ARCHIVE: **Archived due to the 2009 rule revision. Refer to VA30007.09.024 for the updated document.**

TITLE: **Sampling and Analysis of Fraction Organic Carbon (f_{oc}) in Soils**

DATE EFFECTIVE: August 2003

HISTORY: Update of VA3007.00.004 - Revision was necessary to clarify the guidance within the document and to reflect changes in rule citations that became effective on October 21, 2002. However, the technical content of the archived TDC document remains accurate and is accurate under the 1996 VAP rules.

KEYWORDS: Organic carbon, property-specific soil standards, sampling

RULE/ AUTHORITY: OAC 3745-300-07(D)(4), 3745-300-07(F)(4), 3745-300-08(B)(3)(e), 3745-300-09(D)(3)(b)(iv) and 3745-300-09(H)(1)(e)

QUESTION: If a property-specific f_{OC} for soils is measured at a property, what considerations are necessary for sampling and analysis?

BACKGROUND: Fraction organic carbon (**f_{oc}**) is a dimensionless ($g_{(carbon)}/g_{(soil)}$), mass measure of the quantity of soil organic carbon relative to soil media. The measure is used to estimate the capacity of a soil to adsorb or bind certain contaminants. The **f_{oc}** is needed when calculating property-specific soil standards for various exposure pathways, including but not limited to: direct contact with soil (determination of soil saturation limits; OAC 3745-300-08(B)(3)(e) and 3745-300-09(H)(1)(e)), leaching to ground water (OAC 3745-300-07(D)(4)), and volatilization to indoor air (OAC 3745-300-07(F)(4) and 3745-300-09(D)(3)(b)(iv)).

ANSWER:

Sampling considerations

Sampling to determine a representative **f_{oc}** at a property is dependent on the geologic features of the property such as topography and soil type. These features may affect whether the sampling is representative for the pathway of concern.

The determination of **f_{oc}** should be based on sampling locations that are not impacted by releases of petroleum or other organic chemicals of concern.

The surface organic layer should not be used to represent conditions for soils at the property. This layer typically contains high organic carbon concentrations. Use of this layer may result in an overestimation of the soil's ability to adsorb contaminants. The number of samples, and the horizontal and vertical distribution of sampling are dependant on the heterogeneity of the subsurface and the purpose for which the determination is being made. If the property-specific $\mathbf{f_{oc}}$ is measured to determine a property-specific soil saturation concentration (as described in OAC 3745-300-08(B)(3)(e)), an $\mathbf{f_{oc}}$ value representative of the direct contact point of compliance (e.g., a minimum depth of 2 feet for commercial or industrial properties), as described in OAC 3745-300-07(G) should be used. If the $\mathbf{f_{oc}}$ value is to be used for a property-specific soil leaching evaluation in accordance with OAC 3745-300-07(D)(4), then a depth-weighted average $\mathbf{f_{oc}}$ for the leaching zone should be determined.

Because of the variability of the distribution of soil organic carbon, an $\mathbf{f_{oc}}$ from neighboring properties should not be considered representative at the voluntary action property. However, in lieu of determining a property-specific $\mathbf{f_{oc}}$, the VAP will accept default values for various pathways. The defaults are 0.6% (0.006) for direct contact, 0.2% to 0.3% (0.002 to 0.003) for the leaching to ground water pathway, and 0.2% (0.002) for volatilization into indoor air. See Ohio EPA's Support Documentation for the Development of Generic Numeric Standards (February, 2002), Ohio EPA's Derived Leach-Based Soil Values, Appendix Technical Support Document (February, 2002), and Users Guide for the Johnson and Ettinger Model for Subsurface Vapor Intrusion Into Buildings (June, 2003).

Method of analysis

The method of analysis must be capable of measuring an $\mathbf{f_{oc}}$ value that is representative of the concentration of organic carbon within the soil matrix. For non-calcareous soils, the organic carbon concentration is equal to the total carbon concentration. However, for calcareous or newly limed soils, the concentration of inorganic carbon is subtracted from the total carbon concentration to determine the organic carbon content. The mass lost on ignition is an estimate of soil organic matter which contains approximately 58% carbon. A correction factor (0.58) is applied to estimate the organic carbon content of soil from the measurement of mass lost on ignition.

- The ASTM D2974-87 method provides a protocol for the

stepwise quantification of organic and inorganic fractions of soil carbon. Most of the organic components are burned off at temperatures of 440 degrees Celsius (^{0}C), and carbonates are volatilized at approximately 750 ^{0}C. Though 440 ^{0}C is the temperature for determining $\mathbf{f_{oc}}$, Ohio EPA recommends that the volunteer conduct the full ASTM D2974-87 procedure and report initial gravimetric soil water content, $\mathbf{f_{oc}}$ (440 ^{0}C), fraction inorganic and recalcitrant organic carbon (750 ^{0}C), and soil pH measured in a 1:1 soil-water slurry.

- Additional analytical methods for determining total carbon and organic carbon values by dry and wet combustion (acid digestion) are presented in "Total Carbon, Organic Carbon, and Organic Matter," by D. W. Nelson and L. E. Sommers, from Methods of Soil Analysis, Part 3.Chemical Methods, 1966.

SUMMARY:

Due to its important role in binding contaminants in soil media, the $\mathbf{f_{oc}}$ can affect the analysis of exposure pathways and migration of the contaminants to other environmental media. In order to accurately determine $\mathbf{f_{oc}}$ of soil at a property, it is important to consider the geologic setting of the property, the heterogeneity of the soil profile, the presence of hydrocarbons or other sources of organic carbon in the soil, and the purpose for which the determination is being made. To accurately determine the $\mathbf{f_{oc}}$ of soil at a property, VAP recommends use of a method which clearly delineates organic carbon concentration from inorganic carbon.

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