when sufficient hydraulic pressure is applied, as might be the case with a manure impoundment. This represents, perhaps, the most hazardous possibility for groundwater contamination because large amounts of manure can flow into the groundwater in a very short length of time. Some states do not permit earthen manure impoundments, regardless of design, in areas with collapse potential.

4. Puncture. Since a liner is relatively thin, it must be protected from puncture during and after construction. Animal traffic, rocks, stumps, and roots can cause puncture opening in a clay liner. Carefully clearing the subgrade of these materials prior to liner construction is necessary.
5. Drying. If a clay liner is allowed to dry out, shrinkage cracks may occur, and permeability will be compromised. Measures should be taken after a liner is constructed to maintain proper moisture content until the liner is submerged. Consideration might be given to placing an "insulating" soil cover over the liner to minimize drying. Some states require a minimum liquid depth to be maintained over the liner to prevent drying.

Soil amendments. Some manure storage sites may not have suitable on-site soil materials for constructing a clay liner. In these cases, a soil amendment that modifies the existing soil properties may provide a means to attain the required permeability.

The most common soil amendment used in such cases is sodium bentonite. Sodium bentonite is a volcanic clay that swells to about 15 times its original volume when placed in water. When properly mixed with non-clay soils, the resulting mixture will exhibit properties of a clay soil and can attain the required permeability. When a liner is constructed using bentonite as a soil amendment, the bentonite is usually mixed with existing soil at the excavation boundary at the rate of 1 to 3 lbs/sq ft. Minimum recommended thickness for a bentonite liner is 6 inches.

Some soils in Group III containing high amounts of calcium may not attain the required permeability. Soil dispersants containing sodium (soda ash, tetrasodium pyrophosphate, and sodium tetraphosphate) may be used to disperse the blocky structure of such soils so that they attain the required permeability. Recommended rates of dispersant use are 10 to 20 lbs/100 sq ft for soda ash and 5 to 10 lbs/100 sq ft for the phosphates. Minimum recommended thickness for a dispersant liner is 6 inches.

Synthetic liners. Synthetic liners made of reinforced plastics, HDPE, or other synthetic materials may be used as a seepage barrier in some cases. Usually these liners are not as cost effective as a clay liner or liner constructed with soil amendments. However, in some cases soil with the necessary characteristics may simply not be available on-site or within a practical hauling distance. In such cases, a synthetic liner may offer a solution. Installation of such liners may require special procedures such as providing a geotextile or layer of sand below the liner to prevent puncture or tearing by the underlying material. Synthetic liners are usually installed with seams that must be closed by heating or vulcanizing as the liner is installed. The performance characteristics, installation procedures, and maintenance of synthetic liners are highly specific to the particular liner. If you anticipate using a synthetic liner, consult with the liner manufacturer or a qualified individual experienced in synthetic liner selection and installation.

Soil amendments such as bentonite can be used to modify existing soil properties, reducing seepage to target levels.

When soils with the needed permeability characteristics are not available, a synthetic liner may be required.