Counterpoint

By G. Fred Lee, Ph.D., P.E., D.E.E., and Anne Jones-Lee, Ph.D.,
with responses by Jeremy O'Brien for SWANA

Comments on the SWANA Summary Report "Recent Studies Indicate Minimal Heavy Metal Releases from MSW Landfills"

The May/June 2005 issue of *MSW Management* contains a review of the Solid Waste Association of North America (SWANA) Applied Research Foundation report in which J. O'Brien, executive director of the SWANA Research Foundation, presents a summary of the potential for heavy metals in today's municipal solid waste (MSW) leachate to pollute groundwater.

MSW Management considers this such an important topic that we are presenting Drs G. Fred and Anne Jones-Lee's challenge and SWANA's response to the article as the basis for an ongoing dialog on our Web site. To facilitate this we are appending this to the basic article at **www.mswmanagement.com/mw_0505_recent.html**. We then invite you to avail yourself of the "Comment on This" button found in the left margin of the web page. These comments will be added to the Web discussion.

The Counterpoint presented here stems from O'Brien's conclusion: "Based on a review of recent studies and published literature, the SWANA report concluded that MSW landfills can provide for the safe, efficient, and long-term management of disposed products containing RCRA heavy metals without exceeding limits that have been established to protect public health and the environment. It further concluded that MSW landfills should contain the releases of RCRA heavy metal pollutants at levels that protect public health and the environment for extremely long periods of time if not forever."

Lee Challenge

The SWANA Applied Research Foundation report to which O'Brien (2005) refers is "The Effectiveness of Municipal Solid Waste Landfills in Controlling Releases of Heavy Metals to the Environment," dated March 2004 (SWANA 2004). Lee (2004) provided a detailed review of this report.

SWANA Response

The SWANA report was prepared by Jeremy O'Brien, P.E., SWANA's director of applied research. To provide an independent review of the research findings and conclusions presented in the report, SWANA engaged the services of the late Dr. Frederick Pohland. Dr. Pohland was the Weidlein Chair of Environmental Engineering in the Department of Civil and Environmental Engineering at the University of Pittsburgh. In addition, the report was subjected to an outside peer review by an independent panel comprising the leading academicians and researchers in this field.

- *Dr. Debra R. Reinhart, chair, Civil and Environmental Engineering Department and professor and associate dean, College of Engineering and Computer Science, University of Central Florida*
- *Dr. Morton A. Barlaz, professor and associate head, Department of Civil, Construction, and Environmental Engineering, North Carolina State University*
- *Dr. Timothy G. Townsend, associate professor, Department of Environmental Engineering Sciences, University of Florida*

All of the reviewers agreed that the report accurately and correctly presents the findings of the studies reviewed in the report.

Lee Challenge

As Lee comments, the SWANA Applied Research Foundation report, which claims that heavy metals in municipal solid waste (MSW) landfill leachate do not represent a threat to cause groundwater pollution, is based on a flawed approach for assessing the critical concentrations of heavy metals in MSW leachate that can be adverse to groundwater quality. The SWANA report uses the US EPA TCLP regulatory limit as a measure of the concentrations of heavy metals in MSW leachate that would not cause groundwater pollution. However, this is not the purpose for which TCLP regulatory limits were developed. TCLP regulatory limits were established to classify wastes as "hazardous" versus "nonhazardous." So-called "nonhazardous" waste components can still generate leachate that is a significant threat to public health and the environment. The TCLP regulatory limits were arbitrarily established without proper regard to how constituents such as heavy metals in MSW leachate can impair the beneficial uses of groundwaters and surface waters.

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SWANA Response

The report compares average heavy metal concentrations in landfill

leachate to five different regulatory limits, not just the TCLP. These regulatory standards include (1) the TCLP test limit, (2) the groundwater 'Maximum Contaminant Levels' (MCLs) established in Subtitle D regulation for performance-based landfill liners, (3) US Primary Drinking Water Standards 4) Final Effluent Limitations, Guidelines and Pretreatment Standards for the Landfill Point Source Category, and (5) selected local pretreatment standards for industrial wastewaters. The SWANA report does not suggest that because a waste passes TCLP regulatory limits, it poses no risk to groundwater.

Lee Challenge

The SWANA report presents concentrations of heavy metals in today's MSW leachate, which are sufficient at some locations to cause significant adverse impacts to groundwater quality and surface water quality. Under US EPA Subtitle D landfilling practices, there is potential justification for limiting the concentrations of heavy metals in the municipal solid waste stream as part of an effort to reduce the heavy metal concentrations in MSW leachate.

The O'Brien *MSW Management* article contains the same misrepresentation of the potential water quality significance of heavy metals in MSW leachate as was presented in the SWANA (2004) report, where O'Brien states that the heavy metal concentrations in MSW leachate listed in Table 2 "... are all lower than the TCLP regulatory limits." However, as discussed by Lee (2004), the issue is not the concentrations of heavy metals in leachate relative to TCLP regulatory limits, but whether the concentrations of heavy metals in leachate are at concentrations that, when the landfill liner system in the minimum Subtitle D landfill ultimately fails to prevent leachate passage through it, can cause groundwater pollution that is a threat to public health and/or the environment. As discussed by Lee (2004), the US EPA TCLP is not a reliable indication of potential impacts on public health. The TCLP was a political testing procedure that was used to distinguish between hazardous and nonhazardous wastes, where heavy metal concentrations that can be over 30 times (for lead) the US EPA drinking water MCL are used to determine if the waste should be placed in a hazardous waste landfill.

Lee (2004) discusses that there are situations where heavy metals in MSW leachate can be transported for considerable distances in groundwater systems with little or no attenuation in the aquifer. Of particular concern are sand and gravel, fractured rock, and cavernous limestone aquifers.

SWANA Response

The public health threat to groundwater from heavy metal leachate concentrations is dependent on (1) the concentrations of heavy metals in the leachate, (2) the quantities and flow rates of leachate

that escapes through the landfill's composite liner system, (3) the degree of attenuation of the heavy metals in the escaped leachate quantities that would occur before the leachate reached the groundwater source, and (4) the dilution of the leachate heavy metal concentrations in the groundwater. For leachate that does escape through the liner system, there would be some reduction in leachate heavy metal concentrations due to attenuation even for landfills located above fractured rock systems. (Landfills are required to a have a minimum of 10 feet of soil above bedrock).

For landfills that exhibit the average heavy metal concentrations indicated in the report, SWANA's conclusion is that—due to (1) the low heavy metals concentrations in the leachate and (2) the minimal quantities of leachate that are expected, on average, to escape from lined, Subtitle D landfills, the environmental and public health threat are—on average—relatively low. Further, the scenario described by Dr. Lee assumes no treatment of the groundwater prior to consumption. The scenario described by Dr. Lee also appears to represent a worst case. Finally, it would be useful for the reader if Dr. Lee were to describe the level of peer review associated with Lee (2004).

Lee Challenge

The SWANA report and the O'Brien *MSW Management* article attempt to present the image that there are processes that take place in landfills to limit the leaching of heavy metals from MSW components. While there are processes that can limit the mobility of heavy metals in MSW landfills, it is obvious, based on the data presented in O'Brien's Table 2, that the attenuation processes in MSW landfills do not prevent concentrations of heavy metals in MSW leachate that are a threat to public health when the leachate penetrates through the landfill liner system and pollutes groundwater. Table 2 shows concentrations of heavy metals such as lead in some MSW leachate to be 20 times the drinking water MCL. For arsenic the concentration in some MSW leachate is 10 times the MCL.

SWANA Response

The leachate metal concentrations presented in Table 2 are compared in the full SWANA report to the "Maximum Contaminant Levels" (MCLs) established by the US EPA for groundwater protection for landfills that are constructed with "performance-based" liner systems. In developing these MCLs,

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the EPA assumed that the leachate pollutant concentration would be diluted or attenuated by a factor of 100 by the time the groundwater underyling land parcels adjacent to the landfill site would be impacted. In comparison, SWANA found that a "dilution-attenuation factor" (DAF) of only 10 would be sufficient for all of the average heavy metal concentrations to meet the groundwater MCLs established by the EPA as well as the US Primary Drinking Water Standards. Further, average concentrations for two of the metals—barium and silver—were found to comply with groundwater MCLs (as well as US Primary Drinking Water Standards) with no consideration of dilution or attenuation impacts (i.e., an assumed DAF of 0).

In the examples cited by Dr. Lee, when the average lead concentration of 133 ug/L is compared to the current US Primary Drinking Water Standard for lead—15 ug/L, a DAF of only 10 would be required for the average lead concentration in the leachate to meet the drinking water standard. Similarly, the average concentration of arsenic reported in Table 2—0.441 mg/l—would only have to be diluted or attenuated by a factor of 10 to meet the drinking water standard for arsenic (0.05 mg/l).

Lee Challenge

Another topic area that the SWANA report and O'Brien inadequately discuss is the so-called protective nature of today's minimum design US EPA Subtitle D landfills. O'Brien states, "Landfill liner systems

substantially prevent the leaking of leachate from the landfill to the land upon which the landfill is constructed. Based on recent investigations, these liners appear to have a "half life" (i.e., a time frame during which a 50% change in the material properties of the liner occurs) of 970 years. Therefore, the integrity of the liner system can be expected to last through the time frame when significant quantities of leachate are being generated."

While O'Brien did not reference the so-called "recent investigations," he lists as a reference a US Environmental Protection Agency report with a date of December 2002. This reference listing is incorrect in that it should have been referenced as Bonaparte et al. (2002), which was issued as a US EPA report in December 2002. A critical review of this report (see Lee and Jones-Lee 2005) shows that there are many reasons why the period of time before failure of a minimum design Subtitle D landfill liner system can be much less than the extrapolated value of 970 years.

The referenced report ("Assessment and Recommendations for Improving the Performance of Waste Containment Systems," July 2002) was authored by leading experts (Rudolph Bonaparte, GeoSyntec Consultants; David Daniel, University of Illinois; and Robert Koerner, Drexel University) through a cooperative agreement with the US EPA.

Lee Challenge

O'Brien states, "MSW landfills should contain the releases of RCRA heavy metal pollutants at levels that protect the environment for extremely long periods of time if not forever." This statement is based on an unreliable assessment of the critical concentrations of heavy metals in landfill leachate relative to the potential for heavy metals in MSW leachate to cause groundwater pollution that is a threat to those who use leachate-polluted groundwaters as a domestic water supply. A proper analysis of the threat that heavy metals in MSW leachate represent to cause groundwater pollution that is a threat to domestic water supplies must be made on a site-specific basis considering the characteristics of the aquifer system that will be polluted when the landfill liner system eventually fails to prevent leachate from penetrating the liner system.

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SWANA Response

The scenario presented by Dr. Lee of leachate penetrating through the liners system appears to assume that (1) substantial quantities of leachate are leaked at significant rates at the future point in time when the landfill's top and bottom liner systems are determined to have ultimately failed, (2) no metal attenuation occurs either in the soil portion of the composite liner or the soil underneath the liner, (3) no dilution of the leachate occurs in the groundwater, and (4) no treatment of the impacted water source occurs before human consumption. As stated earlier, SWANA found that a DAF of only 10 would be sufficient for the all of the average heavy metal concentrations reported for MSW leachate to meet the groundwater MCLs established by the EPA as well as US Primary Drinking Water Standards.

SWANA's intent in this report was to make a general assessment of the public health and environmental risks associated with heavy metal releases from Subtitle D landfill based on average concentrations reported in leachate and landfill gas. As indicated in the report, there are some locations where pretreatment of the leachate is required to meet local pretreatment standards. Similarly, there may be instances where local leachate concentrations, combined with local hydrogeologic conditions and liner system failures, may warrant a site-specific analysis of the threat to domestic water supplies presented by heavy metal leachate concentrations. However, for landfills that exhibit the average heavy metal concentrations indicated in the report, SWANA's conclusion is that due to (1) the low heavy metals concentrations in the leachate and (2) the minimal quantities of leachate that are expected, on average, to escape from lined, Subtitle D landfills, the environmental and public health threat are—on average—relatively low. SWANA would agree that the implications of siting a landfill are site-specific but this is typically part of the original siting and permitting process.

Lee Challenge

An issue that evolves from this discussion is whether it is appropriate to restrict the heavy metal content of the MSW wastestream. Of particular

concern are the large amounts of electronic items that are being deposited in MSW landfills. The SWANA report is being used, albeit incorrectly, to claim that there is no need to restrict electronic waste deposition in MSW landfills. The SWANA (2004) report and O'Brien (2005) summary paper on this report do not provide information that can be reliably used to justify allowing electronic waste items in the MSW wastestream. At this time it is unclear whether allowing consumer electronic waste items in the solid wastestream will significantly increase the threat to public health through pollution of groundwaters by MSW leachate. However, since minimum design US EPA Subtitle D landfills will ultimately cause groundwater pollution, it is appropriate to reduce items in the MSW wastestream that potentially lead to increased pollution of groundwater.

SWANA Response

As indicated in the report, the major heavy metal of concern with respect to electronic discards is lead, due to its large quantities in CRTs (on average, 4 pounds of lead per device) and its large fraction (97.6%) of the heavy metal portion of the municipal solid wastestream. The SWANA report concludes that, despite the recent increase in discarded consumer electronics, the quantities of lead being disposed in MSW landfills have decreased in the last 15 years. Further, the average concentrations of lead in MSW leachate are less than a factor of 10 higher than the US Primary Drinking Water standard, even before considering the impacts of dilution and attenuation should a portion of the leachate escape through the landfill liner system. There are physical, biological and chemical processes that occur within MSW landfills (high pH; reducing environment; precipitation due to presence of sulfides and sorption in the waste mass) that serve to keep disposed lead from leaching out of the waste mass. For these reasons, SWANA has concluded that MSW landfills provide an effective safety net for the management of electronic discards that are not recycled.

Based on an overall review of his comments, Dr. Lee's argument appears to be with the efficacy of US EPA Subtitle D regulations in general rather than the specific issue of whether or not discarded consumer electronics represent a significant public health threat, in and of themselves, when landfilled. It appears that many of Dr. Lee's concerns would apply to many other types of discards and wastes that are currently permitted to be disposed in Subtitle D landfills.

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