

STANDARD OPERATING PROCEDURE
Soil Bulk Density Determination Using the Eijkelkamp Soil Sampler

KEY WORDS

Soil; Eijkelkamp Bulk Density Soil Sampler

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1.0 INTRODUCTION

The California Department of Pesticide Regulation periodically conducts field studies where soil bulk density is characterized. Soil bulk density is determined by associating the dry weight of a soil sample with its specific volume.

Several types of equipment are available for sampling soil to determine bulk density. The strengths and weaknesses of each equipment type are largely dependent on the configuration of soil sample to be collected. A large-diameter soil collection ring might be preferred for sampling soil at the surface where a more representative sample will be obtained. A long, narrow collection cylinder offering greater soil penetration capability might be preferred for collecting a single, deep, contiguous soil sample. For collecting undisturbed soil samples to determine bulk density at specific or sequential soil depths the Eijkelkamp Bulk Density Soil Sampler offers the greatest accuracy (Richardson and Clayton, 2013).

1.1 Purpose

This SOP defines the method for collecting a soil sample using the Eijkelkamp Bulk Density Soil Sampler and to determine soil bulk density.

2.0 EQUIPMENT

2.1 Eijkelkamp Soil Sampler, including

2.1.1 Sample rings

2.1.2 Extension

2.1.3 Handle crossbar

2.2 Putty knife

2.3 Shovel

2.4 Rubber or plastic mallet

2.5 Bucket Auger

2.6 Sample jars - 1/2 pint wide mouth mason jars, labeled and weighed (to 0.1g)

2.7 Balance (accurate to 0.1g)

2.8 Soil Bulk Density Worksheet ([Appendix 1](#))

2.9 Drying oven

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3.0 SOIL COLLECTION PROCEDURES

3.1 Check all equipment before heading out to the field.



3.2 Insert the soil sample collection ring into the sampler head.



When inserting soil sample collection ring into sampler head, make sure beveled end is facing towards the sampler head's end



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- 3.3** Attach the sampler head to the handle making sure that the pin is firmly locked into the groove.



- 3.4** Soil sampler shown fully assembled.



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- 3.5** Use an auger or shovel to remove soil to just above the desired depth to be sampled for bulk density.



- 3.6** Place the fully assembled soil sampler on top of the soil sample to be collected. Drive the soil sampler into the soil to a depth that ensures the sample ring is full of soil (greater than 5cm, but less than 10cm).



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- 3.7** If it is difficult to push the soil sampler into the soil, strike the top of the soil sampler with a rubber or plastic mallet.



- 3.8** Once reaching the proper depth, turn the handle of the soil sampler 90° to break the soil at the base of the sampler from the soil below.



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3.9 Continue to rotate the soil sampler while lifting it from the hole.



3.10 Remove the soil sample collection ring from the sampler head.



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- 3.11** Use a putty knife to remove excess soil from the top and bottom of the sample collection ring so that the soil is flush with the sides of the ring.



- 3.12** Place caps on both ends of the sample collection ring to maintain sample integrity.



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- 3.13** Label the sample collection ring and place it in a secure location for transport.



- 3.14** Brush or tap the sampler head to remove excess soil before taking the next sample.



- 3.15** To continue sampling, follow steps 3.2 through 3.14.

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4.0 SAMPLE PREPARATION

Typically, soil samples are dried in the Eijkelkamp Soil Sampler rings. However, soil samples collected using the Eijkelkamp rings could be transferred to mason or other jars for storage. Sections **4.1 – 4.4** explain the procedure for drying soil in the rings or jars and weighing of the samples.

- 4.1** Remove the plastic lids from the rings containing the samples and wrap the bottom of the rings with small pieces of aluminum foil. If soil samples are contained in jars then remove the lid.
- 4.2** Set the samples in a 105°C oven and allow them to dry until a constant weight is reached. Typically, leaving the samples in the oven overnight is sufficient however; leaving them in the oven longer will not present any problems.
- 4.3** Remove the soil from the Eijkelkamp Soil Sampler rings and foil, or glass jars, and weigh dry soil samples. Record the weights in the “**Dry Soil Weight**” column of the Soil Bulk Density Worksheet ([Appendix 1](#)).

NOTE: Sample bulk densities are automatically calculated once the sample soil dry weights are entered into the workbook.

- 4.4** Put un-weighed samples back in the oven until sample preparation can be resumed.

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5.0 CALCULATING BULK DENSITY

The Soil Bulk Density Worksheet ([Appendix 1](#)) automatically calculates the bulk densities of the samples using the following equation:

$$\text{Equation 1: Bulk Density (g/cm}^3\text{)} = M_d / V$$

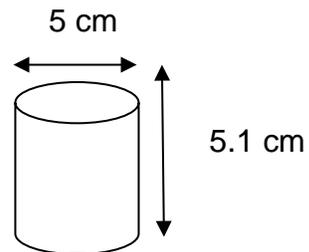
M_d = Mass of dry soil sample (grams)

V = Soil volume (cm³)

Standard Eijkelkamp Sampler Cylinder Size:

Area: 19.6 cm²

Volume: 100 cm³



6.0 TYPICAL BULK DENSITIES FOR VARIOUS SOIL TYPES

According to Koorevaar, et al (1983), the expected bulk densities for various soil types are as follows:

- **Peat Soils** 0.25 g/cm³
- **Loamy and Clay soils** 1.1g/cm³
- **Sandy Soils** 1.6 g/cm³
- **Compacted Soils** 1.90 g/cm³

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7.0 REFERENCES

Koorevaar, P., G. Menelik, and C. Dirksen. *Elements of Soil Physics. Developments in Soil Science 13.* 3rd ed. Vol. 13. Netherlands: Elsevier Science Publishers, 1983. 9. Print.

Marshall, T. J., and J. W. Holmes. *Soil Physics.* 2nd ed. Great Britain: Cambridge University Press, 1992. Print.

Richardson, K and M. Clayton. Review of Equipment Used to Sample Soil for Determination of Bulk Density 2013. Memo
http://www.cdpr.ca.gov/docs/emon/pubs/ehapreps/analysis_memos/2427_bulk_density equip_comp_memo.pdf