

## PERSPECTIVE

## The Bottom Liner

Marc C. Bruner

I heard a news item recently that suggested that the United States was in the middle of a minor time capsule crisis. It seems that the Bicentennial year of 1976 encouraged a flurry of activity to place time capsules. The earliest of these were generally scheduled to be exhumed in 25 years, or the year 2001. The minor crisis arose when one of several things happened. First, the capsules simply couldn't be found because the directions to locate the capsule were wrong. Second, the capsules were placed in inappropriate locations, or had been made of materials that could not withstand burial for 25 years, and the capsules had disintegrated or were useless. Third, some capsules were located and made of appropriate materials, but they had not been sealed adequately, and the contents inside were spoiled.

This news item led me to reflect, believe it or not, upon the design and construction of landfill liners. Time capsules and landfills have somewhat of a common goal—keeping what is inside them isolated from the environment and secure for long periods of time. The problems encountered with the time capsules point out the basic principles for designing landfill liner systems. Liners, like time capsules, should be placed in the appropriate locations, and those locations should be clearly identified. They should also be made of appropriate materials, and should be installed with sufficient care to assure their long-term integrity. Surrounding those simple principles, there lies an abundance of misunderstanding and confusion.

The first and most simple confusion arises from people assuming when the term liner is used, it means that a single material is being placed on the ground and thinking that is all that is involved. Contemporary liners are liner *systems*, with multiple components that are designed to complement each other to provide a higher level of environmental protection. A typical liner sys-

tem is a carefully designed and constructed system of earthwork and specialized materials several feet in thickness. In fact, liner design begins with the facility siting process and some basic, common sense engineering. Criteria like not siting landfills over sinkholes, assuring through foundation analysis that a site can support the weight of the landfill without subsiding and causing the liner to fail, and determining the location of the water table in relation to liner placement are the first steps in the process that leads to the design of modern liners.

After the right place for a landfill and the liner have been identified, the materials for the liner system are selected. These are based, in part, on local availability. The basic components of a liner system are earth, clay, geosynthetics (i.e., plastic), rocks, and piping. Earth is used to construct a stable base for construction and to provide a protective layer over or between liner components. If there are deposits of clay in the area that are acceptable, meaning that they have the right physical and chemical makeup to make a low permeability layer, they may be used as a liner component. The clay layer is typically from one to three feet thick, depending on the permeability. These clay liners are combined with a geosynthetic layer to make what is called a composite liner. In areas where clay is unavailable, the design may use two layers of geosynthetic, separated by sand or some form of synthetic medium to provide a drainage layer between the two liners. These are typically called double liners. Both composite and double liners have piping systems installed on top of their liners to collect the liquid, called leachate, that may accumulate. Double liners collect leachate from both primary and secondary liners, and composite liners collect leachate from over a primary liner only. Earth, with sufficient permeability to assure water will move through it, is used to cover the top of the liner system to protect it from weather and to prevent damage to the liner when waste is first placed upon it.

The geosynthetic liners, and the material they are made of, are perhaps the most misunderstood and controversial component of landfill liner systems. Three plas-

tic materials have been used since the 1980s: Polyvinyl Chloride (PVC), Low-density Polyethylene (LDPE), and High-density Polyethylene (HDPE). Over time, HDPE seems to have become the most commonly used liner material. No matter what material is selected, liners are typically tested for chemical resistance against the leachate that is generated in landfills, using either synthetic leachate or actual leachate for a landfill. Most people know that polyethylene used in liners is the same basic material used in some plastic containers, trash bags, and insulation materials. This leads to part of the misunderstanding about liners. Most people intuitively understand that there are different types of steel, concrete, glass, and other types of building materials. But when it comes to landfill liners, and the siting of a landfill, that perspective is sometimes lost, and landfill liners are assumed to be the same as trash bags and pop bottles in thickness and quality. Liners are viewed as fragile, not durable, and not repairable.

Perhaps the most interesting thing I have seen in the public debates over landfill liners is the internal conflict some seem to suffer when it comes to plastics in or under landfills. I have heard people observe that plastics should be banned from disposal in landfills, because they are so resistant to decomposition that they will last virtually forever. At the same time, people in the same discussion will comment that landfill liners, made of essentially the same plastics, are so fragile that they will break down in a few years. It is almost as if the durability of these plastic materials is determined by the intent of the person generating them. If they are placed with the intent of disposal, they remain in perpetuity; if they are placed with the intent of lasting, they are ephemeral.

Issues of the nature of liners aside, I believe the single most important factor in assuring those landfill liner systems function properly is quality control during construction. The quality and performance of the materials used in liner systems are all well known. Perhaps the most significant variable is the skill of the people doing the installation. For this reason, there are extensive inspection and testing requirements

required in regulation, and even more extensive inspections are often incorporated into the contracts for construction. Seams in liner material that are joined at the factory prior to shipment are tested, and the quality control documentation is provided to the purchaser. Methods have been developed to test every inch of liner seam that is welded or glued in the field. In addition, there are requirements to take samples of the work and test them destructively in the laboratory. A third party, independent of the contractor and the purchaser, is retained to conduct the inspections and supervise the installation. A landfill operator is required to keep the documentation of the installation and testing of the liner con-

struction for the life of the landfill, plus the long-term care period of thirty years after closure. With many larger facilities, this means records will have to be kept for fifty or more years. This is, of course, in addition to all of the groundwater monitoring data, which is retained for the same time period.

I began by suggesting that landfills are *like* time capsules. Actually, I believe landfills *are* time capsules. Archaeologists and anthropologists look to the landfills of the past for clues as to how our ancestors lived their lives. One archaeologist, William Rathje, has even taken to excavating contemporary landfills for clues to both our

present and past. The bottom line is that, for good or ill, modern landfills will represent our society to those that follow us. The liner systems we use on our landfills assure that the waste we discard, with little or no thought to its ultimate destination, will provide insight to future investigators. Fortunately for them, it appears we do a better job at building landfill liners than we do at burying time capsules.

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*Address correspondence to Marc C. Bruner, Solid Waste Authority of Palm Beach County, 7501 North Jog Road, West Palm Beach, FL 33412; (e-mail) mcbruner@swa.org.*