

The Science Behind Apparent CEC, Atterberg Limits, Morphology, and Expansive Mineralogy and Regulation

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ABSTRACT

More than 50% of households in North Carolina utilize on-site systems for treatment of household wastewater. With the growing housing industry in the state, approval of new sites for on-site systems is steadily increasing. Many soils can be identified as suitable or unsuitable for on-site wastewater treatment using field indicators from soil taxonomy such as soil color, morphology, consistence, and stickiness. However, laboratory measurements are needed to assess soils falling on the margin between suitable and unsuitable based on mineralogical constraints, particularly the occurrence of > 10% expanding-layer, 2:1 phyllosilicate minerals (smectites) in fine-textured soils. This presentation will discuss the advantages and disadvantages of various field and laboratory measurements used as indicators of soil mineralogy.

The minerals in the clay-sized fraction of soil affects the degree to which soils shrink (when dry) and swell (when wetted). As a clay soil swells, the amount and size of pore space decreases and affects the ability to move water (effluent) through the soil. Direct assessments of the ability of a site to move water can be done with a percolation test. However, testing the soil at an appropriate water content can take several days. As an alternative, field indicators of drainage (color), and texture and clay mineralogy (consistence, stickiness) are most commonly used. When these evaluations fail, both direct and indirect laboratory analyses to estimate mineralogy are used. The most direct method for clay mineralogy is x-ray diffraction (XRD) analysis, which is time consuming and moderately expensive. Laboratory measurements that indirectly estimate clay mineralogy include Atterberg tests (plasticity index), coefficient of linear extensibility (COLE), bulk density, saturated hydraulic conductivity (Ksat), and cation exchange capacity (CEC). The principles behind each of these indirect methods as an estimator of mineralogy will be explained.

Because of proposed regulations for assessing site suitability using apparent CEC, the scientific basis for using an ACEC cutoff of 16.3 meq/100 g soil for mixed mineralogy (>10% smectite in soils with >30% clay) will be described. This cutoff is based on median CECs of smectites and kaolinites, two of the more common layer silicate minerals found in the clay fraction of soils in the Piedmont and Coastal Plain. The necessity to use a specific CEC technique at a specific pH (7) will be explained.

Site suitability is based on numerous factors (mineralogy, water table, texture, landscape, etc.) that represent the ability of a site/soil to adequately treat sewage and then disperse it into the environment. No single site assessment method (field or lab) will be suitable for all situations. Only after a soil is determined unsuitable using field methods will an alternative method be used. Of the available lab methods ACEC is the most accurate, cost effective, and time efficient method for estimating mineralogy.