

APPENDIX O
SOIL TYPE DETERMINATION GUIDELINES

March 18, 2005

O.1. BACKGROUND

When initially implemented, the Missouri Risk-Based Corrective Action (MRBCA) process included one set of Tier 1 Risk-Based Target Levels (RBTLs). This initial set of RBTLs applied to all media, receptor, and exposure pathways addressed by the MRBCA process. The Missouri Department of Natural Resources (MDNR) has since put into effect new Tier 1 RBTLs. The new RBTLs, for both the Departmental and Tanks MRBCA Guidance, are soil type dependent. This means that the RBTLs applicable to a specific site depend on the type of soil present at the site. Where initially there was one set of Tier 1 RBTLs, there are now three: one set for Type 1 or sandy soils, one for Type 2 or silty soils, and one for Type 3 or clayey soils.

Each of the three Tier 1 soil types is a virtual composite of several soils having similar properties. Using the properties of these individual soils, the department developed average porosity and water content values for each soil type. Table 1 below shows the specific soils considered in developing each general soil type and the average porosity and water content values of each general soil type.

Table 1			
Soil type	Soil (SCS Classification)	Porosity (avg.)	Water content (avg.)
1	Sand	0.38	0.08
	Loamy sand		
	Sandy loam		
2	Clay loam	0.44	0.17
	Silt		
	Loam		
	Silty clay loam		
	Sandy clay loam		
	Silt loam		
3	Clay	0.44	0.21
	Silty clay		
	Sandy clay		

As the table indicates, the specific soil types are identified in accordance with Soil Conservation Service (SCS, now Natural Resource Conservation Service) classifications. Therefore, the SCS classification system, including the US Department of Agriculture (USDA) textural classification chart, must be used in determining a site-specific soil type. A copy of the USDA chart is found below as Figure 1.

In developing the three Tier 1 general soil types, MDNR primarily considered the moisture content and total porosity of each. Even so, soil porosity and moisture content measurements are not required in determining the type of soil present at a specific site, though the evaluator might find this information useful. These guidelines stipulate that soil type determinations be based on soil grain size analyses and the evaluation of boring logs.

O.2. DETERMINATION GUIDELINES AND REQUIREMENTS

The soil type determination must be applicable to the entire geographical extent of the site (that is, the entire area of contamination as determined by the application of the delineation criteria stipulated in the MRBCA guidance document) and 10 feet below the vertical extent of the soil contamination. If contamination originating at the site has resulted in groundwater contamination, the soil type determination shall apply to the entire soil column from the surface to the top of the saturated zone (i.e., the vadose zone).

A Missouri-registered geologist (RG) or qualified Missouri-licensed professional engineer (PE) must seal the soil type determination applicable to a site being evaluated under the MRBCA process. In determining the soil type, the RG or PE, or someone under the direct supervision of a RG or PE, shall employ all reasonable and appropriate professional standards applicable to soil type identification. The use of Method 3A1, Particle-Size Analysis, found in the *Soil Survey Laboratory Methods Manual, Soil Investigation Report, Number 42, Volume 3.0, January 1996* or the American Society for Testing and Materials (ASTM) standard D422-63 (2002), *Standard Test Method for Particle Size Analysis of Soils*, is a required component of the soil type determination process. With either method, the results must be plotted on the USDA textural classification chart, a modified copy of which is included below as Figure 1, in order to determine the appropriate soil type.

For samples to be analyzed using one of the aforementioned methods, MDNR recommends that the sample be collected from a portion of the site free of significant contamination. Because geotechnical laboratories generally are not set up to manage contaminated samples, ideally the samples should be collected outside the area of contamination, though the samples must come from an area having the same soil type as is found within the area of contamination. Regardless of where the samples are collected, they must be representative of soils within the area of contamination. Samples may be collected concurrently with the collection of samples to be analyzed for the various Tier 2 geotechnical parameters.

For sites where site characterization activities are complete at the time these guidelines are made generally available (i.e., the date on page one), the evaluator may make a soil type determination using existing site characterization data, specifically boring logs. For such sites, MDNR will not require grain size analyses provided that the existing site characterization data is sufficient to allow the evaluator to accurately determine soil type. All soil type determinations made based solely on existing site characterization data must be thoroughly documented and explained. If MDNR determines that the existing site characterization data is not adequate to support a soil type determination, MDNR may require further soil type evaluation, including the collection of soil samples for grain size analysis.

In addition to analyzing one or more representative soil samples as described above, in order to ensure that all soil types at a site are identified, one or more borings or probes must be advanced to a depth at least 10 feet below the vertical extent of soil contamination or, if groundwater is contaminated by

constituents originating at the site, to the top of the saturated zone. Each boring or probe must be comprehensively logged at intervals sufficient to account for all significant changes in soil stratigraphy, including the identification of discrete seams less than three inches thick. In certain cases, the advancement of borings or probes into the saturated zone might be necessary to ensure accurate identification of all soil types at a given site. The boring log or logs shall be evaluated and considered by the RG or PE in determining the overall site-specific soil type.

Soil heterogeneity shall be accounted for in the determination process and appropriately considered in making a final soil type determination. Soil testing conducted as a part of the soil type determination process must be demonstrably representative of all soil types overlying and immediately underling soil and groundwater contamination at a specific site. The person making the soil type determination shall be responsible for determining the number and distribution of soil samples necessary to ensure that all relevant soil types at a site are accurately identified such that the overall soil type can be determined. In all cases, at least one sample representative of the soil column from the surface to at least 10 feet below the vertical extent of the soil contamination, or, if groundwater is contaminated, to the top of the saturated zone, shall be collected for analysis by one of the aforementioned analytical methods. Where significant soil heterogeneity exists, MDNR may require that more than one sample be collected and analyzed.

In situations where the type of soil at a specific site is not one of the three soil types discussed above, or where the degree of soil heterogeneity is such that the soil at a site cannot be accurately identified as any one particular type, MDNR will require that the RBTLs for Soil Type 1 apply to the site.

In situations where two or three soil types exist at a site in approximately the same amounts, MDNR will require that the RBTLs associated with the most conservative of the Soil Types apply to the site. For the purposes of the MRBCA process, Soil Type 1 is considered the most conservative, followed by Soil Type 2 and, the least conservative, Soil Type 3.

As is an option with all sites, sites having two or three soil types in approximately the same amounts may be evaluated under Tier 2 of the MRBCA process. Under Tier 2, the type of soil at a site need not necessarily be identified in accordance with these guidelines. Instead, specific fate and transport properties of the soil or soils shall be identified via the collection of an appropriate number of representative soil samples for analysis of the geotechnical properties discussed in Section 5.0 of the MRBCA guidance.

O.3. REPORTING

At present, MDNR does not have electronic forms available for documenting soil type determinations. We anticipate that such forms will be available in the future. Until that time, soil type determinations shall be documented as discussed below.

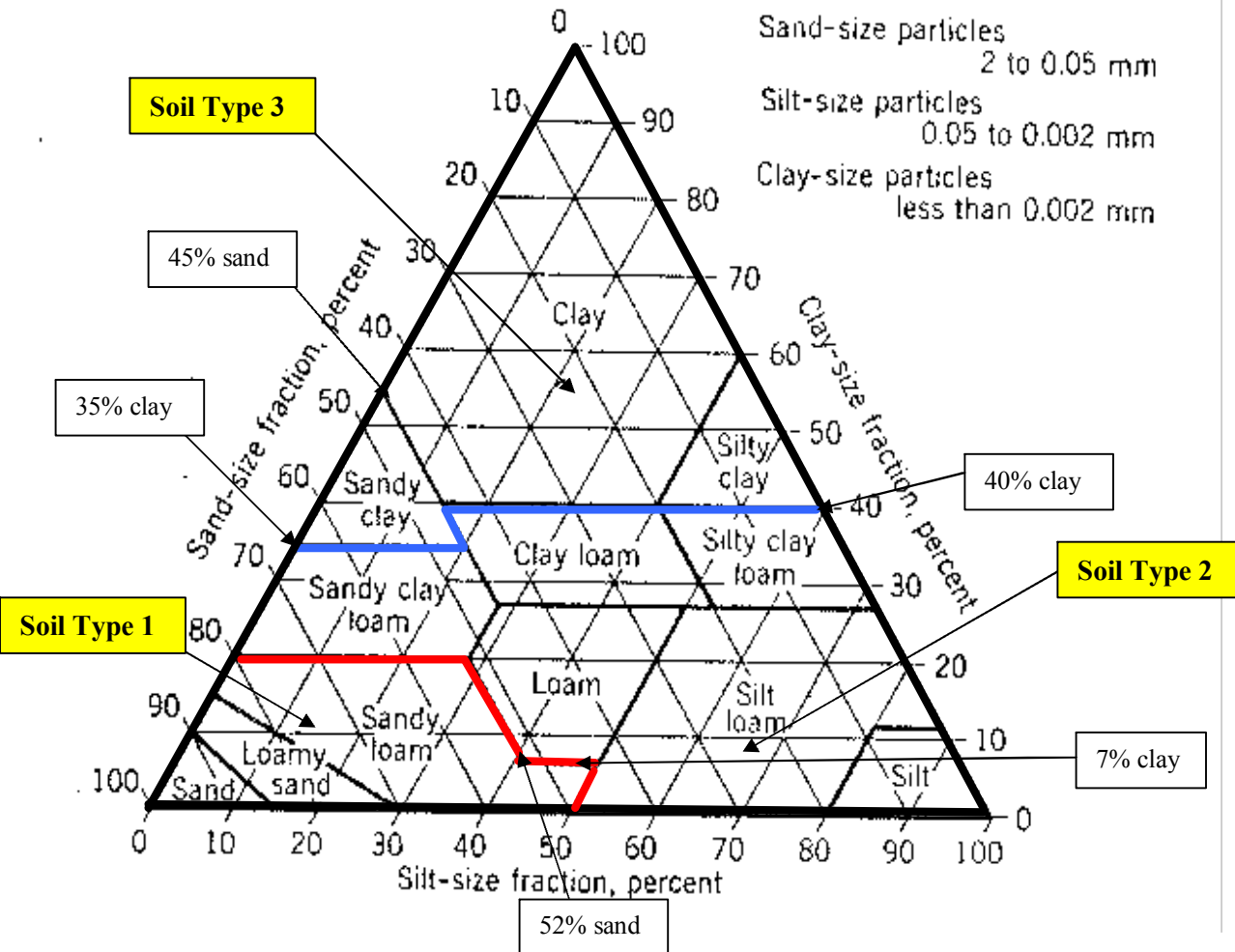
A report documenting the soil type and determination process must be submitted to the MDNR. The report may either stand-alone or be included as a discrete part of a site investigation or MRBCA Tier 1 or Tier 2 report (i.e., as an appendix or attachment). In any case, the report shall, at a minimum, include the following:

- A narrative section explaining how the soil type determination was made and identifying the soil type or types identified at the site. Include in this section the rationale for soil sample locations and a narrative discussion of the soil stratigraphy of the site as determined through the evaluation of boring logs;
- All applicable and necessary supporting documentation, including, at a minimum, boring logs, laboratory analytical results, chain of custody forms, cross-sectional diagrams, and a site map showing the location(s) where soil samples used in the soil determination process were collected. Where more than one soil type is present at a site, the report shall include a site map or cross sectional diagram showing the distribution of each soil type across the site; and
- The seal and signature of a Missouri registered RG or PE.

MDNR prefers that the soil type determination report be submitted prior to the Tier 1 or Tier 2 report, as the target levels applicable to a site will be dependent on the type of soil present at the site. We recommend that the soil type determination report be submitted with or as a part of the initial site characterization report.

If site characterization is complete (i.e., all contamination has been defined in accordance with the provisions of the MRBCA guidance document), the evaluator should submit a site characterization report, a MRBCA risk assessment report, and a work plan for corrective action, ongoing monitoring, or other necessary activities.

Figure 1: USDA Textural Classification Chart



Soil Descriptions Using Figure 1

- Sand: >85% sand
- Loamy sand: 70 to 91% sand
- Sandy loam: 7 to 20% clay, >52% sand, <7% clay, <50% silt, and >43% sand
- Sandy clay loam: 20 to 35% clay, <28% silt, >45% sand
- Loam: 7 to 27% clay, 28 to 50% silt, and 52% or less sand
- Silty loam: 50% or more silt and 12 to 27% clay, or 50 to 80% silt and <12% clay
- Silt: 80% or more silt and <12% clay
- Silty clay loam: 27 to 40% clay and 20% or less sand
- Clay loam: 27 to 40% clay and 20 to 46% sand
- Sandy clay: 35% or more clay and 45% or more sand
- Silty clay: 40% or more clay and 40% or more silt
- Clay: 40% or more clay, 45% or less sand, and <40% silt