Comments on GeoSyntec's "Performance-Based System for Post-Closure Care at MSW Landfills," Presented at ASTSWMO Meeting, Salt Lake City, Utah, 22-24 July 2003

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GeoSyntec Consultants, on behalf of solid waste management companies and agencies, through the Environmental Research and Education Foundation, presented "Performance-Based System for Post-Closure Care at MSW Landfills" at the ASTSWMO Meeting in Salt Lake City in July 2003. GeoSyntec is a private consulting firm that earns a considerable part of its income from designing landfills for public agencies and private entities. It is the author's finding that GeoSyntec staff frequently testify on behalf of a landfill applicant, where they have not adequately and reliably discussed the long-term public health and environmental problems associated with a proposed landfill expansion or new landfill. It was presentations by GeoSyntec staff and others that caused the author and his colleague to develop the paper,

> Lee, G. F. and Jones-Lee, A., "Practical Environmental Ethics: Is There an Obligation to Tell the Whole Truth?" Published in condensed form "Environmental Ethics: The Whole Truth," *Civil Engineering Forum*, 65:6 (1995). http://www.gfredlee.com/ethics.htm

As discussed below, GeoSyntec is continuing the approach that they have been following over the years of providing unreliable information on the potential long-term impacts of minimum Subtitle D landfill liner and cover systems' ability to provide for high degrees of public health and environmental protection for as long as the wastes in a dry tomb landfill will be a threat.

The objective of the so-called performance-based approach for assessing the duration of post-closure care (PCC) for municipal solid waste landfills is to develop an approach that can be used to convince regulatory agencies that it is possible, based on the performance of the landfill liner and cover systems during part of the current mandatory minimum 30-year PCC period, to reliably predict the long-term (for as long as the wastes are a threat) performance of landfill liner and cover systems to provide high degrees of protection of public health and the environment.

The issue of the deficiencies in the current Subtitle D regulations in providing adequate post-closure care funding for Subtitle D landfills for as long as the waste components in a dry tomb landfill will be a threat is an issue of concern to many who are interested in protecting groundwater resources from the inevitable pollution by landfill leachate and the long-term releases of landfill gas from the landfill during the period that landfill gas can be generated. Lee and Jones-Lee have published extensively on these issues in a series of papers and reports. The GeoSyntec July 2003 presentation on this issue ignores many of the key factors that cause the so-called performance-based approach for establishing PCC to be fundamentally flawed.

It is clear from the PowerPoint presentation by GeoSyntec at the ASTSWMO Meeting that the GeoSyntec staff responsible for this presentation either do not understand, have not read

the literature, or are deliberately distorting the information available on the expected behavior of MSW components in a dry tomb landfill. Those with an elementary understanding of the processes that take place in MSW Subtitle D landfills of the type being permitted today and who will reliably report on them know that the key to landfill waste conversion to non-polluting materials is the moisture content of the wastes. If municipal solid wastes are "dry," they will not generate landfill gas or leachate, effectively forever. That is the basic premise of the dry tomb approach. No landfill gas or leachate can be generated so long as the wastes are dry.

However, if a true dry tomb can be developed, then once the landfill is closed and the wastes dry out, the wastes will not, as GeoSyntec stated in their presentation, "no longer be a threat," but just the opposite – the wastes will be a threat forever. If at any time in the infinite future the cover fails to keep the wastes dry, the moisture that penetrates through the failed cover will promote reactions with the waste components to produce landfill gas and leachate, which will be a significant threat to groundwater resources, public health and the environment.

While GeoSyntec attempts to portray the behavior of minimum Subtitle D landfills as occurring in a well-defined process, their discussion of this process is flawed. There is no way to reliably predict, at this time or in the foreseeable future, when a minimum Subtitle D landfill cover will not be effective in keeping the wastes dry. It is known, however, that breaches in the low-permeability layer (HDPE - plastic sheeting) can readily occur without their being detected by the current landfill cover monitoring approach, which consists of visual inspection of the surface layer of the soil overlying the HDPE layer. The plastic sheeting layer is buried below a surface soil layer of six inches to a foot and a drainage layer of a foot or so. While, as discussed in our writings, it is possible to install leak detectable covers that can provide for a determination of when the low-permeability layer of the cover fails, this approach has not been adopted by regulatory agencies or landfill owners because of the long-term (*ad infinitum*) cost of operating and maintaining, and ultimately repairing, the landfill cover.

The other aspect of this situation is that, as discussed below, GeoSyntec is not adequately and reliably describing the ultimate failure of the bottom liner. There is no doubt that, during the infinite period of time that the wastes in the landfill will be a threat to lead to groundwater pollution by landfill leachate, the bottom liner of the landfill will decay, through free radical and possibly other means, which will lead to the inability of the leachate collection system to collect all leachate and transfer it to a sump where it can be pumped out, if anybody is around to pump it when leachate starts to be generated again due to cover failure in the infinite post-closure care period needed to protect public health and the environment.

The long-term failure of dry tomb landfills is promoting the use of so-called "bioreactor" (more properly called "leachate recycle") landfills, in which leachate that is pumped from the landfill is pumped back into the landfill in an effort to enhance landfill gas formation through increased moisture content of the wastes. As we have written in the early 1990s, appropriately conducted leachate recycle followed by leaching of the wastes with clean water can lead to a non-polluting waste residue (provided that the wastes were shredded in order to prevent plastic garbage bags from protecting the wastes from exposure to moisture); however, leachate recycle (or bioreactor) technology should not be conducted in a minimum Subtitle D single composite lined landfill, since this will increase the potential for groundwater pollution. It can be done in a

double composite lined landfill, where if the upper composite liner fails, the leak detection system between the two composite liners can detect this failure. At that time it will be necessary to shut down the leachate recycle and install a leak detectable cover or exhume the wastes from the landfill in order to prevent groundwater pollution.

Consulting firms like GeoSyntec, on behalf of their clients (landfill developers), will make claims about how today's minimum Subtitle D landfills are engineered systems with multiple barriers. The facts are that, while there is engineering involved in the design of the landfill containment system, engineering cannot overcome the fundamentally flawed approach of trying to use thin plastic sheeting and compacted soil/clay to prevent groundwater pollution by landfill leachate for as long as the wastes in the landfill will be a threat. As discussed in our writings, the evolution of the liner systems that are used is based on using the next cheapest thing to nothing (no liner). It is not based on the finding that the compacted soil layer or plastic sheeting can be expected to perform to protect public health, groundwater resources and the environment from the hazardous and deleterious materials in the landfilled wastes for as long as they are a threat.

Another aspect of the unreliable information provided by GeoSyntec is with respect to the ability of the groundwater monitoring systems to detect leachate-polluted groundwaters when they first reach the point of compliance, in accordance with regulatory requirements. GeoSyntec continues to ignore the findings of Dr. John Cherry of the University of Waterloo, who is a world-renowned groundwater hydrologist, on the unreliability of the groundwater monitoring systems that are used at minimum Subtitle D landfills to detect when leachate has passed through the liner and has reached the point of compliance for groundwater monitoring. This point is no more than 150 meters from the downgradient edge of the landfill, and must be on the landfill owner's property. As discussed in detail in our writings, which are based on Cherry's analysis and subsequent work done at the University of Waterloo on the actual lateral spread of leachate-polluted groundwaters from a source, such as a rip, tear or point of deterioration in the liner system, in many aquifer systems, the lateral spread will be such that the leachate plume can readily pass between the monitoring wells and not be detected by them. This means that the monitoring of groundwater to protect offsite groundwaters from pollution is fundamentally flawed.

As part of the July 2003 GeoSyntec presentation, on a PowerPoint slide entitled "Problem Statement," the bulleted items state,

- *"30-year PCC timeframe of Subtitle D is not site-specific or performance based*

- *No guidance is available on how to define length of PCC or to evaluate the performance of a PCC program*

- *Subtitle D Regulations provide no clear direction on how to end/exist post closure*

The bottom line with respect to the length of PCC and the proper implementation of Subtitle D regulations with respect to PCC is that the PCC shall continue for as long as the wastes in the landfill are a threat to release constituents which are potentially adverse to public health,

groundwater resources and/or the environment. While GeoSyntec and landfill owners would like to be able to shut off the PCC responsibility, this cannot be done until the wastes in the landfill are no longer a threat. This cannot be evaluated by short-term measurements, as proposed by GeoSyntec.

In the PowerPoint slide entitled "Typical Landfill Cycle," this diagram is not based on "dry tomb" landfills or landfills in which substantial parts of the waste are deposited in polyethylene bags that are crushed, but not shredded.

In the PowerPoint slide entitled "Where do Bioreactor/Leachate Recirculation Sites fit in?" again, GeoSyntec has provided an inaccurate discussion of issues. Bioreactor/leachate recirculation landfills, as being developed/operated today, ignore the fact that there will initially be an accelerated gas production and leachate formation when there is moisture added to the landfill; however, over time, there will be slow release of the wastes that are "hidden" in plastic bags. This is likely to occur after the bioreactor part of the landfill operations have ceased.

GeoSyntec, in the slide entitled "i. Project Objective," states that ultimately the project is to develop regulatory guidance for state implementation. Any regulatory agency that follows the GeoSyntec approach will be opting for cheaper-than-real-cost garbage disposal at the expense of future generations' public health, groundwater resources and the environment.

The PowerPoint slide entitled "ii. Premises of the Approach" states,

> *"1. Waste, gas, and leachate can be effectively contained as long as they are a threat to the environment."*

This statement is propaganda, and not factual. As discussed in my writings, the facts are that the wastes in a Subtitle D dry tomb landfill will be a threat effectively forever to pollute groundwaters, and for a very long time, to produce landfill gas, both of which are a threat to public health and the environment. There are no processes that take place in a dry tomb landfill that will totally eliminate this threat.

The same slide states,

- *"Landfill liners and caps will continue to function well beyond the PCC period*
- *Landfill caps effectively contain the contents of the landfill well beyond the PCC period"*

It is possible that some landfill liners and caps will continue to function beyond the 30-year post-closure care period. It is also possible that failures will occur before the end of the 30-year period that will not be detected by the current monitoring approach. The key issue is whether the cap can keep the wastes sufficiently dry over the effectively infinite period of time that the wastes will be a threat to generate leachate, and whether a single composite liner of the type allowed in Subtitle D landfills will maintain its designed integrity for as long as the wastes in the landfill will be a threat. There is no question about the fact that neither the cap nor the liner can be expected to function effectively for as long as the wastes will be a threat in a dry tomb landfill, to prevent release of landfill gas and leachate to the environment.

This slide also states,

- *"Caps have been shown to substantially reduce leachate generation"*

This can be true for a period of time after the cap is installed, provided high quality construction is achieved; however, it is inappropriate to assume that the initial integrity of the cap will be maintained for as long as the wastes in the landfill will be a threat.

GeoSyntec states,

"2. The need to contain waste, gas, and leachate decreases over time
- *Leachate quality improves and landfill gas generation decreases as waste is decomposed*
- *Leachate from decomposed waste presents a reduced threat to the environment"*

These statements are true; however, in a dry tomb landfill, once an effective cap is installed and moisture entering the landfill is decreased to essentially zero, the wastes do not further decompose, since decomposition (landfill gas generation and leachate formation) depends on moisture. The dry tomb landfill will start landfill gas and leachate production again when the cap loses some of its integrity and moisture starts to enter the landfill. This could be within the 30-year PCC period, or could begin at year 31, 100, 500 or beyond. There is obvious need for *ad infinitum* monitoring, maintenance and post-closure care funding to address the inevitable failure of the cap and liner system while the wastes in the landfill are still a threat.

Slide 17, entitled "Containment/Barrier Layer Durability," states,

"Geomembrane Liners
- *"…the particular polymers used in the manufacture of products for the construction of landfill liner systems* **will not degrade** *in the environments they will encounter in landfills…" [USEPA, 1988, EPA/600/2-88/052].*
- *"The polymers under discussion and the first-grade polymers of these compounds* **should maintain their integrity** *in landfill environments for considerable lengths of time, probably in terms of* **100's of years***…" [USEPA, 1988, EPA/600/2-88/052]."*

This statement ignores the well-known process of free radical attack on HDPE geomembrane liners. Bonaparte, of GeoSyntec, is deliberately presenting distorted information on this issue, since he knows from Koerner's chapter of the Bonaparte, et al. (2002), report that HDPE layers do decompose over time. This is more of the distorted information that I have seen Bonaparte present in support of a client in the permitting of a landfill.

Bonaparte, R., Daniel, D., Koerner, R., "Assessment and Recommendations for Improving the Performance of Waste Containment Systems" US Environmental Protection Agency Office of Research Development EPA/600/R-02/099, Cincinnati, OH, March (2002). http://www.epa.gov/ORD/NRMRL/Pubs/600R02099/600R02099.pdf

The next bullet on the same slide states,

- *"In 1993, USEPA stated in the document entitled,* "Solid Waste Disposal Facility Criteria" *that* "EPA's database has shown that **leachate from MSWLF units is not aggressive to these types of material**"**,** *referring to polyvinyl chloride, crystalline thermoplastics, and thermoplastic elastomer geomembrane liner materials."*

"Clay Liners

- *…dilute solutions of organics have essentially* **no effect on the hydraulic conductivity of clays***" [Mitchell and Madsen, 1987].*
- *"Attack of [clay] liners by chemicals is a major concern only for relatively concentrated chemicals" [Daniel, 1987]."*

These statements are true. It was my graduate students and staff, as part of research that we conducted in the 1970s on behalf of the US EPA, who first discovered that concentrated organics could cause desiccation cracking of packed clay columns (liners). We also showed at that time that dilute solutions of organics did not cause this problem.

The slide entitled "Leachate Generation of Capped Landfills" shows only a nine-year period after installation of the low-permeability cap. It does not show what will happen later on when the cap no longer functions effectively to prevent moisture from entering the landfill.

There are a number of slides in the GeoSyntec presentation devoted to various "modules," such as the "Leachate Module." All of these modules are flawed, since they do not properly represent the long-term conditions of the wastes and the landfill cover system.

The slide entitled "Financial Assurance" contains a statement "*Retain the 30-year Financial Assurance Requirement."* This is propaganda, and technically invalid. There is need for this requirement to change from "30 years" to "as long as the wastes are a threat." Contrary to the statement made, there is need to universally increase the funding requirements and PCC period.

As I commented above, the basic premise of GeoSyntec's position is fundamentally flawed. It ignores the established literature on the ultimate degradation of the cap and liner, and the inadequate funding that is being made available to address this problem under the current Subtitle D regulations. The change that needs to be made in the PCC is to require that a dedicated trust be established that is of sufficient magnitude to address all plausible worst-case failures of the landfill cover, bottom liner, or groundwater monitoring system, and to remediate polluted groundwaters for as long as the wastes in the dry tomb landfill will be a threat. For planning purposes, the period of this threat should be considered infinite.

Additional information on the inadequate and unreliable information provided by GeoSyntec in its July 2003 presentation advocating a Performance-Based System for Post-Closure Care at MSW Landfills is available from my website, www.gfredlee.com, in the Landfills – Groundwater section.