Rachel's Environment & Health News
#177 –UNRECOGNIZED CAUSE OF LANDFILL FAILURES
April 18, 1990

With 80% of the nation's garbage still being buried in landfills (see REHN #176), we must ask whether our landfills are as well-designed as can be. One important and overlooked source of landfill failures is lightning from thunderstorms.

As most of our readers know, a landfill is a bathtub in the ground. The bathtub can leak through its bottom, or it can fill up with fluids and leak over its sides. To prevent this from happening, landfills are now "capped" with clay or plastic when they are retired from service. The cap is supposed to act as an umbrella, preventing rain from filling up the bathtub and preventing the formation of toxic leachate that might pour out the bottom if the bottom leaked. The cap is the essential element in a landfill's safety design: it keeps liquids out. When the cap is destroyed, nature will begin to distribute the contents of the landfill into the local environment, using water as the vehicle for distribution. Damage ensues.

Lightning packs a tremendous wallop when it strikes the ground. Lightning bolts last only a few millionths of a second, but they typically involve five million volts and anywhere from 2,500 to 220,000 amperes of current. Lightning can bore large holes in the ground where it strikes. Geologists have a name for holes made by lightning: fulgarites (after the Latin name for lightning, fulgar). Fulgarites are created when lightning strikes sandy soil; a hole is bored into the sand and the sides of the hole get so hot (estimated to be 3200 degrees Fahrenheit, or 1800 degrees Celsius) that the sand melts and forms a glass tube. A large hole bored by lightning can be eight inches in diameter and can reach to a depth of 15 feet.

Because buried telephone cables need protection, a lot of data has been collected on the frequency of lightning strikes. Lightning accompanies two types of thunderstorms: convection-type storms caused by local heating of air near the earth, and frontal-type storms resulting when a warm, moist front meets a cold front which may extend over hundreds of miles. Frontal-type storms produce more lightning strikes per storm.

Which type of storm predominates in your region? Take a look at our map of the U.S. The uppermost heavy line from Tucson, AZ through Albuquerque, NM, sloping up to Lawrence, KS, then to Urbana, IL, and on east to Washington, DC, separates the U.S. into two storm-type zones. Areas above this line have mostly convection-type storms, and areas below the line have frontal-type storms. We'll call this the "storm line."

As the map shows, the number of thunder storms in the U.S. varies from an average of 10 per year along the western edge of California, Oregon and Washington, to a high of 100 per year in central Florida.

To estimate the number of lightning strikes you would expect per square mile per year at your local landfill, multiply the number of storms per year times a "stroke factor" which is 0.28 if you're above the storm line, and 0.37 if you're below the storm line.

Let's take New Jersey, for example. We're above the storm line, and we have 20 lightning storms per year, so we multiply by 0.28 to learn that each square miles of land will be struck by lightning 20 x 0.28 = 5.6 times per year, or 56 times each decade.

How does that translate into, say, a 10-acre landfill? Ten acres = 0.016 square miles (one-sixtieth of a square mile), so a ten-acre landfill will be struck an average of 56 x 0.016 = 0.9 (close to 1) times per decade, or about once every 11 years.

A landfill that covered twice as much area (20 acres) would be struck twice as often; one ten times as big (100 acres) will be struck ten times as often. And, because a landfill is ordinarily elevated above surrounding terrain, these average numbers actually underestimate the frequency of lightning strikes. Landfills are ordinarily elevated above surrounding terrain because garbage is heaped up in a pile. Big landfills can rise a hundred feet above the surrounding landscape; some rise even higher. Landfills are therefore more susceptible to lightning strikes than is flat ground.

Let's take another example. Central and northern Indiana have 40 storms per year and they're above the storm dividing line, so each square mile is struck an average of 40 x 0.28 = 11 times per year, or 110 times per decade. A 10acre landfill in this region will be struck, on average, 11 x 0.016 = 1.76 (nearly 2) times per decade, or roughly once every six years.

Central Florida is below the storm line and it has 100 storms per year, so each square mile of land will be struck 100 x 0.37 = 37 times per year or 370 times per decade. A 10-acre landfill there would be struck 370 x 0.016 = 5.9 (about 6) times per decade.

Since lightning can burn a hole eight inches in diameter up to 15 feet deep, it must be obvious that no plastic liner (1/10 of an inch thick) will deter lightning in any way whatsoever. The only cap that could work would be a 20-footthick layer of clay. An alternative would be lightning protection.

The National Fire Protection Code requires lightning protection for all structures containing flammable liquids or gases. The explosive methane gas generated within a landfill probably meets this specification. To fulfill their objectives of protecting the environment, landfill caps should be fitted with lightning protection, just the way military ammunition dumps are protected. Tall towers with heavy cables strung between them, solidly grounded, are one option. A 10-acre landfill could be protected by four 250' towers spaced 900 ft. apart. Such towers would have to meet Federal Aviation Administration regulations for obstruction lights and standby power supplies, to minimize hazards to aircraft.

Large landfills could not be protected by towers because the towers themselves would penetrate the cap, destroying its integrity. Such large fills will need to be entirely covered with heavy, well-grounded steel cages (called Faraday cages).

Lightning protection is a well-developed field of engineering. If the designers, owners and regulators of landfills are serious about protecting the environment, they will address the hazards of lightning and take the necessary steps to see that public health is protected from landfill failures caused by lightning.

Get: AT&T, TELECOMMUNICATION ELECTRICAL PROTECTION (Place of publication unknown: AT&T Technologies, Inc., 1985). Available by phoning 1-800-432-6600, or 1-317-352-8556. Order publication "Select Code 350-060."

Peter E. Viemeister, THE LIGHTNING BOOK (Garden City, New York: Doubleday, 1961).

National standards for lightning protection are documented in LIGHTNING PROTECTION CODE 1983 ANSI [American National Standards Institute]/NFPA [National Fire Protection Association] No. 78 available from: NFPA, Batterymarch Park, Quincy, MA 02269; phone (617) 770-3000.

For alerting us to lightning hazards to landfills, we are indebted to Mr. Leon Whittaker, Rt. 1, Box 266, Cumberland, VA 23040.

--Peter Montague

Descriptor terms: landfilling; lightning

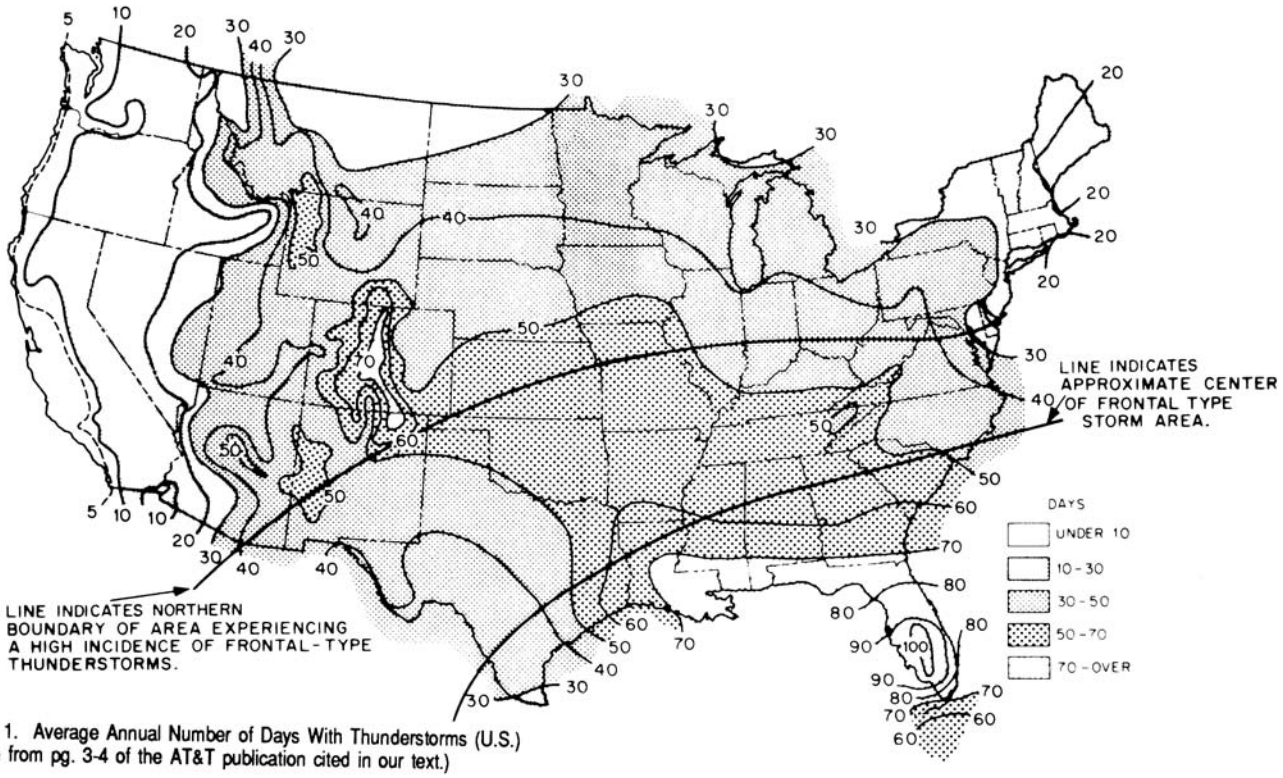

Figure 1. Average Annual Number of Days With Thunderstorms (U.S.) (Taken from pg. 3-4 of the AT&T publication cited in our text.)

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.