Comments on EPA Project XL
Final Project Agreement for the Yolo County Accelerated Anaerobic & Aerobic Composting (Bioreactor) Project
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Comments Submitted by
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Several weeks ago I received a notice of a Yolo County/US EPA Project XL stakeholder meeting, inviting public participation in this meeting. While, at the time that I received this notice, I had no previous contact with Project XL, I have had a long-standing interest, spanning over 40 years, in assessing the impacts of municipal solid waste landfills on groundwater resources, public health and the environment. Since Project XL is concerned primarily with a large-scale demonstration of bioreactor technology for managing municipal solid wastes, it is of interest.

In the early 1980s, while I held a Distinguished Professorship in Civil and Environmental Engineering at the New Jersey Institute of Technology, I received a contract from the US Army to conduct a comprehensive review of leachate recycle at Army base landfills. This contract resulted in the development of a report,

> Lee, G.F., Jones, R.A. & Ray, C., "Review of the efficacy of sanitary landfill leachate recycle as a means of leachate treatment and landfill stabilization," Report to the US Army Construction Engineering Research Laboratory, Champaign, IL, USA (1985),

and several professional papers. The primary conclusion from this review was that leachate recycle has a potential of reducing the time necessary for the wastes in a municipal solid waste landfill to be "stabilized." At that time, a number of states had banned leachate recycle because of the potential for greater groundwater pollution associated with the introduction of moisture into the landfill. The US EPA, as part of establishing a "dry tomb" landfilling approach, concluded that the addition of moisture to landfills should not be allowed because of the increased potential for groundwater pollution.

As part of our report on this project, we recommended approaches that could be used to accelerate the stabilization of municipal solid wastes through addition of moisture to treat the wastes. Our recommendations were published in,

> Lee, G.F., Jones, R.A. & Ray, C., "Sanitary landfill leachate recycle," *Biocycle* 27: 36-38 (1986), and

> Lee, G.F. & Jones-Lee, A., "Landfills and groundwater pollution issues: 'Dry tomb' vs. F/L wet-cell landfills," *Proceedings of Sardinia '93 IV International Landfill Symposium*, Sardinia, Italy, pp. 1787-1796 (1993).

Last year I was asked to present a paper at the Air and Waste Management Association national meeting devoted to leachate recycle. This paper,

> Jones-Lee, A. and Lee, G.F., "Appropriate Use of MSW Leachate Recycling in Municipal Solid Waste Landfilling," Proceedings of Air and Waste Management Association annual national meeting, Salt Lake City, UT, cd-rom, June (2000),

was presented at this meeting that was held in Salt Lake City and has been published in the Proceedings. A copy of the paper and the slides that were used in this presentation are available from our website, www.gfredlee.com. While the paper was prepared independent of and without knowledge of Project XL, it has direct applicability to the way in which Project XL should have been established.

Purpose of the Project

The Yolo County solid waste management staff are to be commended for taking the initiative in supporting work directed toward more appropriate landfilling of municipal solid wastes than the conventional "dry tomb" approach. However, there are important questions about what will be learned by Project XL, compared to what is already known about the bioreactor approach. If this project were being conducted in the mid-1980s, then I would largely support it as proposed. Today, however, it appears to me that little is going to be learned about the bioreactor approach, either anaerobic or aerobic, over what is already known. As discussed in my 1985 report as well as subsequent publications on leachate recycle, it is well-established that the addition of moisture to a landfill will enhance, to some extent, landfill gas production and leachate generation. There is no need for additional projects to demonstrate this; this is well known. What is needed is to understand how best to design and operate a bioreactor to optimize the fermentation and leaching of wastes. This project is not structured to adequately address the issues for the funds being expended. A significantly different approach to evaluation of bioreactor design and operation should have been developed as part of Project XL than is proposed to be conducted.

As discussed in my papers, there are a number of key engineering issues that need to be addressed as part of learning how to develop and operate a bioreactor. In my presentation on this topic at Salt Lake City, there were several members of the audience who supported this issue with respect to how best to get moisture evenly distributed throughout the bioreactor landfill. This is not a trivial issue. Also, such issues as what is the optimal moisture content, depth to hydraulic loading rate, etc., all need to be addressed in large-scale pilot studies.

Specific Comments on Proposal

> Page 6, under "II. Detailed Description of the Project," in the second paragraph states,
> *"This process significantly increases the biodegradation rate of waste and thus decreases the waste stabilization and composting time (5 to 10 years) relative to what would occur within a conventional landfill (30 years, to 50 years or more)."*

There are several aspects of this statement that need to be addressed. First, it is important to note that the cessation of landfill gas production in a classical sanitary landfill does not mean that the landfill is a non-polluting landfill. Of equal, or possibly even greater, importance in terms of protecting

public health, groundwater resources and the environment, is the leaching of the wastes so that the leachate does not contain constituents that are a threat to groundwater quality. This issue is not being adequately addressed in the proposed Project XL.

In our work on bioreactor wet cell fermentation leaching approach, we advocate the use of leachate recycle on shredded wastes, where recycle occurs in a double composite lined landfill, which uses shredded green waste as a daily cover until landfill gas production has essentially ceased. Based on the mid-1970 work of John Pacey in Sonoma County, it appears that this could occur in about five years. Following the cessation of landfill gas production, the wastes should be washed with "clean" water without leachate recycle in order to remove any of the residual components that represent the long-term threat to groundwater quality.

The issue that is largely being ignored in this project and in most leachate recycle bioreactor projects is the development of a non-polluting residue in the landfill. While many landfill owner-operators have as an objective as part of conducting a leachate recycle project the disposal of the leachate, the objective of such projects should, in fact, be the development of a waste residue that does not represent a threat to public health, groundwater resources and the environment. This is the perspective that should be used in developing a bioreactor. It should not be the superficial treatment of the wastes that are not contained within plastic bags, but should be focused on producing treatment of the wastes so that the waste residues are not a threat to public health, groundwater resources and the environment.

The plastic bag issue is a significant issue that is being treated superficially in this project. The failure to shred the waste or to conduct parallel cells – one shredded and one unshredded – is a significant deficiency in the project. The statements that were made at the stakeholders' meeting about how inspection of the ongoing project being conducted by Yolo County showed that the wastes in the crushed plastic bags were "black," as support for the fact that the wastes are not hidden from water, reflects a lack of understanding of the processes that occur. Wastes turn black because of iron sulfide when oxygen is exhausted, which would be the case that would occur within plastic bags. Within plastic bag wastes, there will be hydrogen sulfide produced, which will lead to black color upon reaction with iron. This should not be interpreted to mean that leachate or water added to a landfill is fully penetrating the wastes within the crushed plastic bags. It is obvious that this cannot occur.

The wastes that are in the plastic bags, which can be a substantial part of the total residential household waste, will be hidden from the recycled leachate and give a false sense of accomplished treatment. While dumping leachate into a landfill will, for those parts of the landfilled wastes that are exposed to the leachate, produce landfill gas in five to ten years that would normally take 30 to 50 years, it does not address the substantial part of the wastes that are hidden within the plastic bags. This is the issue that needs to be addressed in a bioreactor. Failure to address this means that the project is highly superficial and grossly inadequate in addressing issues that need to be properly considered and evaluated.

On page 7, under "DESIGN AND OPERATIONS OF PROPOSED MODULE D BIOREACTOR," reference is made here and several times elsewhere about the liner system design exceeding the requirements of Title 27 and Subtitle D. This statement is somewhat misleading. Title

27 and Subtitle D present minimum prescriptive requirements which may be applicable to some sites. They do not indicate that these minimum design requirements are going to be protective at all sites. Title 27 specifically requires a site-specific evaluation of liner design. It should not be assumed that a minimum Subtitle D single composite liner will be protective of groundwater resources from pollution by landfill leachate for as long as the wastes in a "dry tomb"-type landfill or a leachate recycled landfill will be a threat.

Figure 2 is presented on page 8. The components of this figure need to be labeled so that somebody can understand what they are.

Page 8, under "Liner and Leachate Collection and Removal System (LCRS) Components," there is a significant technical error made through most of this section with reference to achieving permeabilities less than about $10^{-7.5}$ cm/sec. As Dr. D. Daniel, formerly of the University of Texas, now of the University of Illinois, pointed out many years ago, at effective permeabilities of about $10^{-7.5}$ cm/sec diffusion control takes over, so there is no such thing as a 10^{-8} or 10^{-9} permeability in terms of the rate of transport of leachate or leachate components through a clay liner. The constituents will move through the liner at a faster rate than the advective permeabilities discussed.

Another aspect of this discussion that seems to be ignored, or at least, not stated, is that unsaturated transport of leachate occurs within landfills with a moisture content less than the waste moisture holding capacity. Wastes that appear dry – i.e., less than the moisture holding capacity – are transporting potential pollutants as unsaturated flow on the surface of the waste to the bottom of the landfill.

I find the design of the proposed Project XL landfill liner system significantly deficient compared to what should be used for a bioreactor. As discussed in our writings, bioreactor approaches should only be conducted in a double composite lined landfill with a leak detection system between the two liners. There are ten states or parts of states in the US that would not allow the landfill liner design that Yolo County proposes to use in this bioreactor Project XL. This is because of the fact that it will fail.

There are several aspects of this problem that apparently have not been recognized by those who have developed this liner system. One of these is the fact that the clay layers underlying the plastic sheeting layer will lose the water of compaction through unsaturated transport. This will lead to dry-out and cracking of the clay. The thicker clay layer that is proposed is not necessarily an appropriately significantly improved liner system. This is similar to the approach that the state of Wisconsin attempted to use, where there was a five-foot thick clay liner. The US EPA determined that this was not a protective approach and forced the state to go to a composite lined system.

Page 10, Figure 3 also needs to be labeled as to what the components are.

In the first paragraph on page 10, there is discussion about clogging, where there are some questions raised as to whether clogging would occur. This should not be questioned. Clogging is a serious problem, and, even with the high-permeability materials that are proposed, there still will

likely be clogging and head build-up on the liner that will lead to increased leakage rates through holes, points of deterioration, stress cracks, etc.

At the bottom of page 10, the last paragraph near the end, there is reference to the Giroud and Bonaparte discussion of liner leakage. It is important to understand that the Giroud and Bonaparte discussion of liner leakage applies to new HDPE liners with high-quality construction. It does not necessarily apply to many HDPE liners, especially after waste placement, which can cause rupture of the liner, and over time, as the HDPE liner deteriorates.

Page 12, in Table 1, presents the composition of leachate. One of the most important constituents that are potential pollutants in the leachate (lead) has not been analyzed by Yolo County. This is a significant deficiency in Yolo County's monitoring program.

Page 12, the first paragraph states, *"Due to the critical nature of this project..."* What is meant by "critical nature?" I do not know of anything that is "critical" about this project.

Page 12, the end of the second paragraph states that the results of this project will help develop leachate treatment systems at other locations. As currently designed, this project will provide very little information that can be transferrable to other situations.

With respect to the aerobic treatment discussed in the last paragraph of page 12, I question whether this should be done. This project looks too much like a "grab bag" approach, where definitive information on neither anaerobic nor aerobic approaches will be developed to the degree that it should based on the funding available. If it were up to me, I would not conduct the aerobic part of this, since I feel that there is little likelihood that significant aerobic treatment of municipal solid wastes will occur in the US in the foreseeable future. Instead, the focus should be on how to conduct an anaerobic fermentation leaching biocell reactor system.

During our discussions at the stakeholder meeting, I raised the issue of the flaring of landfill gas producing dioxins. I find no reference to the flaring of landfill gas or the monitoring of the flare emissions for dioxins. This should be a mandatory part of any flaring study of this type.

On page 16, under "Solid Waste Stabilization and Decomposition," there is a bulleted item, "Biochemical Methane Potential." What is that? How is it measured? Also, how do you measure "Surface Integrity?" How is the sampling going to address the issue of the plastic bag wastes?

Page 19 and at several other locations, there is an editorial problem with "*et al.*" "*Et*" never has a period after it. Also, in Table 5 and in other locations, "pH" always has a lower case "p." It is a mathematical symbol (negative log of), and should never be capitalized, even at the beginning of a sentence.

Page 20, under "Contingency plan for failure of the primary liner system," states, *"The primary liner system is contained by a secondary liner system that serves as a leak detection system."* Either I do not understand the liner system that is proposed for this landfill, or this statement is incorrect. There is a secondary HDPE layer, but, as far as I can tell, it is not a "leak detection

system." There is need to better describe the liner in properly labeling figures, etc., than is done in this write-up to eliminate this confusion.

Overall

It is unfortunate that this project has gotten as far as it has without adequate review of fundamental issues and the implications of the results of this project on public health, groundwater resources and environmental protection. I am sorry to be so negative on the project; however, I am concerned that such a large amount of funds are going to be spent in the name of bioreactor technology development, where little is going to be gained over what was known as the result of John Pacey's work in Sonoma County in the 1970s.

If there are questions about these comments, please contact me.

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September 5, 2000

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Dear Ramin:

I wish to follow up on several of the comments you made in your August 29, 2000, letter responding to my comments submitted on July 1, 2000, on the Yolo County Final Project Agreement for the anaerobic and aerobic bioreactor landfill project.

In your second paragraph, you state (with regard to my comments on the importance of protecting of protecting groundwater quality):

> *"We feel that the monitoring of various constituents in the leachate will be conducted on fairly frequent intervals (see Table 3 on page 19 of the FPA for specific frequencies) such that we'll have a good understanding of the concentrations of the various constituents in the leachate over the life of the project."*

The proposed monitoring program does not assure that there will be groundwater quality protection. As discussed in my writings, even if all the constituents in the leachate or leachate-polluted groundwaters meet drinking water standards, this does not assure that waters contaminated with leachate are safe to drink. Leachate is a complex mixture of thousands of chemicals. Only a very limited number of these are monitored.

The statement is made in the final sentence of this paragraph,

> *"In addition, we anticipate that the quality of the leachate will improve over time so that the potential threat to groundwater resources will be less than that under conventional practices."*

This is not the issue. There is need to stop polluting groundwaters by leachate – not reduce pollution. This can be done with appropriate design and appropriately conducted leachate recycle. Unfortunately, the Yolo County project does not incorporate the necessary design and operation procedures to achieve this level of protection.

On page 1, paragraph 3, you state,

> *"We believe that our liner design will be protective and as you may already know, the California Regional Water Quality Control Board 5 recently conducted a site specific evaluation of our liner design and determined that it will be adequate for the bioreactor operations that we will be conducting at our landfill."*

California Regional Water Quality Control Boards, including Region 5, have been approving liner systems which will obviously fail to protect groundwaters from pollution for as long as the wastes in the landfill are a threat. You should not rely on approval by the CVRWQCB as an indication that the liner system is adequately designed for groundwater quality protection. It is not.

On the second paragraph on page 2, regarding dioxins and landfill gas flares, as I have discussed, the literature on this topic is conflicting. A study by the US EPA (ref?) indicated that the potential for dioxin emissions from the combustion of landfill gas is small, and on the magnitude of 35 to 240 times less than of municipal waste combustion (? – it sounds like you are quoting from a report, and I'm not sure about the numbers). Again, this is not a proper evaluation of the issue. The issue is whether landfill gas flares produce dioxins at all. If so, what is the hazard to public health and the environment from these dioxins. Comparison to a municipal solid waste incinerator is totally inappropriate, since this is not the issue. No one is proposing to put a solid waste incinerator at the Yolo County landfill site.

The discussion you have provided on my comment on the need to conduct monitoring is inadequate. The landfill gas flares at this landfill should be monitored for dioxins to determine the levels. If they are below acceptable detection limits, then it can be concluded that there is no threat. If they are above detection limits, then there is a threat – in this case, primarily to wildlife.

Overall, as I commented in my July 1 comments, I feel that the Yolo County Public Works Department is to be commended for its initiative in developing this project. Unfortunately, the project is designed and being conducted based on approaches that were appropriate for the mid-1980s – but not for the year 2000. For essentially the same money, the project could have focused on the areas that need research, instead of, as it is planned now, providing additional information on issues that are already fairly well understood.

I am sorry I cannot be fully supportive of this project; however, having been involved in landfill leachate recycle issues since the early 1980s, and having a good understanding of landfill problems today and the approaches that are needed to begin to meaningfully address them, bioreactor projects of this type must be on the forefront of new developments – not simply repeat what has been known for many years.

G. Fred Lee