Geotechnical Parameter Documentation

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Tanks Section
To highlight the importance of accurately determining and documenting site-specific geotechnical parameters during risk assessment.
<table>
<thead>
<tr>
<th>Introduction: MRBCA risk assessment process</th>
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<tbody>
<tr>
<td>1. Characterization of contamination</td>
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<tr>
<td>2. Geotechnical parameters</td>
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</table>
## Determination of MRBCA Geotechnical Parameters

(Sections 5.6 and 8.0)

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>A.</td>
<td>Site-specific values</td>
</tr>
<tr>
<td>B.</td>
<td>Default values (soil type dependant)</td>
</tr>
<tr>
<td>C.</td>
<td>Literature values (USGS)</td>
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<tr>
<td>D.</td>
<td>Adjacent site values</td>
</tr>
</tbody>
</table>
The soil subsurface

- Soil particle
- Water
- Air space
- Adsorbed phase
Vadose zone lithology

Homogeneous soil:
- One sample
- Silty clay
- Silty clay
- Silty clay
- Silty clay

Heterogeneous soil:
- Many subsamples
- Stiff clay
- Silty clay
- Fine sand
- Coarse sand
MRBCA geotechnical parameters

1 - Dry bulk density
2 - Soil porosity
3 - Volumetric water content (VWC)
4 - Fractional organic carbon content (FOC)
Dry bulk density (g/cc)

The dry weight (110 degrees C) of an undisturbed soil sample divided by its field volume (ASTM Method D2937-94)

Dry bulk density is inversely related to porosity (high porosity/more friable soil/less compacted/low bulk density)
How to obtain dry bulk density?

1. Soil sampling:
   - Collect soil samples using Shelby tube or thin-walled sampler or equivalent method
   - Homogeneous soil: one sample
   - Heterogeneous soil: one soil sample from each soil type (horizon) - consider the % of each soil type in the vadose zone
Dry bulk density (continued)

2. Literature values:
   - USGS-CARES value (depth)

3. MRBCA default value (1.5)

Generally reasonable values are reported
(range of 1.0 to 2.0)*

*California Department of Pesticide Regulation
Soil porosity (cc/cc-soil)

The ratio of volume of voids in a soil sample to the volume of the sample (ASTM Method D854)
How to determine soil porosity?

We need to determine:
  - dry bulk density
  - specific gravity

Porosity = 1 – dry bulk density/specific gravity or particle density

At MRBCA Tier 2 porosity for the vadose zone, capillary fringe, & foundation or wall cracks are assumed identical.
Specific gravity (ASTM D854)

The mass of solid matter in a given soil sample as compared to an equal volume of water
<table>
<thead>
<tr>
<th>Soil</th>
<th>Specific gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>2.63 – 2.67</td>
</tr>
<tr>
<td>Silt</td>
<td>2.65 – 2.7</td>
</tr>
<tr>
<td>Clay &amp; silty clay</td>
<td>2.67 – 2.9</td>
</tr>
<tr>
<td>Organic soils</td>
<td>&lt;2.0</td>
</tr>
<tr>
<td>(Histosols-peat (OMC 0.12 - 0.18)</td>
<td></td>
</tr>
</tbody>
</table>

*University of Akron, OH*
Verification of soil porosity value

- Boring logs information/ soil type/MRBCA default values (0.38, 0.44)
- Literature value of comparable lithology
- Adjacent site value of comparable lithology
## Soil porosity values

<table>
<thead>
<tr>
<th>Material</th>
<th>USGS</th>
<th>Argonne Nat. Lab.</th>
<th>Tanks MRBCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>0.25</td>
<td>0.25 - 0.50</td>
<td>0.38</td>
</tr>
<tr>
<td>Silt</td>
<td>NA</td>
<td>0.35 - 0.50</td>
<td>0.44</td>
</tr>
<tr>
<td>Clay</td>
<td>0.50</td>
<td>0.40 - 0.70</td>
<td>0.44</td>
</tr>
</tbody>
</table>
Volumetric water content (cc/cc)

The ratio of volume of water to the volume of soil (ASTM Method D2216-92)

- VWC is used in models
- Convert gravimetric value to volumetric value

\[ VWC = \frac{GWC \times \text{dry bulk density}}{\text{density of water}} \]
How to determine volumetric water content?

1- Collect multiple soil samples across the site at varying depths and determine the water content from each of the vadose zone lithologic units.

2- Calculate average water content in lab reports for soil samples collected from the vadose zone.

3- USGS value- CARES (check depth).

4- MRBCA default value (determine soil type).
1. Volumetric water content higher than porosity?

2. High volumetric water content for sites with shallow depth to groundwater (3 to 5 feet – SSTLs > effective saturated concentration for soil and groundwater)
Fractional organic carbon content
(g-C/g-soil)

The weight of organic carbon in the soil divided by the weight of the soil
How to determine fractional organic carbon content?

1. Collect soil samples from area of no petroleum impact (PID-log)
   Consideration of lithology: composite samples from two or more borings

2. USGS-CARES- organic matter content-corrector factor
Fractional organic carbon content (continued)

✓ Vadose zone:

Three subsamples from 3 feet depth to the top of the water table (from 0 to 3 feet/soil zone/high OMC)

✓ Saturated zone:

two subsamples, one immediately below the top of the saturated zone and one 3 feet below the top of the groundwater table
Sensitivity illustrations

- Assess Indoor inhalation of vapor exposure pathway
- Use MRBCA software version 2.1 of 2005
- Use soil type 1 default parameters
- Determine tier 2 site-specific target levels for benzene for soil and groundwater for a resident and nonresident
Effect of porosity on Benzene SSTLs

Porosity | VAC
---|---
0.35 | 0.27
0.38 | 0.30
0.40 | 0.32
0.44 | 0.36
0.50 | 0.42

VWC = 0.08
FOC = 0.006
Effect of VWC on Benzene SSTLS

<table>
<thead>
<tr>
<th>VWC</th>
<th>VAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.08</td>
<td>0.30</td>
</tr>
<tr>
<td>0.10</td>
<td>0.28</td>
</tr>
<tr>
<td>0.17</td>
<td>0.21</td>
</tr>
<tr>
<td>0.20</td>
<td>0.18</td>
</tr>
<tr>
<td>0.25</td>
<td>0.13</td>
</tr>
<tr>
<td>0.30</td>
<td>0.08</td>
</tr>
<tr>
<td>0.35</td>
<td>0.05</td>
</tr>
</tbody>
</table>

P = 0.38
FOC = 0.006
Effect of FOC on Benzene SSTLs

<table>
<thead>
<tr>
<th>OMC*</th>
<th>FOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil (1,340)</td>
<td>0.02</td>
</tr>
<tr>
<td>Subsoil (1,220)</td>
<td>0.008</td>
</tr>
<tr>
<td>MRBCA</td>
<td>0.006</td>
</tr>
</tbody>
</table>

*Journal of the American Chemistry Society

P = 0.38
VWC = 0.08
Summary

- Collect soil samples for geotechnical parameters according to the guidance procedures
- Collect soil samples from all soil horizons at sites where the soil profile is heterogeneous
- Submit laboratory reports and calculations
- Submit boring logs with PID results
- Support results with literature or comparable site values
Geotechnical parameters

QUESTIONS?

COMMENTS?