.

Adequacy of MOEE Landfilling Regulations. The current MOEE landfilling regulations are deficient in several areas in protecting public health and the environment from adverse impacts of landfill derived constituents. In addition to the deficiencies associated with the reasonable use policy and some of the water quality objectives, one of the most important deficiencies is the failure of these regulations allow to adequate bufferlands between the waste deposition areas and adjacent properties. Metro will likely have to purchase or gain easements from adjacent properties in order to dissipate adverse impacts of the proposed landfill associated with odor, dust and noise.

Impact on Agriculture. While Metro's consultants claim that the proposed landfill will not be adverse to agriculture, thus far they have not presented convincing evidence on this issue. The work of Gartner Lee on the origin of the Temiskaming Little Clay Belt region groundwater shows that, based on the information available now, there appears to be little likelihood that leachate polluted groundwaters that could arise in the vicinity of the proposed AMSLF would be transported to the Little Clay Belt region and thereby pollute groundwaters in the region. However, the TFA investigations have revealed that the Munroe esker could potentially be a pathway for transport of leachate polluted groundwaters to the Little Clay Belt region. This is an issue that must be adequately addressed so that the farming interests are confident that there is little likelihood of adverse impacts if this landfill is developed.

Dust. There will be potentially significant dust releases off-site, arising from landfill operations. At this time, inadequate attention has been given to the potential human health hazards associated with PM 10 particles in this dust.

Birds. The evaluation of potential bird problems at the proposed AMSLF is highly superficial and in some instances inaccurate. Without highly effective bird control programs, gulls and other birds could possibly become a problem at the proposed landfill through impacts on aviation and possibly through the transport of disease.

Economic Evaluation. The economic evaluations performed by Metro's consultant does not provide sufficient details to enable the peer reviewers' to evaluate the adequacy and reliability of the projected costs of landfilling at the proposed AMSLF. Of particular concern is the potential that the true cost of operation and especially post-closure care will be substantially higher than

those projected. It is possible that these costs may add 10 to several 10's of dollars per ton to the disposal costs associated with the development and use of the proposed AMSLF. Further, the expected revenue associated with developing a landfill gas recovery system may have significantly overestimated the revenue that will in fact be generated by the recovery and use of landfill gas.

Development of the AMSLF as a Waste Treatment System. Metro and its consultants have concluded that the shredding of the waste to enhance the hydraulic characteristics of the landfill and thereby reduce its contaminating lifespan is not justified. It appears, however, that an inappropriate analysis of this situation has been made. Metro needs to reevaluate the potential benefits of shredding the waste placed in the landfill and the addition of moisture to the landfill to enhance the rate of waste stabilization through conversion of many of the organics into landfill gas and the leaching of the waste to remove leachable components in a shorter period of time than will occur under the proposed mode of operation.

Overall Assessment.

It is likely that addressing what are now known and what could develop as potentially adverse impacts of the proposed AMSLF could significantly increase the cost of landfilling at this site from that currently projected by Metro and its consultants.

Additions to the Main Body

One day before the final PLC meeting on December 10, 1995 at which the author was to present his conclusions on the adequacy of Metro's consultants review of the proposed AMSLF, Metro made available to the author about 2 feet of revised consultants reports. These reports were supposed to address, to some extent, some of the comments made by the peer reviewer and others in the draft reports that they reviewed and commented on. There was, obviously, insufficient time to determine whether Metro's consultants had adequately and reliability incorporated revisions into the final reports that addressed the concerns of the peer reviewer that arose from a review of the draft reports. It should not be assumed that Metro's consultants final reports have adequately and reliably addressed the peer reviewers's comments. A review of these issues will have to be conducted with supplemental funding as part of Phase 2 of the Assessment process, should Metro decide to proceed with further development of this landfill.

Leachate Treatment.

At this time, Metro proposes to treat the leachate for most constituents to within five times of the MOEE water quality objective and/or drinking water standard. Metro plans to use a mixing zone of up to one half the width of the Misema River and several hundred meters downstream of the discharge in which the excessive concentrations of constituents in the treated leachate, compared to MOEE objectives, will be diluted to concentrations equal to or less than the objectives. While this approach apparently would be accepted by MOEE, such an approach should not be allowed. There are situations, such as for bioaccumlatable chemicals i.e. mercury, where organisms could accumulate within their body tissue, excessive mercury concentrations within the mixing zone and thereby represent a hazard to those who use these organisms as food.

The primary reason for not allowing a mixing zone for hazardous chemicals in the treated leachate is that MSW leachate, after treatment, still contains a large number of potentially hazardous unregulated chemicals. By requiring that Metro treat the leachate so that it could be discharged to the Misema River without dilution for all regulated chemicals, it would be possible to reduce the hazards by a factor of five associated with the unregulated hazardous chemicals in the treated leachate. This is appropriate for this type of situation where complex mixtures of potentially hazardous chemicals are being discharged into a relatively pristine system - the Misema River. Under such conditions dischargers should be required to provide additional treatment beyond the minimum necessary to satisfy current regulatory approaches.

The proposed approach of not allowing a mixing zone for potentially hazardous chemicals is in accord with the resolution adopted by the PLC at the December 10, 1995 meeting, of zero pollutant discharge from the lechate treatment plant to the Misema River. This resolution is appropriate and should be adopted.

It is also important that Metro not attempt to use the existing MOEE policies - standards as the basis for development of this landfill where the minimum protection that these policies require represents the level of control that Metro will commit to in protection of the health, interests and welfare of those potentially impacted. For example, with respect to existing surface water quality, the current MOEE objective for mercury in water is well-known to be inadequate to protect pregnant women from harm due to eating fish which have been taken from waterbodies that have mercury at the currently allowed concentrations, based on PWQO's.

Although it is not clear at this time that MOEE will require the treatment of the leachate so that it has no chronic toxicity to aquatic life at the point of discharge, Metro should commit to protecting aquatic resources so that there is no aquatic life toxicity as assessed by either acute or chronic toxicity measurements using several sensitive test organisms. In those instances where MOEE standards may not reflect the most current information available on the impacts of chemicals on human health, aquatic life and wildlife, Metro should treat the leachate in accord with the latest generally accepted reliable information for protection of public health, aquatic life and wildlife.

Discharge of Pit Dewatering Waters to the Misema River. Metro's consultants conclude, based on the chemical characteristics in the three AMS pits that are proposed to be used as landfills, that this pit water can be safely discharged to the Misema River without treatment. However, a review of the adequacy of the studies conducted by Metro and its consultant of the characteristics of the pit waters, shows that there were significant deficiencies in some aspects of these studies. For example, the analytical methods used to measure arsenic in the pit waters was not sufficiently sensitive to detect arsenic at concentrations that are potentially adverse to Misema River water quality. Therefore, if the pit waters contained elevated levels of arsenic compared to drinking water standards, there is a potential that the discharge of pitwaters without treatment for the removal of arsenic could be adverse to the Misema River water quality.

Similarly, the studies on the pit waters did not include any assessment of aquatic life toxicity or the bioaccumulation of hazardous chemicals in the fish that were taken from one of the pits.

These pit waters, therefore, could contain chemicals that could be toxic to aquatic life in the Misema River and/or could bioaccumulate within aquatic organisms in the Misema River.

A more comprehensive evaluation of the characteristics of the AMS pit waters must be conducted before it can be concluded that these waters can be safely discharged to the Misema River without treatment and/or significantly altering the rate of dewatering of the pits from that proposed.

Plausible Worst Case Scenario Evaluation. During the review of the Metro's draft consultant reports, the author suggested that Metro require that its consultants conduct a plausible worst case scenario evaluation for leachate management and then address how this situation would be detected, remediated, the amount of funds needed to control the problem and the source of the funds that would be needed at any time in the future for the remediation. At the Temiskaming Federation of Agriculture - PLC workshop on December 9, 1995, a Metro consultant presented, for the first time, a plausible worst case scenario failure for the hydraulic containment approach. He indicated that under this scenario, leachate that escapes from the landfill would come to the surface as a discharge near the landfill. This lechate then would drain to Boston Creek and the Misema River polluting both waterbodies. At this time, no details have been provided on the development of this worst case scenario and its reliability. It will be important, as part of Phase 2, to conduct an in depth review of this proposed worst case scenario to be certain that it is reliable and does in fact represent a true worst case situation.

Also, information will be needed on what Metro would do if this situation did, in fact, develop to prevent significant impairment of the water quality in the Misema River, Boston Creek and downstream waterbodies at any time in the future where this scenario could occur.

Landfill Gas.

At the TFA - PLC December 9, 1995 workshop, a Metro consultant indicated that a change in the proposed design of the landfill has occurred in which the circumferential vertical liner near the upper part of the landfill has been replaced by a granular drainage layer. Rather than trying to block the lateral transport of leachate through this region, Metro's consultants propose to allow all leachate that enters this area to become part of the leachate collection system and be removed by pumping or collection in the gravity drainage system. While this system could be more effective in preventing leachate migration laterally from the landfill near the ground surface, it could potentially allow for more landfill gas migration laterally which could result in off-site, near surface groundwater pollution by VOC's such as vinyl chloride. It is well known that landfill gas - VOC migration through the vadose zone (above the water table) is a significant cause of groundwater pollution associated with MSW landfills. This issue needs to be addressed as part of the Phase 2 Assessment of the proposed landfill in order to develop an approach to detect landfill gas migration under conditions where the gas collection system does not collect all of the gas that is produced in the landfill. This is not an uncommon situation for MSW landfills, especially with an inadequately maintained gas collection system.

Impact on Agriculture.

Agricultural interests in this area are concerned that a major fault or fracture exits near the Adams Mine Site Landfill that could rapidly transport leachate to the groundwaters that are used as a water supply in their area. While Metro's consultants assert that this situation does not exist, thus far they have not presented information that presents convincing evidence on this issue. The author has developed a detailed discussion of the issues that need to be addressed as part of evaluating whether the proposed Adams Mine Site Landfill represents a threat to the groundwater resources in the Temiskaming Little Clay Belt region. Many of the issued raised by the author were addressed, to a considerable extent, by Gartner Lee in their presentation at the TFA -PLC December 9, 1995 workshop. At this meeting it was indicated that the groundwater supplies of the Little Clay Belt region are derived locally and that there is little or no possibility of transport of leachate polluted water from the AMSLF reaching the agricultural water supplies of the region. While from the information provided, this situation seems to be appropriate, it is important that it be independently evaluated.

The TFA has, through it own investigations, determined that the Monroe esker could be a potential transport mechanism for leachate polluted groundwaters to reach the Little Clay Belt region. It appears that Metro's consultants have not adequately investigated this situation. This is obviously a topic area that needs attention to be certain that when this esker crosses the Misema River it could not transport leachate derived from the landfill side of the river to the other side of the river and then on down to the Little Clay Belt region.

Impact of Birds. In previous comments on the impacts of gulls and other birds, the author has indicated that he found that Metro's consultants report on this topic was highly superficial and likely in error. On the morning of December 11, 1995, when the author left Kirkland Lake, he had the opportunity to discuss, with the pilots of the airline, the normal flight path for travel from the Kirkland Lake airport. The PLC members may recall that in Metro's consultants report on birds indicated that the flight path for commercial airlines was not near the AMSLF. However, the author reported that in September when he took off from the Kirkland Lake airport that he flew over the AMS. It was found through discussions with the pilots that every flight between Kirkland Land and Earlton flies over the AMS. It is therefore clear that the Metro's consultants assessment of potential bird impacts associated with AMSLF development was not only superficial but in significant error. From the information provided by the Gartner Lee staff, it is now clear that Metro will likely have to spend substantial funds for control of bird impacts in order to protect commercial and private aviation.

Economic Impacts. Metro, through its consultants Hemson Consulting Limited, made available to the author Technical Appendix K - Economics dated December 4, 1995 on December 9, 1995. This appendix is indicated as an "Interim Report". A critical review of this report shows that it, like other Metro consultant's reports, does not provide the peer reviewers with the information necessary to assess the reliability of the conclusions presented in this report on the potential economic aspects of the proposed AMSLF.

Metro is requiring that its Council accept the reliability of the conclusions presented in this report without having available independent investigation of the technical validity of these

conclusions. It has been stated by Metro staff that whether Metro Council decides to go ahead with the AMSLF Assessment or selects one of the alternative proposals for managing Metro's garbage, would be based primarily on economic considerations. This means that Metro Council must have reliable information on economic issues associated with the AMSLF as well as the alternative proposals.

As is well known, economics is less than a precise science. In order for Metro Council to reliably evaluate the economic aspects of the proposed AMSLF, it is important that they be provided with reliable economic information. At this time, it appears that the Council may not have received such information. While it is impossible to evaluate the reliability of the information provided in the Economics report since insufficient detail is provided to enable such an evaluation, from the author's experience and expertise in evaluating the long term cost of landfill post-closure care, it appears that Metro and its consultants have significantly underestimated the long term costs associated with the development of the AMSLF. Of particular concern is post-closure costs. As an example, if the contaminating lifespan of the AMSLF is not the projected 100 years, but several hundred years to a thousand or more years, the cost of post-closure care changes drastically.

Further, the economics of post-closure care seems to be highly dependent upon obtaining revenue from the sale of landfill gas. The economics of landfill gas recovery and use are such that, for many landfills located in a much more desirable location with respect to utilization of landfill gas, it is uneconomical to recover landfill gas as a source of income. In the AMSLF situation, it is questionable whether it is appropriate to conclude that there will be substantial income derived from the sale of landfill gas during the post-closure care period for the AMSLF.

Before Metro Council decides, based on economic considerations, to proceed to Phase 2 of the Assessment, there is need for reliable, independent assessment of the reliability of the economics of Metro's consultant's economic report. It is my assessment, based on having considered these issues for a number of other sites, that a proper economic analysis could readily show that the cost per ton of developing, operating and closing of the proposed AMSLF could be 10 to several 10's of dollars per ton more than that projected in the consultant's economics interim report. It appears that these issues will have to be addressed as part of Phase 2 Assessment of the proposed AMSLF.

It is important that Metro Council understands that the bid prices for the disposal of Metro Toronto solid waste in US landfills may not necessarily reflect the ultimate cost of such disposal. The author is familiar with the significant economic deficiencies in the approach that was adopted by the US EPA in developing current US landfill regulations. The US Congress and the US EPA, as part of developing these regulations, opted for a short term political resolution of MSW landfilling practices. It is well understood by the technical community in the USA that current US landfills only postpone when groundwater pollution occurs by MSW leachate.

It is also well understood that US landfilling companies are developing massive liabilities associated with landfilling of wastes that will ultimately pollute groundwater for landfills sited in those areas where groundwater pollution is possible. Dr. Jones-Lee and the author have published several papers on these issues. They include: "Municipal Landfill Post-Closure Care

Funding: The 30-Year Post-Closure Care Myth" Report G. Fred Lee and Associates (1992), "Landfill Post-Closure Care: Can Owners Guarantee the Money Will Be There?" in Solid Waste and Power 7(4):35-39 (1993), "Landfilling of Solid & Hazardous Waste: Facing Long-Term Liability" IN: Proceedings of the 1994 Federal Environmental Restoration III & Waste Minimization II Conference (1994) and "Overview of Landfill Post Closure Issues" presented at the American Society of Civil Engineers Convention (1995).

Metro Council should not assume that because a US company quotes a price per ton for solid waste disposal that this is the only cost that the people in Toronto will face in that approach for waste management. As discussed in these articles, it is well known that US garbage companies will not be able to meet the long term liabilities that are accumulating with current methods of solid waste management involving disposal in US landfills that meet current minimum regulatory requirements. At some time in the future, essentially all of the owners of current landfills will be subject to having to pay for the massive costs associated with groundwater pollution cleanup. There certainly will be significant attempts to collect part of these funds from those who contributed waste to the landfill. While landfill companies may assert that disposing of waste in their landfill will not result in any long term liability for future remediation of polluted groundwaters, there are significant questions about whether such claims are reliable and will, in fact, be valid for as long as the waste in the landfill represent a threat.

Basically, Metro Council is faced with the situation of trying to make a business economic decision on how best to manage Metro's garbage over the next 20 or so years without having reliable information on the true costs for the various alternative approaches. It is important that Metro and its Council develop a more reliable assessment of not only initial but long term costs associated with managing Metro's solid waste for developing the AMSLF and the alternative approaches for MSW management.

Overall Assessment

The economic aspects of the proposed development of the AMSLF are, at this time, poorly understood. It is virtually certain that the proposed costs of landfilling at this landfill are significantly less than the actual cost that Metro will ultimately experience. Similarly, the ultimate cost of the disposal of Metro's solid waste at the alternative sites are also likely significantly underestimated. A critical, in depth, reliable estimate of the long term liabilities for the disposal of Metro's solid waste for each of the alternatives available should be conducted as part of the Phase 2 Assessment associated with the development of the proposed AMSLF.

Issues that Need to Be Considered in Evaluating the Potential for the Proposed Adams Mine Site Landfill to Pollute Off-Site Groundwaters, Including those Associated with Agricultural Water Supplies in the Temiskaming Little Clay Belt Region

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Presented below is a discussion of the issues that need to be considered as part of evaluating the potential for the proposed Adams Mine Site Landfill (AMSLF) to pollute groundwaters in the Temiskaming Little Clay Belt area that are used for agricultural and domestic purposes. This discussion also presents information on issues that need to be addressed in connection with evaluating near-landfill pollution of groundwaters by the proposed AMSLF.

It has been my experience that a risk assessment approach should be used in evaluating whether a particular source of potentially hazardous or deleterious chemicals could be adverse to a groundwater supply water quality. A discussion of the application of such an approach to the AMSLF and Little Clay Belt agricultural watersupplies is presented below.

Risk Assessment Approach

In addressing problems of this type, I feel that a risk - hazard assessment approach should be used. Several years ago, Dr. Jones and I published a paper, "A Risk Assessment Approach for Evaluating the Environmental Significance of Chemical Contaminants in Solid Wastes," *IN:* Environmental Risk Analysis for Chemicals, Van Nostrand, New York, pp 529-549 (1982). This paper, which was the first paper published on how to conduct such a risk assessment on a proposed landfill, discusses the issues that need to be considered in evaluating the risk - hazard of a landfill to groundwater quality at a particular location. Today, risk assessments of this type are routinely done in connection with industrial hazardous chemical sites and various types of landfills.

The basic components of a landfill risk assessment are presented below.

A source of hazardous and deleterious chemicals i.e., the proposed Adams Mine Site Landfill,

- a transport path from the source i.e., groundwater and
- a receptor i.e., humans, animals and/or plants that may be potentially adversely impacted by the chemicals derived from the source.

Source

The proposed Adams Mine Site Landfill has a variety of potentially significant chemical constituents and pathogenic organisms that could be adverse to public health, agricultural interests and the environment in the Temiskaming area.

Contaminating Lifespan. While Metro's consultants assert that the contaminating lifespan of the proposed Adams Mine Site Landfill will be on the order of 100 years, it is my assessment that their approach for estimating this value likely has significant problems. From the information available, I conclude that the contaminating lifespan would likely be more on the order of a thousand or more years. I need additional information on several of the values assumed in the modeling, the technical basis for these assumptions and the details of the modeling approach before I can conclude that the contaminating lifespan would only be about 100 years.

Golder Associates' representatives have recently provided me with a copy of several of the references that are listed as backup documents to the estimation of the contaminating lifespan. Upon review of these references, I find that they do not provide the information I need to be able to verify that the contaminating lifespan for the proposed Adams Mine Site Landfill would only be about 100 years. If anything, some of the reference material indicates that some of the assumptions made in the modeling may be inappropriate. This is an issue that will need to be addressed in detail as part of Phase 2 of the Assessment should Metro decide to go ahead with the potential development of this landfill.

From a conservative - protective perspective, it should be assumed, unless it can be convincingly demonstrated otherwise, that the contaminating lifespan of the proposed Adams Mine Site Landfill will be at least several hundred years, and likely, a thousand or more years.

Reliability of Hydraulic Containment System. The ability of the hydraulic containment system should be critically analyzed by Metro and its consultants from the perspective of predicting its potential for failure. This information should be critically reviewed by a panel of experts in groundwater hydrology who could assess whether Metro has, in fact, properly determined the reliability of this system and that this system is, in fact, reliable.

Transport Mechanism

A key issue of concern with respect to the potential for the Adams Mine Site Landfill to pollute groundwaters, in the Temiskaming Little Clay Belt agricultural area is whether there is a transport mechanism via groundwater by which hazardous and deleterious chemicals present in the landfill could, at some time in the future, be transported from the landfill to the wells of the farming interests at sufficient concentrations and for sufficient duration to be adverse to the use of this water for domestic or other purposes.

As presented thus far, Metro and its consultants assert that the proposed Adams Mine Site Landfill is not hydraulically connected to the wells which serve as a water supply to the

Temiskaming agricultural area. It is also asserted, although at least from my perspective not adequately demonstrated, that the hydraulic containment mode of operation of the proposed landfill will prevent leachate-polluted groundwaters from escaping the landfill during the contaminating lifespan.

Further, it has been asserted, although the basis for this assertion has not been provided so that it could be independently verified, that should the hydraulic containment system fail to prevent leachate pollution of groundwaters in the region of the landfill, that none of this polluted groundwater would move under the Misema River and Boston Creek since both of these waterbodies are discharge points for groundwater arising upgradient near and beyond the Adams Mine Site.

However, farming interests' representatives are concerned that one or more major fractures or faults exists in the vicinity of the Adams Mine Site that could be, at some time in the future, contaminated by leachate that would rapidly transport this leachate to wells located within the Temiskaming agricultural area. The agricultural interests point out that some of the wells in this region which take water from fractured rock yield large amounts of groundwater and therefore represent major pathways by which groundwater from some considerable distance is transported to these wells. At this time, there is insufficient information provided by Metro and its consultants to justifiably claim that there are no major faults or fractures - pathways through the fractured rock that could serve as a fairly rapid conduit for leachate-polluted groundwaters to reach wells in the Little Clay Belt area. This issue is the bottom-line issue that must be resolved with a high degree of reliability in order to be able to claim that there is little or no possibility that in the hundreds to a thousand years or more that the proposed Adams Mine Site Landfill will be a threat to groundwater quality that leachate from this landfill could be transported to agricultural wells in the Temiskaming agricultural area.

Receptor

The domestic and agricultural water supplies of the Temiskaming Little Clay Belt region are the points at which there is concern about the potential impacts of leachate pollution of groundwaters that could impair the use of these waters for human consumption and the support of agricultural activities. The farming interests in this area are highly dependent on these groundwaters for their livelihood. Landfill leachate contains a wide variety of hazardous and deleterious chemicals at high concentrations that could cause a water supply well to have to be abandoned. The US EPA in 1988 concluded, as part of promulgation of its municipal landfilling regulations, that any water supply well that is contaminated to any extent with municipal landfill leachate must be abandoned and a new well constructed as an alternative water supply source. This is a highly justified conclusion that would be applicable to Adams Mine Site derived leachate-polluted groundwaters that could occur in the Temiskaming Little Clay Belt agricultural area.

This leachate-Polluted groundwater could contain a variety of highly hazardous chemicals that could cause cancer in people and animals that use this water as a water supply. Municipal solid waste (MSW) leachate contains a variety of chemicals which, while in themselves are not hazardous from a public health perspective, can be significantly adverse to those who use this water for domestic and many agricultural purposes. Total salts (TDS), hardness and alkalinity

occur in leachate at high concentrations and do cause increased corrosion and scaling (coating) of plumbing, hot water heaters and other fixtures, appliances and equipment which shortens its life and increases energy consumption associated with its use. Leachate also contains chemicals that could be adverse to certain agricultural crops.

Dr. Jones-Lee and I provided a detailed discussion of these issues in a paper as they apply to domestic water supplies entitled, "Groundwater Pollution by Municipal Landfills: Leachate Composition, Detection and Water Quality Significance," Proceedings of Sardinia '93 IV International Landfill Symposium, Sardinia, Italy, pp. 1093-1103, October (1993). A copy of this paper has been provided to Heathwood Engineering for those PLC members who wish further information on this topic.

Plausible Worst-Case Polluted Groundwater Transport

One of the key issues that needs to be addressed by Metro and its consultants is an evaluation of plausible worst-case conditions where the hydraulic containment mode of operation fails and the Misema River - Boston Creek so-called barriers do not prevent leachate contaminated groundwaters that arise at the edge of the landfill from traveling beyond these so-called barriers. It is suggested that Metro and its consultants should develop a plausible worst case scenario evaluation of how long it would take for leachate-polluted groundwaters arising at the landfill to reach wells of importance to agricultural interests in the Temiskaming area.

In making these estimates, the best information available on the highest permeability that could occur in the fractured rock geology should be used. Of particular concern, is the rate of transport that is occurring to those Little Clay Belt agricultural wells that are yielding large amounts of groundwater through the fractures. How fast is this groundwater moving along the fractures) and from what distance is it derived? These are key issues that must be reliably addressed in the plausible worst-case scenario evaluation associated with estimating the potential minimum travel time from the Adams Mine Site Landfill to agricultural wells in this region.

It is my experience that normally groundwaters do not move more than a few feet per day. This experience, however, is based on sand and gravel aquifer systems. I am not familiar with examples of groundwater transport in fractured rock systems. What is known -from the literature about the fastest possible rate of transport of polluted groundwaters in such systems? Is it more than a few feet per day? Or is it on the order of 10 to 100 feet per year? Another issue of concern is how does pumping of the groundwater influence the rate of transport in fractured rock systems, and over what distance is this influence possibly manifested? Metro and its consultants should review the literature on this topic and provide this information at the December 9 workshop.

If there are significant gaps in information needed to fairly reliably make an estimate of plausible worst-case transport of leachate-polluted groundwaters to the Temiskaming agricultural area, then these information gaps should be defined and a program should be developed to obtain the necessary information as part of Phase 2 of the environmental assessment for the proposed Adams Mine Site Landfill.

Attenuation of Chemical Pollutants in Leachate

In making the estimate of the plausible worst-case (fastest) travel time assuming that the hydraulic containment system fails and that Boston Creek and the Misema River are not barriers, consideration should be given to estimating the amount of attenuation based on the dilution dispersion that could occur in the fractured rock system in the transport from the landfill to the Temiskaming agricultural area wells. It is important not to assume any adsorption, biological transformations and chemical reactions as part of this attenuation since they are likely to be small in this kind of system for some of the constituents in the landfill leachate that could be adverse to agricultural interests. For these types of chemicals, the only mechanism for decreasing the concentration of leachate-derived pollutants with travel distance that should be assumed to be of importance is dilution - dispersion.

An important issue that should be addressed as part of evaluating the potential for leachate leakage from the Adams Mine Site Landfill to pollute the groundwaters is the expected concentration of leachate-derived constituents in these groundwaters. Since the groundwaters in the vicinity of the Adams Mine Site are derived to a considerable extent from upgradient sources, there will be a mixing - dilution process that occurs between any leachate-polluted groundwater arising from the landfill and the groundwater in the vicinity of the landfill that ultimately will be transported off-site. Metro and its consultants should try to estimate the worst-case concentrations of leachate-polluted groundwaters that could arise within the vicinity of the landfill that would be transported off-site. These would be the initial concentrations of constituents that could, through off-site transport, pollute downgradient wells.

One of the issues of concern is the level of knowledge in the literature about dilution dispersion in fractured rock systems of this type. Is there evidence in the literature for long distance transport of pollutants in fractured rock systems? Metro and its consultants should conduct a reliable, in-depth review of the literature on this topic. If it can be reliably concluded that during the transport from the landfill to the agricultural area that sufficient dilution of the constituents in the landfill leachate would occur to reduce the concentrations below any critical levels, then the likelihood of the landfill being adverse to downgradient agricultural wells would be small. Typical leachate concentrations of hazardous and deleterious chemicals should be assumed to occur in leachate at the landfill. Further, it should be assumed that a critical concentration of 0.01 µg/L is appropriate for the unregulated organics that are present in MSW leachate.

If it could be shown that the expected dilution that could occur in the transport from the Adams Mine Site Landfill to any agricultural well that could be constructed would be sufficient to protect groundwater quality under worst-case conditions, then there could be less reliance on hydraulic containment and the Boston Creek - Misema River "barriers. " As a result, there could be considerably less concern about problems associated with the landfill development to agricultural interests of the region. This does not, however, necessarily eliminate concern for the quality of groundwaters on adjacent and nearby properties to the proposed landfill.

Are the Misema River and Boston Creek Groundwater Transport Barriers?

Metro and its consultants assert that even if the hydraulic containment approach does not work during the pumping and gravity drain periods that any leachate-polluted groundwater would be discharged to either Boston Creek or the Misema River. Both of these waterbodies are claimed to be barriers against down groundwater gradient transport of leachate-polluted groundwaters. From my perspective, Metro and its consultants have not provided convincing evidence that this is, in fact, the case and that no transport of leachate-polluted groundwaters could occur under the river and creek surface downgradient which could eventually reach the Temiskaming agricultural area.

If the plausible worst-case scenario evaluation shows that there could be adverse impacts to the agricultural interests due to the construction of the landfill through groundwater transport of hazardous or deleterious chemicals, then it becomes important to evaluate the reliability of Boston Creek and Misema River as true barriers. Under these conditions, Metro and its consultants should present convincing evidence that can be reviewed by a panel of experts that demonstrates that the upward flow of groundwater to Boston Creek and the Misema River is, in fact, a true barrier to downgradient - away from the landfill groundwater transport.

If there are questions about the adequacy of the current data to demonstrate the effectiveness of the barriers, then Metro and its consultants should define what additional data would be needed in Phase 2 of this evaluation to provide a reliable assessment of the ability of the river and creek to serve as barriers. From my contact with hydrogeologists with whom I work in various areas, I have been informed that a series of wells on each side of the river which are screened at various depths to sample water from these depths would be needed to establish whether or not all upgradient groundwaters are discharged to the river or creek and is there any underflow of groundwater below the creek and river away from the landfill.

It will be important for Metro's consultants in addressing these issues at the December 9 workshop to not make blanket statements. All information presented should be in a form so that it can be reviewed in detail by an independent expert panel peer review of the issues.

Understanding the Little Clay Belt Groundwater Hydrology

Another important issue that will need to be adequately addressed to evaluate the potential for leachate-polluted groundwaters which could arise at the Adams Mine Site Landfill to pollute Little Clay Belt agricultural wells is the groundwater hydrology of the Little Clay Belt region. At this time, there seems to be a contradiction in the statements made by Metros' consultants on the origin of the Little Clay Belt groundwater that is used for agricultural purposes.

Early in the assessment process, one of Metro's consultants claimed at a PLC meeting that the Little Clay Belt fractured rock groundwater was transported slowly from long distances. However, in response to a TFA letter, it was claimed by the same consultant that all Little Clay Belt agricultural groundwaters were derived locally via agricultural region precipitation that penetrates through the low permeability clays that overlie the fractured rock aquifer system of the area. Obviously, this issue has to be resolved.

Gartner Lee Limited has been provided with a small amount of money to conduct a preliminary assessment of what is known about the groundwater hydrology of the Temiskaming Little Clay Belt area. I understand that the results of this review will be presented at the December 9 workshop. It will be somewhat surprising if definitive answers are produced from this review that can conclusively show that there is no long distance transport of groundwaters, through the fractured rock system to the Little Clay Belt agricultural wells. These wells are apparently downgradient from the Adams Mine Site and unless the Misema River and/or Boston Creek as well as any other waterbodies between the landfill and the Little Clay Belt agricultural area are, in fact, true barriers to groundwater transport from the landfill to the agricultural region, then it will not be possible to rule out the potential for long distance transport of groundwaters to this region including from the Adams Mine Site area without extensive additional study. If additional study is needed, then this study will have to be conducted as part of the Phase 2 assessment. Ideally, the general characteristics of the additional study should be presented at the December 9 workshop.

Groundwater Water Quality Monitoring

One of the issues that must be addressed in connection with assessing the hazard that the Adams Mine Site Landfill represents to groundwater quality is the ability of any groundwater monitoring system to detect pollution of groundwaters by landfill leachate before widespread pollution occurs. While Metro's consultants assert in the draft Design and Operations report that a groundwater monitoring system would be established to detect leachate-polluted groundwaters if the hydraulic containment system fails, Metro and its consultants have provided no information on the characteristics of the groundwater monitoring system that would be used for this purpose. Detailed information on this system should be provided. Further, Metro should be required to conduct an evaluation of the reliability of the efficacy of such a monitoring system to detect leachate-polluted groundwaters before widespread pollution occurs.

It is well known that groundwater monitoring in fractured rock is virtually impossible to carry out reliably. The basic problem is that the flow through fractured rocks of the type near the Adams Mine Site occurs through fractures. This means that monitoring wells spaced even a few feet apart may not be able to detect leachate transport through the bedrock unless they happen to intercept the fracture(s) that are principally responsible for leachate transport. As I have pointed out previously Haitjema in, "Ground Water Hydraulics Considerations Regarding Landfills," Water Res. Bull. 27(5):791-796 (1991) characterizes monitoring groundwaters for leachate leakage in fractured rock systems near landfills as,

"Monitoring wells in the regional aquifer [consisting of fractured rock] *are unreliable detectors of local leaks in a landfill."*

"The design of monitoring well systems in such an environment is a nightmare and usually not more than a blind gamble."

If Metro and its consultants persist with claiming that they can carry out a meaningful groundwater quality monitoring program associated with the Adams Mine Site Landfill

development, then this should be demonstrated so that it can be independently reviewed by experts.

Production Well Water Quality Monitoring

An alternative approach to groundwater monitoring using vertical monitoring wells is one in which Metro would commit to monitor production wells within the potential sphere of influence of the polluted groundwaters that could be developed under plausible leakage conditions associated with the development of the Adams Mine Site Landfill. A production well is defined as any well that is used by a property owner as a water supply source for any purpose. This monitoring program would be designed to detect incipient (initial) contamination by leachate-derived constituents before significant harm is done. It would need to be carried out effectively forever where on a quarterly basis, samples would be taken of all existing and any future developed production wells and analyzed for constituents that would indicate that landfill leachate is being found in the well at low concentrations.

Typical MSW leachate has a characteristic signature (chemical composition) for a group of conservative chemicals that can be used to indicate when leachate first begins to contaminate a well. Chemical analysis of the groundwaters can be used to detect when leachate contamination of groundwaters first begins to occur before significant harm is done to the users of the groundwater. At that point, the use of the groundwater can be terminated provided that an alternative water supply is available to meet the needs of the well owner.

When sufficient data has been collected from the quarterly monitoring of production wells so that small changes in water quality can be reliably detected, the frequency of monitoring could be reduced to semi-annually, and then possibly, annually. However, the development and implementation of this program will require a much more sophisticated approach toward groundwater monitoring than is typically done in monitoring groundwaters for landfill leachate pollution. Such a program should be carried out by experts and should be conducted by a third party independent consultant who would report the results to a citizens advisory committee overseeing the landfill operations and impacts. The funding of this monitoring program should be provided by Metro where there is *ad infinitum* assured funding.

The potential worst-case sphere of influence would be judged by the shortest possible time that leachate-polluted groundwaters could travel from the landfill to the location of the production well. Once, the projected worst-case plume could have possibly passed the location of a production well, then the monitoring of that well would be initiated and continued *ad infinitum*.

Commitment to Provide Alternative Water Supply Sources

Metro should commit to a program of providing the funds necessary to treat any leachate polluted groundwaters to protect agricultural interests and/or provide alternative water supplies to these interests for as long as the wastes in the landfill, and any polluted groundwaters that could develop from it, represent a threat. For planning purposes, it should be assumed that this period of time is forever. A well-defined program for the development of alternative water

supplies for the agricultural interests should be formulated as part of Phase 2 of this Assessment should Metro proceed further with the development of this landfill.

Evaluate Possible Remediation Approaches

While the pollution of groundwaters by MSW leachate can never be assumed to be completely remediable where the once polluted groundwater "after remediation" would be considered "safe" for human consumption, it is possible to provide high degrees of treatment of MSW leachate-polluted groundwaters so that these waters may be used for a variety of agricultural purposes. Metro should, as part of a possible Phase 2 assessment activity, discuss in detail the remediation approaches that could, and would if necessary, be implemented should a production well be found to be contaminated by Adams Mine Site derived leachate.

The primary purpose of groundwater remediation would be to stop the spread of leachate polluted groundwaters. The remediation program should be conducted at two locations; near the polluted production well as well as near the landfill. The latter should be designed to stop the off-site transport of leachate-polluted groundwaters. Metro should define how it would proceed to accomplish groundwater quality remediation in both areas. Further, if it should develop that it proves to be difficult, if not impossible, to stop the Adams Mine Site Landfill offsite transport of leachate-polluted groundwaters, then Metro should be required to exhume - mine the wastes in the landfill as a possible remediation activity that eliminates the landfill as a future source of polluted groundwater. Landfill mining is now being accomplished at a number of locations in the US. One of the purposes of such mining is the stopping of further groundwater pollution by the landfill.

The magnitude of the funding for plausible worst-case remediation programs for contaminated groundwaters near production wells and near the landfill will need to be defined, and a dedicated trust fund of sufficient magnitude to address all plausible worst-case scenario situations should be established. This trust fund would be paid for by the people in Toronto and other areas who contribute solid wastes to the landfill as part of landfill disposal fees. This fund should be established for an infinite period of time. If, at some time in the future hundreds to a thousand or more years after landfill closure, it is found that the AMSLF no longer represents a threat to groundwater pollution and no pollution has occurred, then it would be possible to return these funds to the people in Toronto.

Resolution of Conflict Between Experts

One of the issues associated with the development of landfills is a conflict between technical experts on groundwater pollution issues. Frequently, non-expert public groups responsible for formulating policy face trying to determine which experts' presentation of information is most reliable. Far too often, decisions of this type are based on a non-technical assessment such as the demeanor of the expert rather than a critical in-depth review of technical issues.

This is an issue that has been of concern to me for a number of years. Recently, the American Society of Civil Engineers, Civil *Engineering,* has published a review of this issue developed by us entitled, "Environmental Ethics: The Whole Truth," *Civil Engineering,* Forum, 65:6 (1995).

This article is based on a report that we developed entitled, "Practical Environmental Ethics: Is There an Obligation to Tell the Whole Truth?" Both of these publications have been provided to Heathwood in order that they may be obtained by PLC members and others.

In our discussions of this issue, we have recommended that should a situation develop where disputes occur between experts in a topic area that the dispute should be resolved by a panel of experts who require that each of the opposing experts presents the technical basis for their position on an issue in a full peer-review arena where all information in support of an expert's opinion is available for the panel and public review. The panel of experts would then recommend to the public body, responsible for formulating a decision on an issue, the appropriateness of each of the opposing expert's positions on the issue in dispute.

Adoption of this approach can lead to a better resolution of the "whole truth" concerning the potential of the AMSLF to pollute groundwaters of the Little Clay Belt region by AMSLF leachate for as long as the landfill will be a threat to groundwater pollution.

December 9, 1995 Workshop

It is suggested that Metro and its consultants discuss the issues raised in these comments at the December 9 workshop and that Gartner Lee representatives review the adequacy of their presentation with respect to addressing the issues in a technically-valid manner.

Addressing the issues raised in these comments would provide a framework for assessing the risk - hazard that the proposed Adams Mine Site Landfill represents to agricultural interests in the Temiskaming Little Clay Belt area. This approach would also provide information that is needed to assess potential local - near landfill water quality impacts that could occur due to the Adams Mine Site Landfill.

Reference as: "Lee, G. F., 'Overview Assessment of the Potential Public Health, Environmental and Groundwater Resource and Other Impacts of the Proposed Adams Mine Site Landfill,' Report to the AMSLF Public Liaison Committee and Metropolitan Toronto, Toronto, Canada, December (1995)."