Detecting Failure of Subtitle D Landfill Liner Systems

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Periodically landfill applicants and some regulators who want to prove that today's Subtitle D landfills are protective will assert that there are no recorded failures of Subtitle D landfills. This is an issue that I have addressed previously in my report, "Detection of the Failure of Landfill Liner Systems," (1996) which is available from my web site, www.gfredlee.com, in the Landfill section.

The statement about "no recorded failures" of Subtitle D landfills is likely correct. I don't know of any recorded failures. However, as discussed in my review, except under extremely sloppy construction and highly lucky groundwater monitoring, the failure of Subtitle D landfills at this time would not be expected to be detected. This is the result of several situations.

First, Subtitle D landfills have only been used for a few years. It should take about 25 years for leachate that passes through holes in the flexible membrane liner to pass through the clay liner.

Second, as discussed in the paper, "Deficiencies in Subtitle D Landfill Liner Failure and Groundwater Pollution Monitoring," (1998) which is also available in the Landfill section of my web site, the typical groundwater monitoring program allowed by regulatory agencies for Subtitle D landfills involving the use of monitoring wells at the point of compliance, which have zones of capture of about one foot, but which are spaced hundreds of feet apart, means that there must be widespread, general failure of the liner system before these monitoring wells can be expected to detect failure.

The initial failure of the liner system will not be through general leakage throughout the bottom of the landfill, but will be through holes, rips, tears, or points of deterioration in the plastic sheeting flexible membrane liner. As discussed by Cherry in 1990, the initial liner failures will produce finger-like plumes of leachate that will have a high probability of passing between the monitoring wells and not being detected by them.

As discussed in my comprehensive review of the deficiencies in the Subtitle D landfilling approach, "Assessing the Potential of Minimum Subtitle D Lined Landfills to Pollute: Alternative Landfilling Approaches," (1998), which is also available from my web site, based on the properties of the wastes allowed in Subtitle D landfills and the characteristics of the liner systems and groundwater monitoring systems, there is no question about the fact that for Subtitle D landfills sited at geologically unsuitable sites where the base of the landfill is connected through a vadose zone to usable groundwaters, it is only a matter of time until those groundwaters are polluted by landfill leachate, rendering them unusable for domestic and many other purposes. This is not a debatable issue.

Many of the components of the wastes in Subtitle D landfills will be a threat to pollute groundwaters forever. The liner systems being allowed at best only postpone when groundwater pollution occurs. The

groundwater monitoring systems being allowed are largely cosmetic in detecting off-site groundwater pollution before widespread pollution occurs. Anyone who claims otherwise either doesn't understand the basic issues involved, or is deliberately distorting the readily available information on these issues.

Additional Information on Reliability of Groundwater Monitoring at Subtitle D Landfills

In response to my recently summarizing the fundamentally flawed nature of Subtitle D landfilling of municipal solid wastes in protecting public health and the environment for as long as the waste in a Subtitle D landfill will be threat, a "landfill engineer" suggested that the typical groundwater monitoring well array that is used at Subtitle D landfills will detect leachate-polluted groundwater before off-site adjacent property pollution of groundwater occurs due to dispersion of the leachate-polluted groundwater plume. While dispersion plays a role in determining the ability of a monitoring well array to detect a leak from a small area source, it cannot be relied on to insure with a high degree of reliability that the typical groundwater monitoring well array that is being used today at Subtitle D landfills will detect groundwater pollution when it first reaches the point of compliance for groundwater monitoring. Dispersion can be an important factor for slow-moving groundwater pollution plumes at considerable distances from the source. However, contrary to the "landfill engineer's" suggestion, the situation in monitoring around a leaking tank is not the same as the typical monitoring situation at Subtitle D landfills. It is my experience that rarely are monitoring wells near a leaking tank somewhat randomly spaced hundreds to a thousand or so feet apart along the down groundwater gradient edge of the tank, as they are with Subtitle D landfills.

Detection of Leaks from Underground Tanks Versus Detecting Landfill Liner Leaks

When investigating leaking underground storage tanks, the potential source of the leak, i.e., the tank and its associated plumbing, are confined to a small area. To determine whether a tank has leaked sufficiently to pollute groundwaters, it is necessary to define, through the use of three monitoring wells, the direction of groundwater flow. Once this direction has been defined, then the placement of monitoring wells to detect leaks is usually straightforward for relatively homogeneous aquifer systems. However, for landfills, which can occupy hundreds to a thousand or more acres, the initial leakage point is unknown. Therefore, it is not possible to strategically locate monitoring wells downgradient which would reliably detect the leak when it first reaches the point of compliance for groundwater monitoring.

In accord with Subtitle D regulations, the point of compliance can be no more than 150 meters from the down groundwater gradient edge of the landfill, and must be on the landfill owner's property. Since there are no restrictions on landfilling to the edge of the property, I have repeatedly seen landfills with waste deposition areas within a few feet of the adjacent property line. Further, in some states, such as California, the point of compliance for Subtitle D landfill groundwater monitoring is the down groundwater gradient edge of the waste deposition area. This means that there can be little distance between where leaks can occur along the down groundwater gradient edge of the landfill, and the point of compliance for groundwater monitoring. While dispersion might be important for helping to detect leaks from the up groundwater gradient side of the landfill for slow-moving groundwater pollution plumes, it is of limited value in detecting leaks on the down groundwater gradient side of the landfill.

Dr. Cherry and his associates at the University of Waterloo examined the lateral dispersion that occurs in a relatively homogeneous aquifer system from a two-foot-long line source of a tracer. This group found that the two-foot-wide source had spread to about ten feet within 150 meters of the source. This means that monitoring wells would have to be spaced no more than 10 to 20 feet apart in order to reliably detect down groundwater gradient side of the landfill leaks. With monitoring wells spaced at least hundreds of feet apart at distances less than 150 meters from the down groundwater gradient edge of the landfill, there is appreciable distance between the monitoring wells, where substantial leachate plumes could pass without being detected.

It is inappropriate to suggest that detecting leaks from underground storage tanks is similar to detecting liner leaks from municipal landfills. The two situations are obviously significantly different.

Detecting Leaks from Landfills Sited above Fractured Rock Aquifer Systems

There are many Subtitle D landfills sited above fractured rock aquifer systems where it is impossible to reliably monitor landfill liner leakage, even if the monitoring wells are spaced only a few feet apart. Under most of these types of situations dispersion will not overcome the fundamental problems of monitoring the eventual failure of the landfill liner system.

Support of Dr. Cherry's Conclusions on the Unreliability of Groundwater Monitoring at FML-Lined Landfills

The work of Dr. John Cherry and his associates at the University of Waterloo has been supported by a number of competent hydrogeologists with whom I have worked, in review of the potential of proposed Subtitle D landfills to pollute groundwaters, as well as the ability of a proposed groundwater monitoring well array to detect this pollution in accord with Subtitle D requirements, when the pollution first reaches the point of compliance for groundwater monitoring.

Detecting Leaks in Fast and Slow-Moving Plumes

For fast-moving plumes in homogenous aquifer systems, dispersion will not necessarily be adequate to significantly improve the reliability of the typical Subtitle D monitoring well array. There are many places within a landfill footprint where leaks could occur and not be detected at the point of compliance for groundwater monitoring. For slow-moving plumes, there are important questions about whether the monitoring system will be maintained and operated when these plumes reach the point of compliance for groundwater monitoring. With no assured post-closure funding after 30 years, there is no assurance that groundwater monitoring systems will still be maintained and operated when they are needed, when the slow-moving plume with its dispersion reaches the point of compliance for ground water monitoring.

Recommended Approach for Permitting of Landfills

It has been my recommendation at landfill permitting hearings, that rather than assuming that arbitrarily spaced groundwater monitoring wells will reliably detect landfill liner leaks in accord with Subtitle D requirements, i.e., when the leachate-polluted groundwater first reaches the point of compliance for groundwater monitoring, the landfill applicant should be required to provide reliable information on the

monitoring well spacing, considering the site-specific characteristics of the geology-hydrology of the aquifer system that will be polluted when the Subtitle D liner system fails to prevent significant leakage of leachate through the liner. The burden of proof for the reliability of the groundwater monitoring system should be on the landfill applicant and not the public whose groundwater could be polluted if the arbitrarily developed groundwater monitoring system fails to detect the leachate-polluted groundwater at the point of compliance. It should be the responsibility of the landfill applicant to define, based on the site-specific characteristics of the aquifer, the monitoring well array needed to have a 95% probability of detecting one to two-foot-long rips, tears, or points of deterioration in the landfill FML liner at the point of compliance for groundwater monitoring, when the leachate-polluted groundwater first reaches this point.

Adopting this approach would quickly show what is well understood, that today's groundwater monitoring systems at many Subtitle D landfills are cosmetic and provide little in the way of reliable monitoring of leachate-polluted groundwaters before widespread liner deterioration occurs. At many Subtitle D landfills, the leaks through the liners will likely first be detected in off-site production wells, rather than by the groundwater monitoring system.