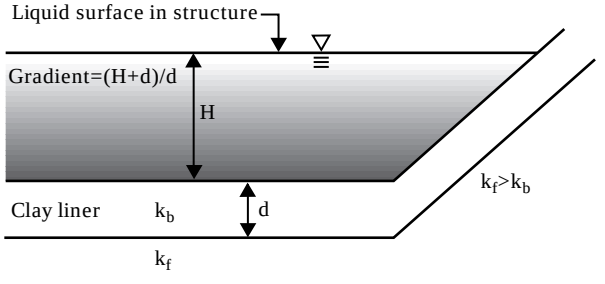
651.1080 Appendix 10D—Geotechnical, Design, and Construction Guidelines

Excavation boundary of a site is underlain by some soils in Group II or problem soils in Group III (flocculated clays) and Group IV (highly plastic clays that have a blocky structure)—Soils in Group II may or may not require a liner. Documentation through laboratory or field permeability testing or by other acceptable alternatives is advised. An acceptable alternative would be correlation to similar soils in the same geologic or physiographic areas for which test data are available. Higher than normal permeability for flocculated clays and clays that have a blocky structure has been discussed. These are special cases, and most soils in Groups III and IV will not need a liner. Note that a liner may be constructed by treating a determined required thickness of unfavorable soils occurring at grade.

The above conditions do not always dictate a need for a liner. Specific site conditions can reduce the potential risks otherwise indicated by the presence of one of these conditions. For example, a thin layer of soil over high quality rock, such as an intact shale, is less risky than if the thin layer is over fractured or fissured rock.

Figure 10D–1 Definition of terms for clay liner and seepage calculations



where:

H = Head of waste liquid in waste impoundment
k_f = Permeability of foundation
d = Thickness of liner
k_b = Permeability of liner

Specific discharge

(a) Introduction

No soil or artificial liner, even concrete or a geomembrane liner, can be considered impermeable. To limit seepage to an acceptable level, regulatory agencies may specify a maximum allowable permeability value in liners. A criterion often used for clay liners is that the soils at grade in the structure, or the clay liner if one is used, must have a permeability of 1×10^{-7} centimeters per second or less. However, using only permeability as a criterion ignores other factors defining the seepage from an impoundment. Seepage is calculated from Darcy's Law (covered in the following section), and seepage calculations consider the permeability of the soil and the hydraulic gradient for a liner at a site.

(b) Definition of specific discharge

The term *specific discharge*, or unit seepage, is the seepage rate for a unit cross-sectional area of a pond. It is defined as follows from Darcy's Law. The hydraulic gradient for a clay liner is defined in figure 10D–1.

Given:

$$Q = k\left(\frac{(H+d)}{d}\right)A \quad \text{(Darcy's Law)}$$

Where:

Q = Total seepage through area A (L^3/T)
k = Coefficient of permeability (hydraulic conductivity) ($L^3/L^2/T$)
$\frac{(H+d)}{d}$ = Hydraulic gradient (L/L)
H = Vertical distance measured between the top of the liner and required volume of the waste impoundment (figs. 10D–1, 10D–14, 10D–15, and 10D–21) (L)
d = Thickness of the soil liner (fig. 10D–1) (L)
A = Cross-sectional area of flow (L^2)
L = Length
T = Time