# MEMO

**Date:** May 20, 2008

**To:** [redacted] **cc:** [redacted]

**From:** [redacted]

**Subject:** **Soil Parameters, Guterl Steel, ET File 100657.01.08**

We reviewed available geotechnical data and provide recommendations for representative soil parameters herein. We understand that these parameters will be used for modeling contaminate fate and transport.

**Soil Description**

The soil being modeled in the fate and transport studies is a glacial till. Based on available laboratory gradation test data, this soil is typically a silty and clayey sand and gravel, generally with about 20 to 40 percent fines passing the No 200 sieve size. Typical of glacial till soils, this material is well graded, with a wide range of particle sizes. Therefore, these soils have small void space and porosity because the smaller soil particles infill the void spaces between the larger particles.

Based on laboratory data, soil descriptions are summarized below:

| Sample ID | % Gravel | % Sand | % Fines | Unified Symbol | Description |
|---|---|---|---|---|---|
| A04D-321-06 | 14.7 | 44.0 | 41.3 | SC-SM | Silt/Clay and Sand |
| A04A-309-07 | 20.3 | 44.0 | 35.7 | SC-SM | Silt/Clay and Sand with some Gravel |
| A04C-305-07 | 58.5 | 17.9 | 23.6 | GM | Silty Gravel |
| A03-223-09 | 33.0 | 45.6 | 21.4 | SM | Silty Sand |
| A02-208-09 | 10.6 | 64.4 | 25.0 | SC | Clayey Sand |
| A04A-211-07 | 6.6 | 24.6 | 68.8 | ML | Silt with some sand |
| A04B-219-05 | 32.9 | 27.9 | 39.2 | GC | Gravel and Clay |
| A02-229-10 | 42.3 | 19.2 | 38.5 | GC | Gravel and Clay |
| A04C-306-07 | 15.2 | 28.4 | 56.4 | ML | Silt with some sand |
| A03-226-31 | 31.8 | 24.5 | 43.7 | GM | Silt and Gravel |
| A05A-213-01 | 50.3 | 36.1 | 13.6 | GM | Silty Gravel |
| A05A-209-01 | 6.5 | 72.6 | 20.9 | SM | Sand with some silt |
| A05A-215-01 | 31.3 | 33.2 | 35.5 | GC-SC | Sand /Gravel and clay |
| A05B-001-02 | 2.4 | 56.6 | 41.0 | SC | Sand and Clay |
| A05A-216-01 | 32.4 | 36.8 | 30.8 | GM-SM | Sand/Gravel with some Silt |

Note that the grain size analyses were not washed. Therefore, the actual percentage of fines is probably greater than the measured values.

**Porosity**

The porosity of glacial till soil is typically low, on the order of 10 to 20 percent (Reference 1). However, measured moisture contents of the till soils at this site are about 15 percent, inferring that their porosity would be about 30 percent. Use 30 percent.

**Hydraulic Conductivity**

The hydraulic conductivity of granular soils can be estimated using grain size data. However, these correlations were developed for clean granular soils with little fines; therefore, they are not valid for these glacial till soils, which contain significant fines.

The hydraulic conductivity decreases with fines content. These glacial till soils contain on the order of 20 to 40 percent fines, and the corresponding hydraulic conductivity is therefore estimated to be on the order of $10^{-5}$ to $10^{-7}$ cm/s (Reference 2). Use $10^{-6}$ cm/s for modeling.

Two laboratory permeability tests were performed on the till. The measured permeability values were $1.23 \times 10^{-6}$ cm/s and $1.46 \times 10^{-6}$ cm/s. These values correspond well to the recommended value.

**Effective Porosity**

The effective porosity is an indicator of the pore volume occupied by mobile water. This parameter has been found to correlate with soil permeability. For these glacial till soils, with hydraulic conductivity on the order of $10^{-6}$ cm/s, the effective porosity is estimated to be about 0.5 to 1.0 percent (Reference 3). Use 0.75 percent.

**Field Capacity**

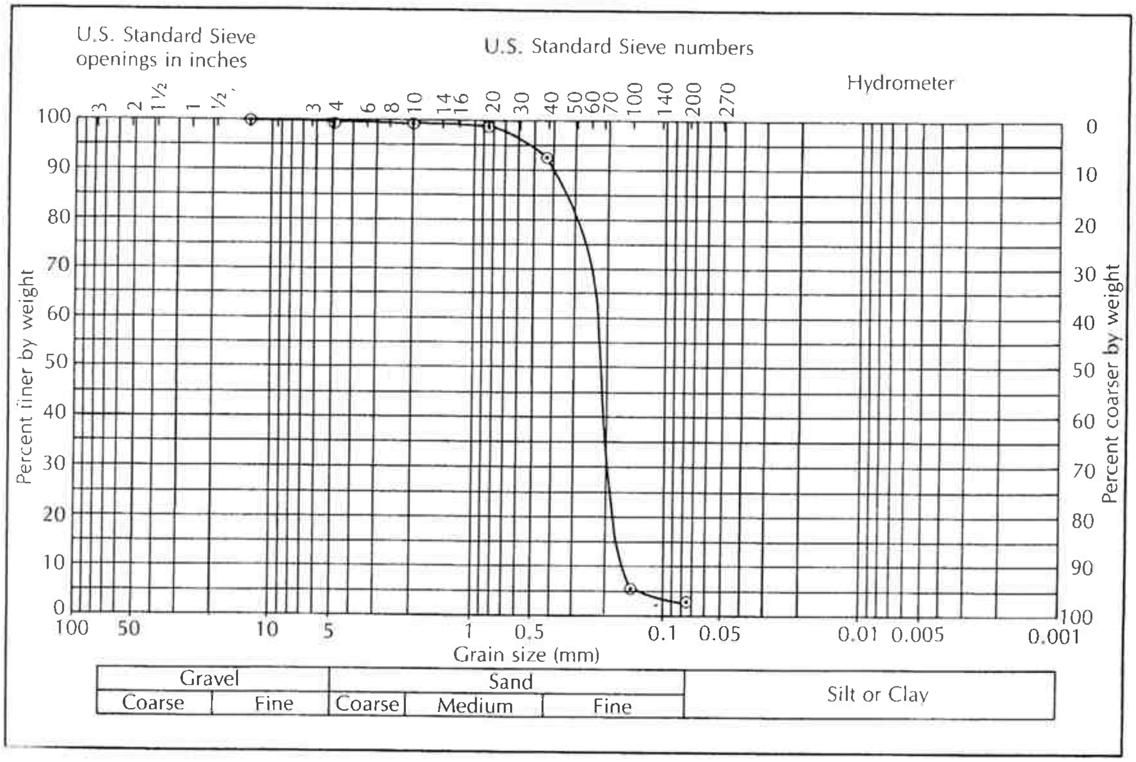
Field capacity is the maximum water content that the soil can retain under gravitational drainage. Based on available laboratory water content data, use 15 percent for modeling.

**Conclusion**

These parameters have been estimated using the limited available data. If the computer model's default values for the parameters are similar to the parameters above, the defaults should be considered acceptable. If there are significant discrepancies between the default parameters and the parameters presented above, it is recommended that the above parameters be used for the model.

References

1. Fetter, C.W, *Applied Hydrogeology*, 4th Edition, Prentice Hall, 2001
2. Dept. of the Navy, NAVFAC DM-7.1, *Soil Mechanics*, May 1982
3. Reddi, Lakshmi N., *Seepage in Soils, Principles and Applications*, Wiley, 2003




▲ FIGURE 3.5
Grain-size distribution curve of a fine sand.

**Table 3.4 Porosity Ranges for Sediments**

| | |
|---|---|
| Well-sorted sand or gravel | 25–50% |
| Sand and gravel, mixed | 20–35% |
| Glacial till[1] | 10–20% |
| Silt | 35–50% |
| Clay | 33–60% |

*Based on Meinzer (1923a); Davis (1969); Cohen (1965); and MacCary and Lambert (1962).*

The general range of porosity that can be expected for some typical sediments is listed in Table 3.4.

### 3.2.3 Porosity of Sedimentary Rocks

**Sedimentary rocks** are formed from sediments through a process known as **diagenesis.** A sediment, which may be either a product of weathering or a chemically precipitated material, is buried. The weight of overlying materials and physicochemical reactions with fluids in the pore spaces induce changes in the sediment. This includes compaction, removal of material, addition of material, and transformation of minerals by replacement or change in mineral phase. Compaction reduces pore volume by rearranging the grains and reshaping them. The deposition of cementing materials such as calcite, dolomite, or silica

Reference 1

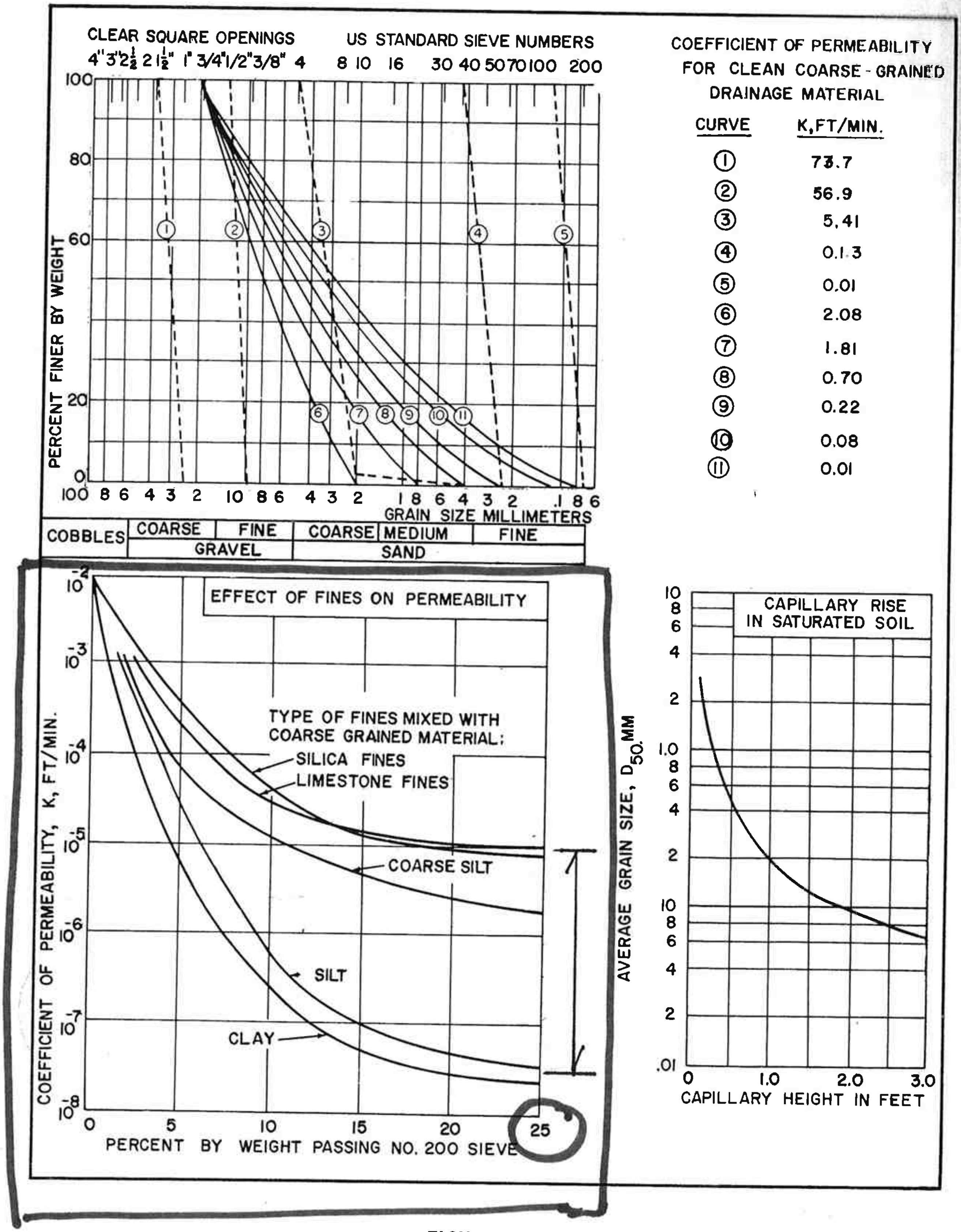
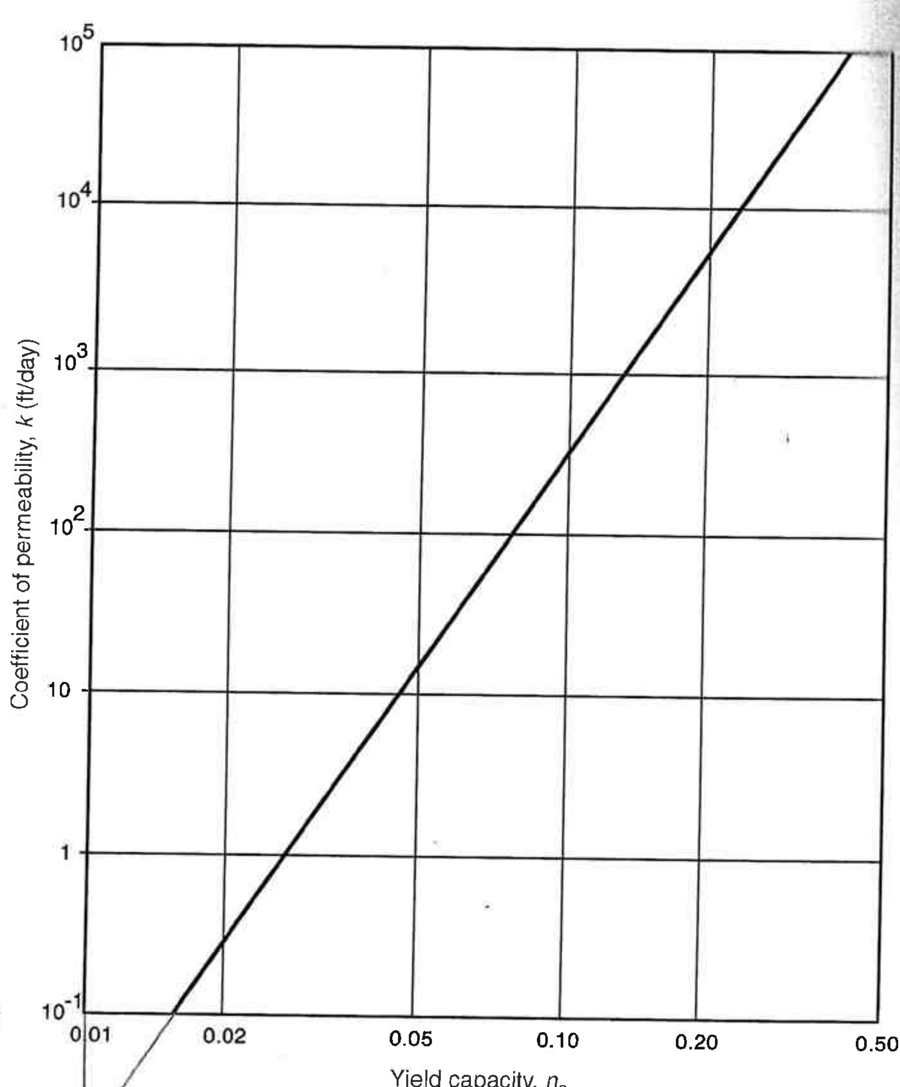



**FIGURE 8-5**
**Permeability and Capillarity of Drainage Materials**



Reference 2




$1 \times 10^{-6}$ cm/s $= 2.8 \times 10^{-3}$ ft/d

.005

**Fig. 10.16.** Yield capacity (effective porosity) versus coefficient of permeability. (Adapted from Moulton, 1980.)

$10^{-2}$

$10^{-3}$

According to the second criterion, the drainage layer characteristics must be chosen so that the layer is capable of draining all the inflow to a suitable collection system. To design according to this criterion, Fig. 10.17 is commonly used. In developing Fig. 10.17, it was assumed that the inflow was steady and was uniformly distributed across the surface of the pavement section. The maximum mound height in the drainage layer $H_m$ controls the thickness of the drainage layer. It is possible to determine the permeability required of the drainage layer once the maximum mound height and the geometrical characteristics (length of flow path $L$ and slope of drainage layer $S$) are

.005

Reference 3



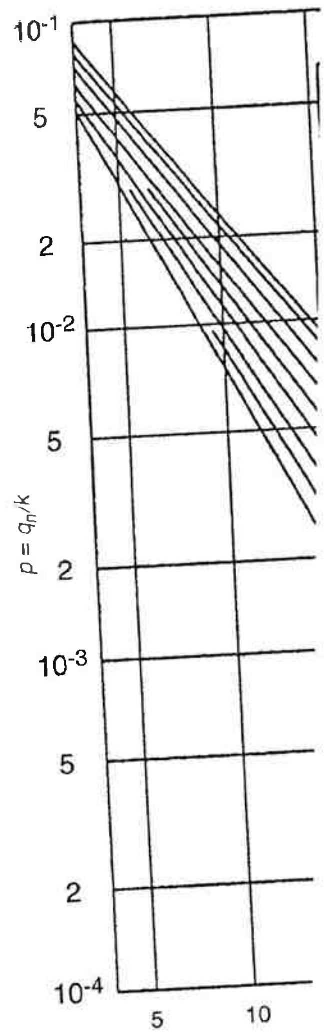



**Fig. 10.17.** Chart for estim
from FHWA, 1992.)

known. Conversely, the r
from $H_m$ once the perme
are specified.

***Example 10.1*** The le
and 0.5 ft, respectively.
material, $k = 2000$ ft/d