Evaluation of the Potential Impacts of the Proposed Expansion of the Casella Waste Management Landfill in Coventry, Vermont

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Casella Waste Management has proposed to expand the landfill located in Coventry, Vermont, to accept 440,000 tons of waste per year for approximately 20 years. The Memphremagog Regional Council (MRC) and representatives of various Quebec communities located on Lake Memphremagog have voiced opposition to the Coventry landfill expansion based on the potential for this expanded landfill to pollute Lake Memphremagog. This lake serves as the domestic water supply for 200,000 people, mostly in Quebec.

Casella Waste Management is quoted as having indicated that this proposed landfill expansion will be a state-of-the-art landfill that will be protective of Lake Memphremagog water quality. According to Mahoney (2004),

"*All they* [the public] *need is a little faith:*

- *That Casella Waste Management will never accept any toxic materials in the 2500 tons a day (five days a week year 'round) that will be trucked to their Coventry landfill from all over Vermont and its neighbors.*

- *That if by some weird circumstance toxic material does make its way to the landflll, his employees will never bury it -- if they discover it, they will contain it and safely dispose of it.*

- *That the plastic landfill liners will last forever and never leak toxic fluids into the drainage basin and thus into the lake from which some 200,000 Canadian neighbors get their drinking water.*

- *That if by some weird circumstance -- say, an earthquake -- the plastic membrane is breached, the compacted clay bottom will prevent the poisons from seeping into the lake.*

- *That the drainage pipes that collect the millions of gallons of toxic leachate in the covered pits will never clog and will always work.*

I understand from the information available that the expansion of the Coventry landfill by Casella Waste Management will, in accordance with state of Vermont landfilling regulations, be based on a double composite lined landfill with a leachate collection system. As discussed in my writings, this design will not prevent groundwater pollution by landfill leachate pollution for as

long as the wastes in the expanded Coventry Landfill will be a threat. **All of those concerned about Lake Memphremagog's water quality should be concerned about the proposed Coventry landfill expansion**. This assessment that the proposed Coventry landfill expansion represents a significant threat to Lake Memphremagog's water quality is based on my over 40 years of work on landfill impacts on water quality.

Attached is a summary of my expertise and experience pertinent to this issue. After obtaining a bachelors degree from San Jose State College in San Jose, CA, in 1955 and a Master of Science in Public Health degree from University of North Carolina, Chapel Hill, NC, in 1957 focusing on water quality, I obtained a PhD degree in environmental engineering from Harvard University, Cambridge, MA, in 1960. For 30 years I taught courses and conducted university graduate-level research at several major US universities. During my university teaching and research career I conducted over five million dollars in water-quality-related research and published over 500 papers and reports on this research. I was involved in university-based research on landfill liners and have published extensively on this issue.

During my university graduate-level teaching and research career I served as a part-time consultant to governmental agencies and industry on water quality management issues, including work on landfill pollution of groundwater and surface waters. During my university career, I served as a consultant to Burlington, VT, on Lake Champlain water quality issues and to the State of Vermont on detergent phosphate water quality issues. In 1989 I retired from university teaching and research and expanded my consulting to a full-time activity. Over the past 15 years a considerable part of my consulting activities has been devoted to helping water utilities and others evaluate the potential for an existing landfill, a proposed landfill expansion or a new landfill to pollute a domestic water supply. I also have expertise in domestic water supply water quality issues, including serving as chair of the American Water Works Association national committee on Water Quality in Reservoirs. Additional information on my qualifications to make these comments is attached.

As I have discussed in my writings, the double composite liner approach (two plastic sheeting and clay layers) for developing landfills of the type that Casella Waste Management proposes to construct in the expanded Coventry Landfill, if properly constructed, can initially be more protective than a single composite lined landfill; however, it also has long-term failure problems that must be adequately addressed if a proposed double composite lined landfill is to prevent groundwater/surface water pollution for as long as the wastes in the landfill will be a threat.

As discussed in my writings, the basic problem with a double composite lined landfill protecting public health and the environment for as long as the wastes in the landfill will be a threat is that some of the waste components in the landfill will be a threat forever, and eventually the plastic sheeting layers will deteriorate, thereby allowing leachate to migrate through the clay layers, ultimately polluting underlying groundwaters. In those situations where the underlying groundwaters are connected to surface waters, such as Lake Memphremagog, the solid waste leachate (garbage juice) will pollute the lake with a wide variety of hazardous and deleterious chemicals.

Inadequate Consideration of Postclosure Issues

In accordance with US EPA and state of Vermont landfilling regulations, the expansion of the Coventry landfill will be based on the "dry tomb" landfilling approach. This approach attempts to isolate the wastes from water that can generate leachate. To the degree that this is accomplished with a high degree of reliability, the landfill will be protective of water resources. However the US EPA and the state of Vermont have failed to properly address the long-term problems that are inherent in dry tomb landfilling. In a dry tomb type landfill the heavy metals, salts and many of the organics will be a threat to produce leachate upon contact with water that infiltrates into the landfill through the landfill cover. In order to prevent leachate formation that is a significant threat to cause groundwater/surface water pollution, the wastes in the landfill must be kept dry forever. However, the plastic sheeting liner will deteriorate over time, and because it cannot be replaced since it is buried under the wastes, the leachate collection systems will no longer function as designed, and groundwater pollution will occur.

In principle, the wastes in a dry tomb type landfill can be kept dry if the low-permeability plastic sheeting layer of the landfill cover is maintained so that no moisture enters the landfill. However, this requires that the landfill owner/operator reliably inspect the low-permeability layer of the landfill cover and make repairs of any areas of deterioration. This is not possible for several reasons. First, the low-permeability layer of the landfill cover is buried under several feet of topsoil and a drainage layer. Under the current design, there is no way to determine when the plastic sheeting layer of the cover has deteriorated by visual inspection of the topsoil layer of the cover. The points of deterioration will not be visible on the surface.

The second and most important reason that the cover of the landfill will not likely keep the wastes dry forever is that the current US EPA and state of Vermont landfilling regulations only require a mandatory 30 years of postclosure funding for landfill maintenance and monitoring. Since many of the waste components will be a threat forever, there is no assured funding to monitor and maintain the landfill for as long as the wastes in the landfill will be a threat. This is a recipe for eventual failure of the dry tomb landfill to prevent groundwater/surface water pollution. In my writings I have advocated that dry tomb landfills should be developed with a dedicated trust fund derived from disposal fees to address plausible worst-case failure of the landfill containment system and monitoring system for as long as the wastes in the landfill are a threat. The amount of the trust fund is far more than the $10 million bond that Casella Waste Management proposes to establish for postclosure failure problems.

The deficiencies of postclosure funding are beginning to be more widely understood. Several of the papers on my website provide references to others who have discussed this issue. Please see the recent comments that I submitted to the Integrated Waste Management Board on post closure funding:

> Lee, G. F., "Workshop on Landfill Postclosure and Financial Assurance," Comments submitted to Mike Paparian, California Integrated Waste Management Board, by G. Fred Lee & Associates, El Macero, CA (2003).
> http://www.gfredlee.com/paparian10-30-03T.pdf

The dedicated trust (not a bond) must be established at the time of landfill establishment. It is inappropriate to rely on Casella Waste Management to provide the needed funding for as long as the wastes will be a threat. Waste management companies such as Casella Waste Management are building up massive liabilities from the various dry tomb landfills that they are operating. There are serious questions about whether current waste management companies such as Casella Waste Management will be in business at the end of the 30-year postclosure period 50 or so years in the future when additional post closure funding will be needed at the Coventry landfill.

Why There is Concern about Coventry Landfill Leachate Polluting Lake Memphremagog

As indicated above, the popular press has indicated that Casella Waste Management has stated that no "toxics" will be allowed in the proposed expanded Coventry Landfill. To the extent that these statements were made by Casella Waste Management staff, it is clear that the staff either have no understanding of the issue of toxics in municipal solid wastes (MSW) or are deliberately misleading the public on this issue. As discussed in my writings, it is well known that conventional MSW contains a wide variety of known chemicals that are toxic to humans and wildlife and are present in MSW leachate. These include some heavy metals and some organics. Further there is a vast arena of unknown hazardous and deleterious chemicals in MSW that are not characterized and not analyzed for in landfill leachate water quality studies.

Recently, Dr. Christian Daughton (2004), Chief, Environmental Chemistry Branch, US EPA National Exposure Research Laboratory, made a presentation, "Ubiquitous Pollution from Health and Cosmetic Care: Significance, Concern, Solutions, Stewardship – Pollution from Personal Actions." This presentation covered information on pharmaceuticals and personal care products (PPCPs) as environmental pollutants. He also discussed the relationship between endocrine disruptors and PPCPs. (A copy of Daughton's presentation, which consisted of 64 PowerPoint Slides, is available upon request from gfredlee@aol.com.)

Daughton pointed out that there are a wide variety of chemicals that are introduced into domestic wastewaters and wastes that are being found in the environment. These include various chemicals (pharmaceuticals) that are derived from usage by individuals and pets, disposal of outdated medications in sewerage systems and solid waste streams, release of treated and untreated hospital wastes to domestic sewerage systems, transfer of sewage solids ("biosolids") to land, industrial waste streams, releases from aquaculture of medicated feeds, etc. Many of these chemicals are not new chemicals. They have been in wastewaters and municipal solid wastes for some time, but are only now beginning to be recognized as potentially significant water pollutants. They are largely unregulated as water pollutants.

According to Daughton (2004),

> *"Since the 1970s, the impact of chemical pollution has focused almost exclusively on conventional "priority pollutants," especially on those collectively referred to as "persistent, bioaccumulative, toxic" (PBT) pollutants, "persistent organic pollutants" (POPs), or "bioaccumulative chemicals of concern (BCCs). The "dirty dozen" is a ubiquitous, notorious subset of these, comprising highly halogenated organics (e.g.,*

DDT, PCBs). The conventional priority pollutants, however, are only one piece of the larger risk puzzle."

Daughton has indicated that there are over 22 million organic and inorganic substances, with nearly 6 million commercially available. The current water quality regulatory approach addresses less than 200 of these chemicals, where in general PPCPs and many other chemicals are not regulated. According to Daughton, "*Regulated pollutants compose but a very small piece of the universe of chemical stressors to which organisms can be exposed on a continual basis."* Daughton has indicated that one of the routes of environmental exposure is through trash placed in municipal solid waste landfills. He specifically singles out "leaching from municipal landfills" as an origin of PPCPs in the environment. He characterizes municipal landfills as "pollution postponement." Additional information on PPCPs is available at www.epa.gov/nerlesd1/chemistry/pharma/index.htm.

Periodically, previously unrecognized significant environmental pollutants are being found in aquatic systems. Two recent examples of this type of situation are perchlorate and the polybrominated diphenyl ethers (PBDEs). With respect to perchlorate as a widespread water pollutant, Silva (2003) of the Santa Clara Valley Water District, has discussed the potential for highway safety flares to be a significant source of perchlorate (ClO_4^-) contamination to water, even when the flares are 100-percent burned. According to Silva,

"A single unburned 20-minute flare can potentially contaminate up to 2.2 acre-feet [726,000 gallons] *of drinking water to just above the California Department of Health Services' current Action Level of 4 µg/L* [for perchlorate]*."*

Silva points out that, "*More than 40 metric tons of flares were used/burned in 2002 alone in Santa Clara County."* Silva also indicates that fully burned flares can leach up to almost 2,000 µg of perchlorate per flare. The spent/used highway flares are often disposed of as trash in municipal landfills. This can be a source of perchlorate in MSW leachate. California's Office of Environmental Health Hazard Assessment (OEHHA, 2004) has recently proposed a public health goal for perchlorate of 6 µg/L. As of December 2003, there were 354 public wells in California with perchlorate above the proposed limit of 6 µg/L.

Another widespread "new" pollutant has been recently discussed by Dr. K. Hooper (2003) of the Hazardous Materials Laboratory, Department of Toxic Substances Control, California EPA. He states,

"Over the past 25 years, tens of thousands of new chemicals (7 chemicals per day) are introduced into commerce after evaluation by USEPA. Few (100-200) of the 85,000 chemicals presently in commerce are regulated. We have reasons to believe that a much larger number than 200 adversely affect human health and the environment."

As an example of unidentified hazardous chemicals in the environment, Hooper discussed finding PBDE (polybrominated diphenyl ether) in human breast milk and in San Francisco Bay seals. Archived human breast milk shows that this is a problem that has been

occurring for over 20 years. According to McDonald (2003) of California Environmental Protection Agency, Office of Environmental Health Hazard Assessment,

> *"Approximately 75 million pounds of PBDEs are used each year in the U.S. as flame retardant additives for plastics in computers, televisions, appliances, building materials and vehicle parts; and foams for furniture. PBDEs migrate out of these products and into the environment, where they bioaccumulate. PBDEs are now ubiquitous in the environment and have been measured in indoor and outdoor air, house dust, food, streams and lakes, terrestrial and aquatic biota, and human tissues. Concentrations of PBDE measured in fish, marine mammals and people from the San Francisco Bay region are among the highest in the world, and these levels appear to be increasing with each passing year."*

PBDEs are similar to PCBs and are considered carcinogens. Some of the PBDEs are being banned in the US and in other countries. PBDEs are present in the municipal solid waste stream.

The perchlorate and PBDE situations are not atypical of what could be expected based on the approach that is normally used to define constituents of concern in water pollution control programs. Based on the vast arena of chemicals that are used in commerce, many of which could be present in aquatic systems through wastewater discharges and so-called non hazardous solid wastes, it is likely that many other chemicals will be discovered in the future that are a threat to public health and aquatic ecosystems.

MSW leachate contains a vast array of PPCPs and other unrecognized hazardous chemicals that are a threat to public health and the environment in domestic water supplies such as Lake Memphremagog.

Overall Evaluation

It is common sense that large regional dry tomb type landfills of the type that Casella Waste Management has proposed as part of the expansion of the Coventry landfill should not be sited where leachate that will be generated in the landfill over the infinite period of time that the wastes in the landfill will be a threat can possibly enter Lake Memphremagog. Further, the existing Coventry landfill, as well as all other landfills that are sited near Lake Memphremagog and its tributaries, should be investigated to be certain that no leachate from these landfills is reaching this lake.

References

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Hooper, K., "Lessons from the PBDEs – The Value of Monitoring Community Body Burdens Using Breast Milk," In: 6th Bienniel State of the Estuary Conference, "The San Francisco Bay-Delta Estuary: Changes and Challenges," San Francisco Estuary Project, Oakland, CA (2003).

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Dr. G. Fred Lee, PE, DEE
Expertise and Experience in Hazardous Chemical Site and Municipal/Industrial Landfill Impact Assessment/Management

Dr. G. Fred Lee's work on hazardous chemical site and municipal/industrial landfill impact assessment began in the mid-1950s while he was an undergraduate student in environmental health sciences at San Jose State College in San Jose, California. His course and field work involved review of municipal and industrial solid waste landfill impacts on public health and the environment.

He obtained a Master of Science in Public Health degree from the University of North Carolina, Chapel Hill, in 1957. The focus of his masters degree work was on water quality evaluation and management with respect to public health and environmental protection from chemical constituents and pathogenic organisms.

Dr. Lee obtained a PhD degree specializing in environmental engineering from Harvard University in 1960. As part of this degree work he obtained further formal education in the fate, effects and significance and the development of control programs for chemical constituents in surface and ground water systems. An area of specialization during his PhD work was aquatic chemistry, which focused on the transport, fate and transformations of chemical constituents in aquatic (surface and ground water) and terrestrial systems as well as in waste management facilities.

For a 30-year period, he held university graduate-level teaching and research positions in departments of civil and environmental engineering at several major United States universities, including the University of Wisconsin-Madison, University of Texas at Dallas, and Colorado State University. During this period he taught graduate-level environmental engineering courses in water and wastewater analysis, water and wastewater treatment plant design, surface and ground water quality evaluation and management, and solid and hazardous waste management. He has published over 850 professional papers and reports on his research results and professional experience. His research included, beginning in the 1970s, the first work done on the impacts of organics on clay liners for landfills and waste piles/lagoons.

His work on the impacts of hazardous chemical site and municipal/industrial solid waste landfills began in the 1960s when, while directing the Water Chemistry Program in the Department of Civil and Environmental Engineering at the University of Wisconsin-Madison, he became involved in the review of the impacts of municipal solid waste landfills on groundwater quality.

In the 1970s, while he was Director of the Center for Environmental Studies at the University of Texas at Dallas, he was involved in the review of a number of municipal solid and industrial (hazardous) waste landfill situations, focusing on the impacts of releases from the landfill on public health and the environment.

In the early 1980s while holding a professorship in Civil and Environmental Engineering at Colorado State University, he served as an advisor to the town of Brush, Colorado, on the

potential impacts of a proposed hazardous waste landfill on the groundwater resources of interest to the community. Based on this work, he published a paper in the Journal of the American Water Works Association discussing the ultimate failure of the liner systems proposed for that landfill in preventing groundwater pollution by landfill leachate. In 1984 this paper was judged by the Water Resources Division of the American Water Works Association as the best paper published in the journal for that year.

In the 1980s, he conducted a comprehensive review of the properties of HDPE liners of the type being used today for lining municipal solid waste and hazardous waste landfills with respect to their compatibility with landfill leachate and their expected performance in containing waste-derived constituents for as long as the waste will be a threat.

In the 1980s while he held the positions of Director of the Site Assessment and Remediation Division of a multi-university consortium hazardous waste research center and Distinguished Professor of Civil and Environmental Engineering at the New Jersey Institute of Technology, he was involved in numerous situations concerning the impact of landfilling of municipal solid waste on public health and the environment. He has served as an advisor to the states of California, Michigan, New Jersey and Texas on solid waste regulations and management. He was involved in evaluating the potential threat of uranium waste solids from radium watch dial painting on groundwater quality when disposed of by burial in a gravel pit. The public in the area of this state of New Jersey proposed disposal site objected to the State's proposed approach. Dr. Lee provided testimony in litigation, which caused the judge reviewing this matter to prohibit the State from proceeding with the disposal of uranium/radium waste at the proposed location.

Beginning in the 1960s, while a full-time university professor, Dr. Lee was a part-time private consultant to governmental agencies, industry and environmental groups on water quality and solid and hazardous waste and mining management issues. His work included evaluating the impacts of a number of municipal and industrial solid waste landfills. Much of this work was done on behalf of water utilities, governmental agencies and public interest groups who were concerned about the impacts of a proposed landfill on their groundwater resources, public health and the environment.

In 1989, he retired after 30 years of graduate-level university teaching and research and expanded the part-time consulting that he had been doing with governmental agencies, industry and community and environmental groups into a full-time activity. A principal area of his work since then has been assisting water utilities, municipalities, industry, community and environmental groups, agricultural interests and others in evaluating the potential public health and environmental impacts of proposed or existing hazardous, as well as municipal solid waste landfills. He has been involved in the review of approximately 65 different landfills and waste piles (tailings) in various parts of the United States and in other countries.

Dr. Anne Jones-Lee (his wife) and he have published extensively on the issues that should be considered in developing new or expanded municipal solid waste and hazardous waste landfills in order to protect the health, groundwater resources, environment and interests of those within the sphere of influence of the landfill. Their over 50 professional papers and reports on

landfilling issues provide guidance not only on the problems of today's minimum US EPA Subtitle D landfills, but also on how landfilling of non-recyclable wastes can and should take place to protect public health, groundwater resources, the environment, and the interests of those within the sphere of influence of a landfill/waste management unit. They make many of their publications available as downloadable files from their web site, www.gfredlee.com.

Their work on landfill issues has particular relevance to Superfund site remediation, since regulatory agencies often propose to perform site remediation by developing an onsite landfill or capping waste materials that are present at the Superfund site. The proposed approach frequently falls short of providing true long-term health and environmental protection from the landfilled/ capped waste.

In the early 1990s, Dr. Lee was appointed to a California Environmental Protection Agency's Comparative Risk Project Human Health Subcommittee that reviewed the public health hazards of chemicals in California's air and water. In connection with this activity, Dr. Jones-Lee and he developed a report, "Impact of Municipal and Industrial Non-Hazardous Waste Landfills on Public Health and the Environment: An Overview," that served as a basis for the human health advisory committee to assess public health impacts of municipal landfills.

In addition to teaching and serving as a consultant in environmental engineering for over 40 years, Dr. Lee is a registered professional engineer in the state of Texas and a Diplomate in the American Academy of Environmental Engineers (AAEE). The latter recognizes his leadership roles in the environmental engineering field. He has served as the chief examiner for the AAEE in north-central California and New Jersey, where he has been responsible for administering examinations for professional engineers with extensive experience and expertise in various aspects of environmental engineering, including solid and hazardous waste management.

His work on landfill impacts has included developing and presenting several two-day short-courses devoted to landfills and groundwater quality protection issues. These courses have been presented through the American Society of Civil Engineers, the American Water Resources Association, and the National Ground Water Association in several United States cities, including New York, Atlanta, Seattle and Chicago, and the University of California Extension Programs at several of the UC campuses, as well as through other groups. He has also participated in a mine waste management short-course organized by the University of Wisconsin-Madison and the University of Nevada. He has been and continues to be an American Chemical Society tour speaker, where he is invited to lecture on landfills and groundwater quality protection issues, as well as domestic water supply water quality issues throughout the United States.

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EDUCATION

Ph.D. Environmental Engineering & Environmental Science, Harvard University, Cambridge, Mass. 1960

M.S.P.H. Environmental Science-Environmental Chemistry, School of Public Health, University of North Carolina, Chapel Hill, NC 1957

B.A. Environmental Health Science, San Jose State College, San Jose, CA 1955

ACADEMIC AND PROFESSIONAL EXPERIENCE

Current Position:

Consultant, President, G. Fred Lee and Associates

Previous Positions:

Distinguished Professor, Civil and Environmental Engineering, New Jersey Institute of Technology, Newark, NJ, 1984-89

Senior Consulting Engineer, EBASCO-Envirosphere, Lyndhurst, NJ (part-time), 1988-89

Coordinator, Estuarine and Marine Water Quality Management Program, NJ Marine Sciences Consortium Sea Grant Program, 1986

Director, Site Assessment and Remedial Action Division, Industry, Cooperative Center for Research in Hazardous and Toxic Substances, New Jersey Institute of Technology et al., Newark, NJ, 1984-1987

Professor, Department of Civil and Environmental Engineering, Texas Tech University, 1982-1984

Professor, Environmental Engineering, Colorado State University, 1978-1982

Professor, Environmental Engineering & Sciences; Director, Center of Environmental Studies, University of Texas at Dallas, 1973-1978

Professor of Water Chemistry, Department of Civil & Environmental Engineering, University of Wisconsin-Madison, 1961-1973

Registered Professional Engineer, State of Texas, Registration No. 39906

PUBLICATIONS AND AREAS OF ACTIVITY

Published over 950 professional papers, chapters in books, professional reports, and similar materials. The topics covered include:

- Studies on sources, significance, fate and the development of control programs for chemicals in aquatic and terrestrial systems.
- Analytical methods for chemical contaminants in fresh and marine waters.
- Landfills and groundwater quality protection issues.
- Impact of landfills on public health and environment.
- Environmental impact and management of various types of wastewater discharges including municipal, mining, electric generating stations, domestic and industrial wastes, paper and steel mill, refinery wastewaters, etc.
  Stormwater runoff water quality evaluation and BMP development for urban areas and highways.
- Eutrophication causes and control, groundwater quality impact of land disposal of municipal and industrial wastes, environmental impact of dredging and dredged material disposal, water quality modeling, hazard assessment for new and existing chemicals, water quality and sediment criteria and standards, water supply water quality, assessment of actual environmental impact of chemical contaminants on water quality.

LECTURES

Presented over 750 lectures at professional society meetings, universities, and to professional and public groups.

GRANTS AND AWARDS

Principal investigator for over six million dollars of contract and grant research in the water quality and solid and hazardous waste management field.

GRADUATE WORK CONDUCTED UNDER SUPERVISION OF G. FRED LEE

Over 90 M.S. theses and Ph.D. dissertations have been completed under the supervision of Dr. Lee.

ADVISORY ACTIVITIES

Consultant to numerous international, national and regional governmental agencies, community and environmental groups and industries.

Municipal Solid Waste Landfills and Groundwater Quality Protection Issues Publications

Drs. G. Fred Lee and Anne Jones-Lee have prepared several papers and reports on various aspects of municipal solid waste (MSW) management and hazardous waste management by landfilling, groundwater quality protection issues, as well as other issues of concern to those within a sphere of influence of a landfill. These materials provide an overview of the key problems associated with landfilling of MSW and hazardous waste utilizing lined "dry tomb" landfills and suggest alternative approaches for MSW management that will not lead to groundwater pollution by landfill leachate and protect the health and interests of those within the sphere of influence of a landfill. Copies of many of these papers and reports are available as downloadable files from Drs. G. Fred Lee's and Anne Jones-Lee's web page (http://www.gfredlee.com). Recent papers and reports on landfilling issues are listed below. Copies of the papers and reports listed below as well as a complete list of publications on this and related topics are available upon request.

Overall Problems with "Dry Tomb" Landfills

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Lee, G. F., "Solid Waste Management: USA Lined Landfilling Reliability," An invited submission for publication in *Natural Resources Forum*, a United Nations Journal, New York, NY, December (2002). http://www.gfredlee.com/UNpaper-landfills.pdf

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Liner Failure Issues

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Lee, G. F., "Comments on Tisinger and Giroud 'The Durability of HDPE Geomembranes,'" Letter to the Editor, Geotechnical Fabrics Report, Minneapolis, MN Submitted by G. Fred Lee & Associates, El Macero, CA, 4pp (1994).

Groundwater Pollution by Leachate

Jones-Lee, A. and Lee, G. F., "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 (1993).

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Landfills Evaluated by G. Fred Lee and Anne Jones-Lee

Arizona	Verde Valley - Copper Tailings Pile Closure
California *(State Landfilling Reg.)*	Colusa County - CERRS Landfill San Gabriel Valley - Azusa Landfill City of Industry - Puente Hills Landfill North San Diego County, 3 landfills San Diego County - Gregory Canyon Landfill El Dorado County Landfill Yolo County Landfill Half Moon Bay - Apanolio Landfill Pittsburg - Keller Canyon Landfill Chuckwalla Valley - Eagle Mountain Landfill Barstow - Hidden Valley Broadwell Hazardous Waste Landfills Cadiz - Bolo Station-Rail Cycle Landfill University of California-Davis Landfills (4) San Marcos - San Marcos Landfill Placer County - Western Regional Sanitary Landfill Placer County – Turkey Carcass Disposal Pits Imperial County - Mesquite Landfill Los Angeles County - Calabasas Landfill Los Angeles County – Palos Verdes Landfill Contra Costa County – Concord Naval Weapons Station Tidal Area Landfill
Colorado (*State Landfilling Reg.)*	Last Chance/Brush - Hazardous Waste Landfill Denver - Lowry Hazardous Waste Landfill Telluride/Idarado Mine Tailings
Florida (*State Landfilling Reg.*)	Alachua County Landfill
Illinois (*State Landfilling Reg.*)	Crystal Lake - McHenry County Landfill Wayne County Landfill
Indiana (*State Landfilling Reg.*)	Posey County Landfill New Haven-Adams Center Landfill (Hazardous Waste)
Michigan (*State Landfilling Reg.*)	Menominee Township - Landfill Ypsilanti- Waste Disposal Inc. (Hazardous Waste - PCB's)
Minnesota	Reserve Mining Co., Silver Bay - taconite tailings Wright County - Superior FCR Landfill
Missouri	Jefferson County - Bob's Home Service Hazardous Waste Landfill

New Jersey (*State Landfilling Reg.*)	Meadowlands - Landfill Fort Dix Landfill Scotch Plains Leaf Dump
New York	Staten Island - Fresh Kills Landfill, Niagara Falls - Hazardous Waste Landfill, New York City – Ferry Point Landfill
Ohio	Clermont County - BFI/CECOS HazardousWaste Landfill, Huber Heights - Taylorville Road Hardfill Landfill
Rhode Island	Richmond - Landfill
South Carolina	Spartanburg - Palmetto Landfill
Texas (*State Landfilling Regulations*)	Dallas/Sachse - Landfill Fort Worth - Acme Brick Hazardous Waste Landfill City of Dallas - Jim Miller Road Landfill
Washington (*State Landfilling R*	Tacoma - 304th and Meridian Landfill
Wisconsin	Madison and Wausau Landfills
Belize	Mile 27 Landfill
Ontario, Canada (*Prov. Landfilling Reg.*)	Greater Toronto Area - Landfill Siting Issues Kirkland Lake - Adams Mine Site Landfill Pembroke - Cott Solid Waste Disposal Areas
Manitoba, Canada (*Prov. Landfilling Reg.*)	Winnipeg Area - Rosser Landfill
New Brunswick, Canada (*Prov. Landfilling Reg.*)	St. John's - Crane Mountain Landfill
England	Mercyside Waste Disposal Bootle Landfill
Hong Kong	Three New MSW Landfills
Ireland	Bottlehill Landfill, County Cork Central Waste Management Facility, Ballyduff, County Clare
Korea	Yukong Gas Co. - Hazardous Waste Landfill
Mexico (*Haz. Waste Landfilling*	San Luis Pontosi - Hazardous Waste Landfill
New Zealand	North Waikato Regional Landfill
Puerto Rico	Salinas - Campo Sur Landfill

Surface and Groundwater Quality Evaluation and Management

and

Municipal Solid & Industrial Hazardous Waste Landfills

http://www.gfredlee.com

Dr. G. Fred Lee and Dr. Anne Jones-Lee have prepared professional papers and reports on the various areas in which they are active in research and consulting including domestic water supply water quality, water and wastewater treatment, water pollution control, and the evaluation and management of the impacts of solid and hazardous wastes. Publications are available in the following areas:

Landfills and Groundwater Quality Protection

Water Quality Evaluation and Management for Wastewater Discharges

Stormwater Runoff, Ambient Waters and Pesticide Water Quality Management Issues, TMDL Development, Water Quality Criteria/Standards Development and Implementation

Impact of Hazardous Chemicals -- Superfund

LEHR Superfund Site Reports to DSCSOC

Lava Cap Mine Superfund Site reports to SYRCL

Smith Canal

Contaminated Sediment -- Aquafund, BPTCP, Sediment Quality Criteria

Domestic Water Supply Water Quality

Excessive Fertilization/Eutrophication, Nutrient Criteria

Reuse of Reclaimed Wastewaters

Watershed Based Water Quality Management Programs:

Sacramento River Watershed Program

Delta -- CALFED Program

Upper Newport Bay Watershed Program

San Joaquin River Watershed DO and OP Pesticide TMDL Programs

Stormwater Runoff Water Quality Science/Engineering Newsletter

G. Fred Lee & Associates was organized in the late 1960s to cover the part-time consulting activities that Dr. Lee undertook while a full-time university professor. In 1989, when Dr. Lee retired from 30 years of graduate-level teaching and research, he and Dr. Anne Jones-Lee, who was also a university professor, expanded G. Fred Lee & Associates into a full-time business activity. Examples of governmental agencies, consulting firms, citizens groups, industries and others for whom G. Fred Lee has served as an advisor include the following:

U.S. Environmental Protection Agency - Various Locations
Vison, Elkins, Searls, Connally & Smith, Attorneys - Houston, TX
International Joint Commission for the Great Lakes
U.S. Public Health Service - Washington, DC
Attorney General, State of Texas - Austin, TX
Madison Metropolitan Sewerage District - Madison, WI
Great Lakes Basin Commission - Windsor, Ontario
U.S. Army Environmental Hygiene Agency - Edgewood Arsenal, MD
City of Madison - Madison, WI
Council on Environmental Quality - Washington, DC
National Academies of Sciences and Engineering - Washington, DC
Water Quality Board State of Texas - Austin, TX
U.S. General Accounting Office - Washington, DC
U.S. Army Corps of Engineers - Vicksburg, MS
Tennessee Valley Authority - Various locations in Tennessee Valley
National Oceanic & Atmospheric Administration - Various locations
Organization for Economic Cooperation & Development - Paris
Attorney General, State of Illinois - Chicago, IL
State of Texas Hazardous Waste Legislative Committee - Austin
State of New Mexico Environmental Improvement Agency - Santa Fe
New York District Corps of Engineers - New York, NY
San Francisco District Corps of Engineers - San Francisco, CA
Wisconsin Electric Power Company - Milwaukee, WI
WAPORA - Washington, DC
Reserve Mining Company - Silver Bay, MN
United Engineers - Philadelphia, PA
Automated Environmental Systems - Long Island, NY
Procter & Gamble Company - Cincinnati, OH
Inland Steel Development Company - Chicago, IL
Kennecott Copper Corporation - Salt Lake City, UT
U.S. Steel Corporation - Pittsburgh, PA
Nekoosa Edwards, Inc. - WI
Zimpro, Inc. - Rothschild, WI
FMC Corporation - Philadelphia, PA
Acme Brick Company - Forth Worth, TX
Monsanto Chemical Company - St. Louis, MO
Gould, Inc. - Cleveland, OH
Illinois Petroleum Council - Chicago, IL
Inland Steel Corporation - Chicago, IL
Industrial Biotest Laboratories - Northbrook, IL
Wisconsin Pulp & Paper Industries - Upper Fox Valley, WI

Thilmany Pulp & Paper Company - Green Bay, WI
Chicago Park District - Chicago, IL
Nalco Chemical Company - Chicago, IL
Boise Cascade Development Company - Chicago, IL
Foley & Lardner, Attorneys - Milwaukee, WI
Timken & Lonsdorf, Attorneys - Wausau, WI
Strasburger, Price, Kelton, Martin & Unis, Attorneys - Dallas, TX
Rooks, Pitts, Fullagar & Poust, Attorneys - Chicago, IL
Jones, Day, Cockley & Reaves, Attorneys - Cleveland, OH
Sullivan, Hanft, Hastings, Fride & O'Brien, Attorneys - Duluth, MN
Hinshaw, Culbertson, Molemann, Hoban & Fuller, Attnys - Chicago, IL
Colorado Springs - Colorado Springs, CO
Mayer, Brown & Platt, Attorneys - Chicago, IL
Pueblo Area Council of Governments - Pueblo, CO
Platte River Power Authority - Fort Collins, CO
Linquist & Vennum, Attorneys - Minneapolis, MN
Norfolk District Corps of Engineers - Norfolk, VA
Spanish Ministry of Public Works - Madrid, Spain
The Netherlands - Rijkswaterstaat - Amsterdam, The Netherlands
U.S. Department of Energy - Various locations in US
King Industries - Norwalk, CT
Attorney General, State of Florida - Tallahassee, FL
State of Colorado Governor's Office - Denver, CO
Cities of Fort Collins, Longmont, and Loveland - CO
E.I. DuPont - Wilmington, DE
Allied Chemical Company - Morristown, NJ
Outboard Marine - Waukegan, IL
Amoco Oil Company - Denver, CO
Appalachian Timber Services - Charleston, WV
Mission Viejo Development - Denver, CO
Fisher, Brown, Huddleston & Gun, Attorneys - Fort Collins, CO
Tom Florczak, Attorney - Colorado Springs, CO
Wastewater Authority - Burlington, VT
Tad Foster, Attorney - Pueblo, CO
Holmes, Roberts & Owen, Attorneys - Denver, CO
Center for Energy and Environment Research - Puerto Rico
City of Brush - Brush, CO
Rock Island District Corps of Engineers - Rock Island, IL
Santo Domingo Water Authority - Dominican Republic
Ministry of Public Works and Environment - Buenos Aires, Argentina
Neville Chemical - Pittsburgh, PA
Fike Chemical Company - Huntington, WV
Stauffer Chemical Company - Richmond, CA
Adolph Coors Company - Golden, CO
Water Research Commission - South Africa
Grinnell Fire Protection Systems - Lubbock, TX

City of Lubbock Parks Department - Lubbock, TX
National Planning Council - Amman, Jordan
City of Olathe - Olathe, KS
City of Lubbock - Lubbock, TX
US AID - Amman, Jordan
Buffalo Springs Lake Improvement Association - Buffalo Springs, TX
Union Carbide Company - Charleston, WV
Canadian River Municipal Water Authority - Lake Meredith, TX
Mobil Chemical Company - Pasadena, TX
Unilever Ltd. - Rotterdam, The Netherlands
Brazos River Authority - Waco, TX
U.S. Army Construction Engineering Research Laboratory - Champaign, IL
James Yoho, Attorney - Danville, IL
Zukowsky, Rogers & Flood, Attorneys - Crystal Lake, IL
State of California Water Resources Control Board - Sacramento
Public Service Electric & Gas - Newark, NJ
Health Officer - Boonton Township, NJ
Scotland & Robeson Counties - Lumberton, NC
International Business Machines Corporation - White Plains, NY
Newark Watershed Conservation & Development Authority - NJ
State of Vermont Planning Agency - Montpelier, VT
CDM, Inc. - Edison, NJ
Attorney General, State of North Carolina - Raleigh, NC
City of Vernon - Vernon, NJ
Ebasco Services - Lyndhurst, NJ
Kraft, Inc. - Northbrook IL, with work in Canada, FL and MN
USSR Academy of Sciences - Moscow, USSR
Tillinghast, Collins & Graham, Attorneys - Providence, RI
City of Richmond, RI
Idarado Mining Company - Telluride, CO
Levy, Angstreich, Attorneys - Cherry Hill, NJ
Newport City Development - Jersey City, NJ
Orbe, Nugent & Collins, Attorneys - Ridgewood, NJ
Schmeltzer, Aptaker & Shepard, Attorneys - Washington, DC
CP Chemical - Sewaren, NJ
Dan Walsh, Attorney - Carson City, NJ
William Cody Kelly - Lake Tahoe, NV
NJ Department of Environmental Protection - Trenton, NJ
Hufstedler, Miller, Kaus & Beardsley, Attorneys - Los Angeles, CA
Main San Gabriel Basin Watermaster - CA
Metropolitan Water District of Southern California - Los Angeles, CA
San Diego Unified Port District - San Diego, CA
Delta Wetlands - CA
Simpson Paper Company - Humboldt County, CA
City of Sacramento - CA
Northern California Legal Services - Sacramento, CA

Rocketdyne - Canoga Park, CA
RR&C Development Co. - City of Industry, CA
American Dental Association - Chicago, IL
Emerald Environmental - Phoenix, AZ
Clayton Chemical Company - Sauget, IL
Stanford Ranch - Rocklin, CA
Public Liaison Committee - Kirkland Lake, Ontario
Miller Brewing Company, Los Angeles, CA
ASARCO Inc., Tacoma, WA
CALAMCO, Stockton, CA
Yunkong Gas Company, South Korea
Sutherlands, Pembroke, Ontario
Silverado Constructors, Irvine, CA
Agricultural Interests in Puerto Rico
City of Winnipeg, Manitoba
Strain Orchards, Colusa, CA
Davis South Campus Superfund Oversight Committee, Davis, CA
Monterrey County, California Housing Authority, Salinas, CA
CROWD, Tacoma, WA
Newport Beach, CA
SOLVE, Phoenix, AZ
Sports Fishing Alliance, San Francisco, CA
Caltrans (California Department of Transportation)
Citizens Group near St. John's, New Brunswick
Colonna Shipyards, Norfolk, VA
Clermont County, OH
Wright County, MN
Waikato River Protection Society, New Zealand
Drobac & Drobac, Attorneys, Santa Cruz, CA
Phelps Dunbar, L.L.P., Houston, TX
Walters Williams & Co, New Zealand
Environmental Protection Department, Hong Kong
NYPRIG New York City, NY
DeltaKeeper, Stockton
City of Stockton, CA
Central Valley Regional Water Quality Board, Sacramento, CA
Carson Harbor Village, Carson, CA
Sanitary District of Hammond, IN
South Bay CARES, Los Angeles, CA