

Standard Operating Procedure No. 65

Density by the sand-cone method – used for volumetric moisture content

REVISION LOG		
Revision Number	Description	Date
65.0	Original SOP	19 September 2004
65.1	Minor revisions to grammar and layout by PJP	10/19/2004
65v1	Finalized by LMK for posting on the Molycorp project website and to send to George Robinson for lab audit. LMK did not edit this SOP	4/3/07
65v2	Editorial by SKA	10/27/08

1. PURPOSE AND SCOPE

This Standard Operating Procedure describes the method for determining in-place density(ρ) and unit weight of in-situ soils using a sand-cone apparatus. Volumetric moisture content is a measure of the proportion of void (pore) volume occupied by water or some other liquid in a sample of porous material at a specific time. Volumetric moisture content is a function of the gravimetric moisture content (SOP 40) and either the bulk density (SOP 32 and SOP 65) or the porosity (SOP 42) of the material. Degree of saturation (also called saturation) can be calculated from volumetric moisture content. Variably saturated flow models, e.g., FEHM [Zyvoloski, 1997], HYDRUS-2D [Simunek et al, 1999], and VS2D [Lappala et al, 1987], as well as seepage models such as SoilVision's SVFlux, use volumetric moisture content or saturation as a state variable.

2. RESPONSIBILITIES AND QUALIFICATIONS

The Team Leader and Characterization Team will have the overall responsibility for implementing this SOP. They will be responsible for assigning appropriate staff to implement this SOP and for ensuring that the procedures are followed.

All personnel performing these procedures are required to have the appropriate health and safety training. In addition, all personnel are required to have a complete understanding

of the procedures described within this SOP, and receive specific training regarding these procedures, if necessary.

All environmental staff and assay laboratory staff are responsible for reporting deviations from this SOP to the Team Leader.

3. DATA QUALITY OBJECTIVES

This SOP addresses objectives 1 and 7 in the data quality objectives outline by Virginia McLemore for the "Geological and Hydrological Characterization at the MolyCorp Questa Mine, Taos County, New Mexico".

- Determine how the hydrogeochemistry and water balance dynamics influence rock pile weathering and stability.
- Determine if pyrite oxidation, moisture content, and microbe populations affect rock pile weathering and stability.

4. RELATED STANDARD OPERATING PROCEDURES

The procedures set forth in this SOP are intended for use with the following SOPs:

- SOP 1 Data management (including verification and validation)
- SOP 2 Sample management (chain of custody)
- SOP 4 Taking photographs
- SOP 5 Sampling outcrops, rock piles, and drill core (solid)
- SOP 6 Drilling, logging, and sampling of subsurface materials (solid)
- SOP 7 Decontamination of sampling equipment
- SOP 32 Bulk Density
- SOP 40 Gravimetric moisture content
- SOP 42 Porosity

The procedures set forth in this SOP also are intended for use with the drill plans and sampling plans.

5. EQUIPMENT LIST

The following materials are required while performing the sand-cone method:

- 5 gallon (20l) plastic buckets
- metal digging tools
- large nails or spikes
- small paint brush
- thermometer
- indelible marker and calculator
- gravimetric moisture content field sample forms
- scale
- sand-cone apparatus

- weights to calibrate scale
- Aluminum weighing tares
- oven
- gravimetric moisture content field sample forms (attached)
- density sand

6. Summary of Method

The sand-cone method described in this SOP is modified from the American Society for testing and Materials standard test method D 1556-00.

A test hole is hand excavated on a flat horizontal bench or surface. All of the mine soil from the hole is retained and stored in a 20l bucket. The hole is filled with a free flowing sand of a pre-determined density (density sand) and the volume of the excavation is determined. The in-place wet density of the mine soil is determined by dividing the wet mass of the removed mine soil by the volume of the hole. The gravimetric moisture content (SOP 40) of the mine soil removed from the hole is determined. The dry mass of the mine soil and the in-place dry density are calculated using the wet mass of soil, the moisture content and the volume of the hole.

Refer to SOPs 1 and 2 for relevant requirements regarding the collection, labeling, preservation, and transportation of samples.

7. PROCEDURES

1. Select or prepare a flat, horizontal surface.
2. Secure the base plate of the sand-cone apparatus to the horizontal surface with large nails or spikes. Ensure that a tight fit is obtained between the plate and the soil surface around the perimeter of the circular opening in the center of the plate.
3. Dig a test hole in the soil inside of the center hole in the base plate. Disturbance to the soil surrounding the test hole should be minimized. The sides of the hole should slope slightly inward and the bottom should be reasonably flat concave. The hole should be kept as free as possible of pockets, overhangs, and sharp obtrusions since these affect the accuracy of the test. Soils that are essentially granular require extreme care and may require digging a conical-shaped test hole.
4. Place all excavated soil, and any soil loosened during digging in to a moisture tight container that is marked to identify the number. Take care to avoid losing any materials.
5. Clean the flange of the base plate hole, invert sand-cone apparatus and seat the sand-cone funnel into flanged hole.
6. Determine the mass of the apparatus with the remaining sand, record, and calculate the mass of sand used.
7. Determine and record the mass of the moist material that was removed from the test hole. When oversized material corrections are required, determine the mass of the

- oversized material on the appropriate sieve and record, taking care to avoid moisture losses. When required, make appropriate corrections for the oversized material.
8. Mix the material thoroughly, and either obtain representative specimen for water content determination, or use the entire sample.
 9. Determine the water content in accordance with SOP 40. Water content specimens must be large enough and selected in such a way that they represent all the material obtained from the test hole.
 10. Calculations shown are for mass in grams and volumes in cubic centimetres. Other units are permissible provided appropriate conversion factors are used to maintain consistency of units throughout the calculations. Calculate the volume of the test hole following procedures in the attached ASTM D 1556 – 00

8. QUALITY ASSURANCE/QUALITY CONTROL

Laboratory scales should be calibrated using standard weights prior to measuring. Oven temperature should be checked and maintained to within 5 degrees C. Minimize sample handling and record all losses of sample mass (spalled grains, sample tipped and spilled, etc.)

9. DOCUMENTATION

Record field number according to SOP 1, date collected, time collected, hole or test pit number, depth of sample, sample temperature, air temperature, and initials of person collecting the sample.

10. REFERENCES

ASTM 1556 – 00 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, April 2000.

Gardner, W.H., 1986, Water Content, in *Methods of Soil Analysis Part 1. Physical and Mineralogical Methods*, Agronomy Monograph no. 9, Soil Science Society of America, Madison, WI, USA, p. 493-509.

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Lappala, E.G., Healy, R.W., and Weeks, E.P., 1987, Documentation of computer program VS2D to solve the equations of fluid flow in variably saturated porous media: U.S. Geological Survey Water- Resources Investigations Report 83-4099, 184 p.

Simunek, J., M. Sejna, and T. van Genuchten, The HYDRUS-2D software package for simulating the two-dimensional movement of water, heat, and multiple solutes in variably

saturated media, Version 2.0, U.S. Salinity Lab, Agricultural research Service, U.S. Dept. of Agriculture, Riverside, CA, USA, April, 1999.

Zyvoloski, G. A., B. A. Robinson, Z. V. Dash, and L. L. Trease, Summary of the models and methods for the FEHM application – A finite-element heat-and mass-transfer code, Los Alamos National Lab. Rep. LA-13307-MS, Los Alamos, NM, 1997.