Comments on the Adequacy of the Sydney Tar Ponds Agency SS Remediation Objectives

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The following comments are offered in response to an inquiry from Marlene Kane concerning the reliability of the Sydney Tar Pond Agency's (STPA) approach for remediation of the Sydney Tar Pond sludges by cement-based solidification/stabilization (SS) as set forth in the August 2009 "Remediation of the Tar Ponds and Coke Ovens Sites Design and Construction Oversight Services Final Pilot Scale Report."

The need for treatment of the tar pond sludges stems from the migration of chemical components of the sludge (such as PCB, PAHs, and heavy metals) to Sydney Harbour and nearby waters where they accumulate in organisms, rendering the organisms a health hazard to those who eat them, and adversely affect the wildlife of the area. Therefore, the proper performance objective for the SS-treatment of tar pond sludges should be the reduction in the mobility of the hazardous chemical components to the point at which they will not migrate from the treated sludge to Sydney Harbour In order to evaluate the effectiveness and utility of SS-treatment, or any treatment approach, a properly conducted risk assessment needs to be developed for the SS treated sludge, such as that used at USA Superfund sites to establish the degree of remediation required for polluted areas. Several years ago we published several professional papers that discuss the development of risk assessments for such purpose, including:

> Lee, G.F. and Jones, R.A., "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). http://www.gfredlee.com/HazChemSites/SiteSpecificTCLP.pdf

and

> Lee, G. F. and Jones-Lee, A., "Development of a Stormwater Runoff Water Quality Evaluation and Management Program for Hazardous Chemical Sites," (1997). [Published in condensed version as Lee, G.F. and Jones-Lee, A., "Stormwater Runoff Water Quality Evaluation and Management Program for Hazardous Chemical Sites: Development Issues," Superfund Risk Assessment in Soil Contamination Studies: Third Volume, ASTM STP 1338, American Society for Testing and Materials, pp. 84-98 (1998).] http://www.gfredlee.com/Runoff/stmhzpap.htm

The performance criteria that have been selected by STPA for the SS-treated sludges have no relationship to assessing, or ability to reliably describe, how well the treatment achieved by the approach meets the objective of protecting public health or environmental quality from sludge-associated contaminants. At best, the SS treatment of these sludges will only slow the rate of pollution of Sydney Harbour; it will not prevent or stop it.

The Remediation Criteria report described the hydraulic conductivity criterion as follows:
"*The hydraulic conductivity criterion was established at 1X10-6 centimeters per second (cm/s) which was derived using an approach of reducing the resultant hydraulic conductivity in the solidified sediment by two (2) orders of magnitude in comparison to surrounding stratigraphic units."*
That hydraulic conductivity treatment criterion is arbitrary; it was not established relative to achieving protection of public health and environmental quality from sludge-associated contaminants. The 1 x 10^{-6} cm/sec value means that water can pass through 1 millionth of a centimeter of the SS Treated sludge or other medium every second. This rate of movement of water with its associated pollutants is relatively rapid compared to movement through truly impervious strata/soils. Ordinarily, low-permeability soils or strata have permeabilities of 10^{-9} to 10^{-10} cm/sec. i.e., over a million times less permeable than the SS treated sludge. Permeabilities of 1 x 10^{-6} cm/sec are considered fairly porous and offer limited resistance to movement of water through them.

As shown in Figure 1 from a US EPA landfill cover design manual, the actual rate of movement of water and some pollutants through the SS-treated sludge having a particular permeability, depends on the amount of water ("head") above the SS treated sludge; the greater the head, the more rapid the transport through the medium. If the SS treated sludge cover permeability is like the SS treated sludge itself, then at times, there will be water passing through the cover into the SS treated sludge. As shown in Figure 2, a soil layer as a cover with a permeability of 10^{-6} cm/sec will allow 1,200 gal of water to pass through it every day with one foot of water (head) on the cover. Even with a thin layer of water on top of the treated sludge, such as would occur after rainfall or snow melt, the water will pass through the cover and through the SS treated sludge carrying with it leachable pollutants.

We understand that STPA is considering placing a wetlands on top of the SS treated sludge. Such an approach would insure that there is a large supply of water that can penetrate through the cap and leach pollutants from the SS “treated” sludge.

The bottom line is that a 10^{-6} cm/sec permeability in the SS treated sludge will allow leachable pollutants to move through the SS treated sludge at a relatively high rate and not be protective of the Sydney Harbour from further pollution by hazardous chemicals in the sludge. Information on the rapid breakthrough times of layers of materials. Figure 3 presents a graph from Workman and Keeble that shows these relationships. This issue is discussed in the following paper:

> Workman, J., and Keeble, R., “Design and Construction of Liner Systems,” Chapter 5.1 IN: Christensen et al. (eds), Sanitary Landfilling: Process, Technology and Environmental Impact, Academic Press, New York, pp. 301-309 (1989).
> http://www.gfredlee.com/Landfills/Workman-Keeble.pdf

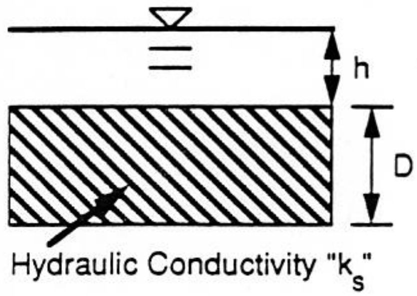
As shown a 1 meter thick layer of compacted soil or other media with a permeability of 10^{-6} will have a break through time (be penetrated) in a few months.

Another problem is that construction permeability is often not maintained over time; many materials become more permeable over time.

Figure 1

Flow Rates Through Liners

(from: US EPA, “Seminars–Design and Construction of RCRA/CERCLA Final Covers,” CERI 90-50, US EPA Office of Research & Development, Washington, DC (1990))



SOIL LINER

Flow Rate Through Soil Liner Alone

$q = k_s i A$

- q = flow rate (m^3/s)
- k_s = hydraulic conductivity of soil (m/s)
- i = hydraulic gradient
- A = area (m^2)

Example:

$h = 1$ ft; $D = 3$ ft

$k = 1 \times 10^{-7}$ cm/s

$= 1 \times 10^{-9}$ m/s

$i = (1+3)/3 = 4/3 = 1.33$

$A = 1$ acre $= 43{,}560$ ft^2 $= 4047$ m^2

$q = k_s i A$

$q = (1 \times 10^{-9}\ m^3/s)(1.33)(4047\ m^2)$

$= 5.38 \times 10^{-6}$ m/s x 60 s/min x 60 min/hr x 24 hr/day

$= 0.465\ m^3$/day x $(3.28\ ft/m)^3$ $(7.48\ gal/ft^3)$

= 123 gal/acre/day

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Figure 2

Flow Rates

(from: US EPA, "Seminars–Design and Construction of RCRA/CERCLA Final Covers," CERI 90-50, US EPA Office of Research & Development, Washington, DC (1990))

Flow Rates if h = 1 ft:

Soil Liner Alone

Hydraulic Conductivity (cm/s)	Flow Rate (gal/acre/day)
1×10^{-6}	1,200
1×10^{-7}	120
1×10^{-8}	12
1×10^{-9}	1

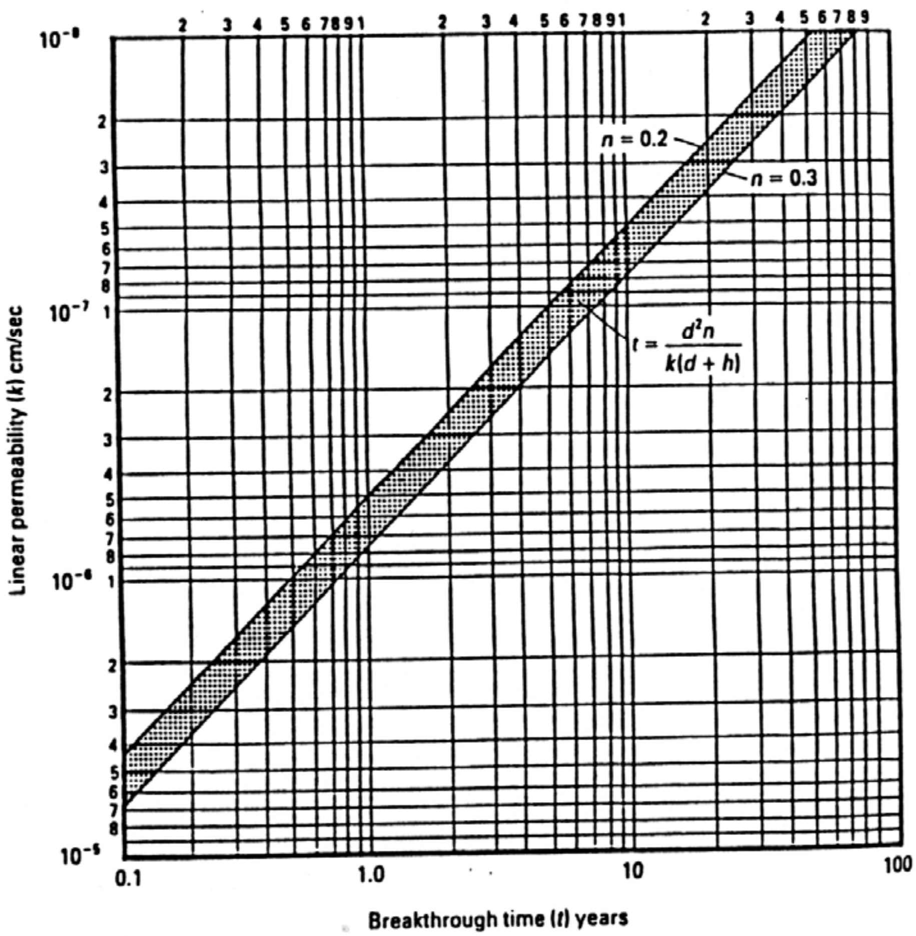
The Remediation Criteria report described the leachability criteria as follows:

"The leachability criteria were established based on letters from NSE dated October 15, 2008 and March 27, 2009 stating that the criteria should be based on two (2) sets of criteria: the first set of criteria was to be derived based on the Massachusetts Contingency Plan (MCP) groundwater (GW) -3 standards taking into consideration the previously agreed upon site specific dilution factor of 7234; and, the second set of criteria were to be based on a comparison of pre- and post-treated sediment Synthetic Precipitation Leaching Procedure (SPLP) leachate concentrations whereby the analyte concentration in the SPLP leachate of sediment with S/S treatment cannot be higher than 500X the corresponding analyte concentration in the SPLP leachate of the sediment prior to S/S treatment."

Those criteria are highly arbitrary and have no technical merit. The fact that Massachusetts Contingency Plan adopted an approach for leaching and an allowed dilution factor does not mean that that approach is technical validity or ensures protection of public health or environmental quality in the system for which it was developed, much less in its application to the regulation of cement-based solidification/stabilization for remediation of tar pond sludges. The leachability criteria specified in the tar ponds remediation criteria were not established on a technical foundation for the real protection of public health and the environment in the Sydney Tar Ponds sludge situation. The issue of the amount of dilution needed to match the pollutant concentrations prior to treatment has no relevance to providing or ensuring sufficient immobilization to prevent further migration of pollutants to Sydney Harbour.

Figure 3

Calculated Breakthrough Time for a 1-m Thick
Clay Liner and 0.3-m Water Head
(Workman and Keeble, 1989)
IN: *Sanitary Landfilling: Process, Technology and Environmental Impact*, Academic Press



Many of the comments were have made concerning the use and reliability of the TCLP in the following, and other, reports and papers are equally applicable to the STPA-adopted approach for determining the degree of immobilization that is needed to claim that the Tar Pond sludges have been adequately treated.

> Lee, G.F., and Jones-Lee, A., "TCLP Not Reliable for Evaluation of Potential Public Health and Environmental Hazards of PCBs or Other Chemicals in Wastes: Unreliability of Cement-Based Solidification/Stabilization of Wastes," Report of G. Fred Lee & Associates, El Macero, CA, September (2009). http://www.gfredlee.com/Landfills/TCLP_Solidification.pdf

Switching from the TCLP to the SPLP does not significantly change the unreliability of this leaching approach to evaluating the leaching of pollutants from the SS treated sludges that can lead to continued Sydney Harbour pollution by hazardous chemicals. In my testimony before the Joint Review Panel in May 2006 and in subsequent publications (listed below) I discussed the very low concentrations of PCBs that can be leached from the SS treated sludges and still cause excessive bioaccumulation of PCBs in edible organisms in the Harbour and nearby waters.

Lee, G. F., "Assessment of the Adequacy & Reliability of the STPA Proposed Approach for Remediation of the Sydney Tar Ponds' Sediments," Presentation to the Sydney Tar Ponds and Coke Ovens Sites Remediation Project Joint Review Panel, Sydney, Nova Scotia, CANADA, PowerPoint Slides; G. Fred Lee & Associates, El Macero, CA, May 15 (2006). http://www.gfredlee.com/Landfills/SydneyTarPondsPowerPt.pdf

Lee, G. F., "Comments on Joint Review Panel Environmental Assessment Report - Sydney Tar Ponds and Coke Ovens Sites Remediation Project," Report of G. Fred Lee & Associates, El Macero, CA, July (2006). http://www.gfredlee.com/Landfills/STPAES-Comments.pdf

Lee, G. F. and Jones-Lee, A., "Progress toward Remediation of the Sydney Tar Ponds: A Major Canadian PCB/PAH 'Superfund' Site," Journal Remediation 17(1):111-119 (2006). http://www.gfredlee.com/Landfills/STP-Remediation-pap.pdf

Lee, G. F., "Unreliable/Inadequate Information on the Efficacy of Solidification/ Stabilization of Sydney Tar Pond Sediments," Report of G. Fred Lee & Associates, El Macero, CA, February (2007). http://www.gfredlee.com/Landfills/SydneyTPSedSolidif.pdf

Lee, G. F., "Update on the Remediation of the Sydney Tar Ponds: Potential Health Effects of Offsite Odor Problems," Report of G. Fred Lee & Associates, El Macero, California November (2009). http://www.gfredlee.com/Landfills/SydneyTarPondsOdors.pdf

The approach used by the Government of Canada and Nova Scotia regulatory agencies for remediation of the Sydney Tar Ponds sludges from the outset – the arbitrary establishment of the funding level that the government would provide without a proper engineering evaluation, and the subsequent selection of SS as the treatment technology on the basis that it appeared to be "do-able" within the funding allocated – is highly unreliable for ensuring protection of public health and environmental quality. Worse, owing to its lack of technical foundation, it provides a false sense of security that the funds being expended are addressing the problems. When it becomes evident that the "remediation" has been inadequate, the public health and environmental quality impacts that will have been allowed by unreliable programs and assurances now, may well be pervasive. As discussed in my testimony before the Joint Review Panel in May 2006 and in subsequent publications (listed below), the STPA approach will fail to provide reliable protection of public health and environmental quality; proper remediation and evaluation approaches will have to be developed and undertaken if true protection of public health and environmental quality is to be achieved.

If you have questions on these comments please contact me. Fred