# Rachel's Environment & Health News
# #116 – Analyzing Why All Landfills Leak
# February 14, 1989

The U.S. Environmental Protection Agency (EPA) has paid for a series of engineering studies to find out the best way to make a landfill. They wanted to know what was the "best demonstrated available technology" (BDAT) for making landfills. These studies reach some surprising conclusions.

Landfills are bathtubs in the ground; the bottom of the bathtub is called a liner and it can be made of compacted clay soil, or it can be made of a huge sheet of plastic underlain by ordinary soil, or it can be a huge sheet of plastic underlain by a layer of compacted soil (usually clay soil). The third combination, plastic liner and compacted soil, is called a "composite liner." (A composite liner is not a double liner; it is a single liner made up of two parts; to create a double liner, you would use two composite liners together, separated by a layer of sand or gravel.) Geoservices did not examine the second type of liner (plastic sheet on ordinary soil) because ordinary soil provides poor support for a plastic liner carrying many tons of weight, so they restricted their analysis to compacted clay liners vs. composite liners.

The EPA wanted to know which liners were the best ones available: compacted clay liners, or composite soil liners? So they hired Geoservices (of Boyton, Florida) to tell them. The resulting study makes dull reading because it is filled with technical details, but the conclusions are fascinating. All liners perform worse than anyone suspected.

**Clay liners**

Geoservices didn't have much good to say about clay liners. The flow of liquids through a liner (the liner's permeability) is measured in centimeters per second (cm/s). The EPA's current requirement for a liner for a hazardous waste landfill is that it pass liquids through it no faster than 10-7 cm/s (read ten to the minus seven centimeters per second, or one ten millionth of a centimeter per second). However, based on actual experience in the field, Geoser vices concludes that this ideal permeability is often not achieved for a variety of reasons. (See pgs. 3-3 through 3-8; case studies of clay liners appear in Appendix A.) Therefore, they assume that the actual permeability in the real world lies between 10-7 and 10-6 cm/s. Geoservices concludes, "Possibly the most significant observation is that with compacted [clay] soil bottom liners, leakage out of the [landfill] will be large (if there is leakage through the top liner).... even in [landfills] meeting current EPA design requirements" including permeability of 10-7 cm/s (pg. 3-18). By "large" leakage, Geoservices means 90 gallons of fluid leaking through each acre each day, or 900 gallons per day leaking from a 10-acre landfill. Their calculations show that, with 3 inches of water standing on the bottom liner, it will take 15 years for leakage to break through a 3-foot-thick compacted clay bottom liner, but once breakthrough has occurred, 90 gallons per acre per day will pass through the liner continuously thereafter. (See pg. 3-16, and Table 3-3 on pg. 3-40.) It won't take very long to contaminate a large drinking water supply if you pour 90 to 900 gallons of toxics into it day after day, year after year. Thus Geoservices has shown that clay liners are an environmental disaster.

**Composite liners**

Geoservices reports that all plastic liners (also called Flexible Membrane Liners, or FMLs) always have some leaks. "A common misconception regarding FMLs is that they are impermeable, that is, no fluid will pass through an intact FML. However, it is important to realize that all materials used as liners are at least slightly permeable to liquids or gases and a certain amount of permeation through liners should be expected. Additional leakage results from defects such as cracks, holes, and faulty seams." (pg. 4-2)

FMLs often develop defects called "pinholes" during manufacture; these result from thin places ("fish eyes"), bubbles, foreign material, or lumps of carbon in the raw molten plastic from which the FML is rolled ("calendered") into sheets. Furthermore, when a large landfill liner is created by joining strips of FML together with glue or by welding, the resulting seams often leak. Geoservices provides some data on typical seam defect rates. They look at six case studies (pgs. B-7 thru B-11). Based on the six case studies, they draw the following "tentative conclusions:" an average of one leak per 30 feet of seam can be expected if there is no quality assurance program (quality assurance being a third party coming along behind with special equipment to check the adequacy of the seams). Even with good quality assurance, "an average of one leak per 1000 feet of seam can be expected with reasonably good installation, adequate quality assurance, and repair of noted defects." (pg. B-11) That is to say, under the best of circumstances, you'll get one leak per thousand feet of seam. If the landfill liner is made by welding strips of FML that are each 20 to 30 feet wide, you can expect one to two defective seams in each acre of landfill.

Based on actual data, Geoservices concludes that a "standard" (typical) leak in an FML has an area of one square centimeter (1/16 of a square inch) and that the "standard" (average) number is one hole per acre. They point out that this "standard" hole size and standard number per acre are based on the assumption that "intensive quality assurance monitoring" will be performed during liner installation, so clearly we are talking about the best case, not the worst case here. Design flaws, poor construction practice, or poor quality assurance would result in larger holes, greater numbers of holes, or even large tears. (pg. B-13)

Geoservices then goes through an elaborate mathematical analysis to figure out how much fluid will pass through a composite liner under the best possible conditions and under less ideal (but still optimistic) conditions. They conclude (pg. B-41) that the "best demonstrated available technology" (BDAT) for composite landfills liners will allow leakage rates somewhere between 0.02 and 1.0 gallons per acre per day. (See Table B-10 on pg. B-51.) Thus they conclude that a 10-acre landfill will have a leak rate somewhere between 0.2 and 10 gallons per day, or between 73 and 3650 gallons of fluid per year; over 10 years, such a landfill will allow the leaking of 730 to 36,500 gallons of fluid. And this is the "best demonstrated available technology"-- the very best we can do when everything goes right.

Next week we will show that leaking 730 to 36,500 gallons of toxics into a water supply during a 10-year period guarantees destruction of the drinking water resource.

We will also show that the Geoservices study is unduly optimistic because, as they say themselves (pg. B-7), "Many tupes of FMLs swell when placed in contact with chemicals. As a result, the distance between polymeric chains increases and permeability increases. Therefore, an FML can have a low permeability for water and a high permeability for some chemicals."

If you're interested in technical details, get: Geoservices, Inc., BACKGROUND DOCUMENT ON BOTTOM LINER PERFORMANCE IN DOUBLE-LINED LANDFILLS AND SURFACE IMPOUNDMENTS. Springfield, Va: National Technical Information Service, April, 1987. Order from National Technical Information Service, Springfield, Va 22161; phone (703) 487-4650. Order No. PB87-18229-1. $36.95."

--Peter Montague

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Descriptor terms: landfilling; landfill design; clay liners; flexible membrane liners; epa; geoservices; best demonstrated available technology; composite liners; leaks; leak rates; statistics; leakage;

Rachel's Environment & Health News is a publication of the Environmental Research Foundation, P.O. Box 160, New Brunswick, NJ 08903-0160; Phone: (732) 828-9995; Fax (732) 791-4603; E-mail: erf@rachel.org; http://www.rachel.org. Unless otherwise indicated, Rachel's is written by Peter Montague.