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University of Pennsylvania  
*Professional Programs*  
*in Earth and Environmental Science*



Present

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## Solid Waste Disposal - Past, Present and Future

Solid waste disposal has undergone major improvements since the 1970's. Open dumps were used for disposal, with municipal solid waste (MSW) placed in depressions and excavations that sometimes contained standing water. Abandoned gravel pits were favorite disposal sites. Vectors including rats and birds fed directly on exposed garbage; fires were prevalent and difficult to extinguish. With the advent of sanitary landfills, six inches of soil cover were placed over the face of trash using heavy earth moving equipment at the close of each day's operations. This controlled both vectors and fires as the face was starved of oxygen. No placement was allowed in standing water and the equipment densified the trash. Clayey soils were required for cover material rather than sand, which decreased infiltration and provided clays to help neutralize leachate. Termed natural attenuation landfills it was assumed that soil below the landfill would neutralize the leachate, by absorption and ion exchange.

Natural clay liners proved to be inadequate and often the clay thickness was unable to neutralize all of the leachate. Leachate, collected at the base of the landfill, often leaked out along the edges, following channels made by escaping methane. To retrofit these landfills, perimeter leachate collection systems were installed and methane collection pipes were inserted into the landfill. The collected methane was then flared for proper disposal.

More stringent requirements for new landfills led to basal leachate collection systems placed above the liner to draw off leachate. A drainage layer of coarse, cohesion-less soil was placed over the collection pipes and garbage deposited above this layer. Methane collection pipes extended through the total landfill height with a layered cap placed on the top during landfill completion. This cap consisted typically of a geomembrane with a drainage layer above it and covered with subsoil and topsoil to promote plant growth. Heavy compactors were used to move trash into place, greatly increasing density. Pockets of daily cover were disrupted by removing cover soil at the start of the next day's trash placement, preventing the development of isolated, perched volumes of leachate. Some leachate was recirculated through the trash during operation to encourage decomposition and thereby decrease trash volume. The landfill base typically consisted of a compacted clay liner below the geomembrane liner with the drainage layer located above it.

Hazardous waste landfills require a double liner system at the base of the fill. No free liquids are allowed in the hazardous material. A compacted clay liner is topped by a geomembrane, then a sandy detection layer. Above this is another geomembrane with the leachate collection system above it and finally the waste material is placed. Landfill caps typically are similar to those for MSW landfill.

Future systems for solid waste disposal will involve substantial recycling of leachate and possibly the introduction of air to enhance decomposition. Methane collection will be an important part of the process with the methane processed to pipeline quality natural gas and utilized by a near-by facility. Double liners will be placed in the sump area to prevent leakage where the leachate accumulates. Various recycling procedures may also be involved to reduce solid waste volume transported to the landfill.

**Date: October 20, 2008**

**Time: 6:00 PM**

**Place: Carolyn Hoff Lynch Auditorium**

On the Penn campus: Chemistry Building; 34 & Spruce Sts. (enter on 34 St)

**NO REGISTRATION REQUIRED**

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