**1.0 TITLE**

# Texture Analysis by Hydrometer for Soils, Spoils, or Tailings.

**2.0 LOCATION**

Soils Prep and Digestion Labs

**3.0 SCOPE & APPLICATION**

This method is applicable to soils, spoils or tailings. Particle size distribution has a profound effect on the success of reclaiming mined or other drastically disturbed land just as it does on managing any agronomic area. Critical factors in revegetation and management of disturbed or degraded sites that are affected by particle size are moisture, temperature, and air relations, as well as physical impedance of roots, chemical reactivity, and erosion

In most soil, spoil or tailing material, particles are classified as primary and secondary. Primary particles are individual sands, silts, and clays that exist separately with no forces of attraction binding two or more of the particles together. Secondary particles form when two or more primary particles are bound or attracted together by physical or chemical forces

The relative amounts of primary sand, silt and clay particles usually are referred to as soil texture. If the percentages of sand, silt and clay are known, the soil texture can be classified into several categories using the USDA textural triangle. The texture analysis by hydrometer is performed on a <2000um sieved sample dried at <40°C.

Soils and spoils < 2000um are the greatest contributors for soil mediums. There is not an optimum texture for all purposes and all plants because requirements vary greatly. However, a plant growth medium with enough sand to allow for aeration, enough looseness to permit plant root growth and development, and enough clay for adequate nutrient and water- holding capacity would be ideal. The particle sizes in the table below are used in the success of reclaiming mined or drastically disturbed lands. Refer to SOPSO035 for additional grain size requirements.

| GRAIN SIZE | CLASSIFICATION |
|---|---|
| > 10 inches | Stone |
| 3 inches to 10 inches | Cobble |
| 2000um to 3 inches | Gravel |
| 2000um | Fine Gravel |
| 850um | Very Coarse Sand |
| 500um | Coarse Sand |
| 250um | Medium Sand |
| 105um | Fine Sand |
| 53um | Very Fine Sand |
| <53um to 2um | Silt |
| <2um | Clay |

**4.0 SUMMARY**

A 40-g portion of air-dried and screened (< 2000um) sample is weighed into a 250mL wide mouthed bottle with a cap. 100mL of Sodium Metaphosphate dispersing agent is added and the sample is shaken overnight. The dispersed sample is transferred to a 1000mL-graduated cylinder. Room temperature Type I $H_2O$ is added, the sample is agitated with a plunger to get the sample into suspension, and the hydrometer is inserted in the suspension. The hydrometer reading is recorded at 40 seconds and 7.25 hours. The 7.25 hour settling time for determining a clay percentage on a 2.0 µm size fraction based on particle density of 2.65 g cm-3 and a solution density of at 0.5 g $L^{-1}$.[1] The percentage of sand, silt and clay will be calculated and corrected for temperature using the blank reading by the computer when the data is entered. The soil texture is then classified using the USDA Textural Triangle. Some clients require multiple time increment readings of the hydrometer in which case a separate Excel bench sheet is used instead of entering data into LIMS.

**NOTE:** Hard copies of the USDA Textural Triangle are included with this SOP and may be found in the Soils main office reference section. Analysts may also use the following website which has been vetted by IT and QA/QC to graph texture: http://nowlin.css.msu.edu/software/triangle_form.html

**NOTE:** Particle size analysis can be done conveniently with a hydrometer, which allows for nondestructive sampling of suspensions undergoing settling. The hydrometer method provides for multiple measurements on the same suspension so that detailed particle size distributions can be obtained with minimum effort.

## 5.0 REFERENCES

5.1 Reclaiming Mine Soils and Overburden in the Western United States Analytical Parameters and Procedures Copyright 1987, Pg 59-63.

5.2 Particle Size Analysis - Hydrometer Method, 15-5., Methods of Soil Analyses, ASA No.9 2nd Edition. 1986 Annual Book of ASTM Standards.

## 6.0 SAMPLE COLLECTION, HANDLING & PRESERVATION

6.1 Samples must be air dried at <40°C or not >140°C and screened <2000um. Confirm there are no other particle size requirements needed before prep is done.

6.2 No hold time has been established for this analysis. Hold Time Table for applicable products:

**Table 6.1:** Hold Times

| Parameter Description | Matrix | Hold Time |
|---|---|---|
| Texture | Solid | Not Regulated |

## 7.0 APPARATUS & SUPPLIES

7.1. Standard hydrometer, ASTM no. 152H, with Bouyousos scale in g/L

7.2. Sedimentation graduated cylinders with 1 Liter mark 36 ± 2 cm from the bottom of the inside.

7.3. Plunger with long handle.

7.4. Ethyl Alcohol and dropper

[1] *Particle Size Analysis For Soil Texture Determination (hydrometer method): https://lter.kbs.msu.edu/protocls/108*

7.5. Timer with second reading

7.6. 3-place analytical balance, calibration verified daily or before use –refer to SOPAD013.

7.7. Stainless steel spatula

7.8. 250mL wide mouth bottle with cap

7.9. Table shaker

7.10. 100mL graduated cylinder

## 8.0 REAGENTS & STANDARDS

8.1 Type I $H_2O$: Full carboy of Type I $H_2O$ at room temperature.

8.2 50g/L Sodium Metaphosphate Dispersing agent: This reagent is VERY sticky if it gets wet. Weigh 50.0g into a weigh dish. Add ~ 500mL of Type I $H_2O$ to a 1000mL volumetric flask and put a stir bar in the flask to start. Put the flask on the stir plate and add the Sodium Metaphosphate to the flask while the solution is stirring. DO NOT rinse the weigh dish with water. Add the final 500mL of Type I $H_2O$ while stirring. Store the solution at room temperature for up to 1 month.

## 9.0 SAFETY

9.1 HAZARDS

All procedures within ACZ pose some safety hazards that may be avoided with attention to detail.

9.2 SAFETY TECHNIQUE

9.2.1 Safety glasses are required and the use of gloves and lab coat is strongly recommended. Shorts and open-toed shoes are not allowed in the lab.

9.2.2 Use care when pouring and pipeting reagents. Always add acid to water. Use the proper method when washing glassware.

9.2.3 Do not eat or use tobacco products in the lab.

9.2.4 Wipe up ALL spills immediately. Implement the Emergency Response Plan if necessary.

9.2.5 Do not wear gloves or lab coat outside of the laboratory. Remove gloves before using a computer, telephone, etc.

9.2.6 Do not conduct “experiments” unrelated to the analysis.

9.3 PROTECTIVE EQUIPMENT

9.3.1 Use a fume hood when there is a potential for strong fumes.

9.3.2 A fire extinguisher is located in each analytical laboratory.

9.3.3 An emergency shower and eye wash station is located in the soils prep lab.

## 10.0 INTERFERENCES

10.1 The water used to fill the graduated cylinders must be at a constant temperature during filling or the hydrometer reading will be inconsistent.

## 11.0 PROCEDURES

11.1. Create a workgroup in LIMS with up to 20 client samples (soil analysis, TEXTURE).

11.2. Gather and organize the <2000um prepped samples for the workgroup.

11.3. Gather the texture bottles and caps hanging on the wall in the soils prep room. Keep them in order and place them on a cart. Bring the bottles to the balance.

11.4. If necessary, verify the balance calibration. Refer to SOPAD013 for details.

11.5. Place the bottle on the balance and tare the balance.

11.6. Weigh 40.0g of sample into the appropriate bottle. PBS is reagent only, but must record 40.0g on benchsheet for final calculation. Record the weight of each sample on the workgroup bench sheet.

**NOTE:** For each client sample, verify that the sample Log-in number on the workgroup matches the sample number on the bottle. This ensures that samples are not inadvertently switched.

11.7. Use a graduated cylinder to add 100mL of Sodium Metaphosphate solution into each bottle. Put the caps on tight and hand shake to remove any sample from the bottom of the bottle.

11.8. Put the bottles in the shaker table sideways if possible so the solids will be completely dispersed.

11.9. Shake the samples on the shaker table overnight (low setting).

11.10. Before leaving for the day, make sure there is a full carboy of Type I $H_2O$ in the prep lab so it will be at room temperature in the morning.

11.11. In the morning, remove the samples from the shaker and organize them at the Prep Lab sink. Follow the same sequence on the workgroup bench sheet.

11.12. Place the carboy of Type I $H_2O$ next to the sink.

11.13. Pour the PBS into the first cylinder. Repeatedly fill the bottle with Type I $H_2O$ to completely rinse the sample from the bottle into the cylinder. QS to 1000mL Do not fill the cylinder past the 1000mL mark.

11.14. Continue until all the samples are rinsed into the appropriate cylinders and QS'd to 1000mL.

11.15. Place the timer next to the texture cylinders and zero the seconds.

11.16. Record the time and room temperature on the bench sheet before the sample is agitated. The second reading will be taken 7.25 hours from this time (the length of time required for the silt to drop out of suspension).

11.17. Agitate the sample with the plunger by completely lowering it and raising it in the sample. Hold the bottom of the cylinder to prevent tipping. Continue agitating and start the timer.

11.18. After 16 seconds, transfer the plunger to the next sample and gently drop the hydrometer into the agitated sample. There should be 20 seconds on the timer at this point.

11.19. The first reading is taken after 40 seconds (60 seconds on the timer).

**NOTE:** If the sample creates foam around the hydrometer, then add ethyl alcohol drop-wise around the neck of the hydrometer within the first 20 seconds. Do not use too much because it will modify the buoyancy of the solution, and do not add it right before taking the second reading, because it causes the hydrometer to move up and down.

11.20. Record the number on the hydrometer at the top of the meniscus formed by the suspension around the stem. The hydrometer reading is for sand, which drops out of suspension in 40 seconds.

**NOTE:** Do not leave hydrometer in suspension longer than 40 seconds as particles will settle out on its shoulders.

11.21. Repeat step §11.16 –§11.20 for each sample.

11.22. After the last sample has been read, determine when the second reading will be taken for the first sample in the workgroup. The second reading is taken 7 hours and 15 minutes from the time recorded in §11.16.

11.23. For the second reading, record the room temperature and time on the benchsheet and place the hydrometer in the blank to start and let it stabilize.

**NOTE:** If more than 7.25 hours has passed since the first reading, then repeat §11.16 –§11.20 and wait another 7.25 hours before taking the second reading. Make a note on the workgroup if the time was missed.

11.24. Read the number on the hydrometer at the top of the meniscus formed by the suspension around the stem. Record the value in the "second reading" column on the bench sheet.

11.25. Continue until all the samples have the second reading completed.

11.26. Do not dispose of the samples in the cylinders until the data has been entered and reviewed. Also make sure further analysis does not include a wet sieve on this sub-sample.

11.27. Enter the data into LIMS to calculate percent sand, silt and clay. Make sure the correct values are entered for both the first and second reading for each sample –check for typos before uploading data.

11.28. Refer to Figure 18.1 or http://nowlin.css.msu.edu/software/triangle_form.html and enter the Textural Classification on the bench sheet and in LIMS.

11.29. AREV data in LIMS and turn in to the department supervisor for SREV.

## 12.0 QUALITY CONTROL

12.1 A blank must be analyzed in order to determine temperature fluctuation in the room during the day. The final texture calculation will correct for temperature fluctuation.

12.2 Analyze one duplicate (DUP) for every 20 or less client samples. The analysis is acceptable if the DUP RPD is ≤ 20 %. The supervisor will determine the appropriate corrective action if the RPD is > 20.

## 13.0 DATA CALCULATIONS, DATA REPORTING & ARCHIVING

13.1 Texture calculations:

1) % sand = 100 – [ ( (40 second reading - blank 1 reading) / dry sx weight) * 100 ]

2) % clay = [ ( (7.25 hour reading - blank 2 reading) / dry sx weight) * 100 ]

3) % silt = 100 – ( % sand + % clay).

13.2 Refer to Figure 18.1 or http://nowlin.css.msu.edu/software/triangle_form.html to determine the texture classification from sand, silt, and clay percents.

## 14.0 METHOD PERFORMANCE/DETECTION LIMITS

14.1 A Method Detection Limit (MDL) study is not required for the procedure.

14.2 A Demonstration of Capability (DOC) is not required because either a Laboratory Control Sample (LCS) is not used or the method does not lend itself to spiking. Completion of the Initial Method Training Form (FRMQA004) is sufficient for training.

## 15.0 DOCUMENTATION

15.1 Record the appropriate information for all reagents in the Soils Department Standard/Reagent logbook and/or LIMS database.

15.2 Complete and attach the Data Review Checklist to the workgroup.

15.3 Label each standard or reagent stored for more than 1 day with the following information:

- Standard name.
- SCN (or other unique ID).
- Preparer's initials.
- Expiration date.
- Prep date.

15.4 Make sure the following information is included on the Workgroup:

- Weight of sample used.
- Time of first sample reading
- Analysis date, start time and completion time.
- Analytical method used.

- Analyst's initials.
- Any remarks about analysis or samples.

## 16.0 WASTE MANAGEMENT/POLLUTION PREVENTION

16.1 Dispose of samples only in the soils prep lab sink.

## 17.0 DEFINITIONS

17.1 Duplicate (DUP)—Two aliquots of a sample analyzed in the same workgroup, under identical circumstances. Analysis of a duplicate sample indicates the precision associated with the laboratory procedure.

17.2 Relative Percent Difference (RPD) –The value obtained by dividing the difference between two replicates by the average of the two replicates and then multiplying by 100.

## 18.0 TABLES & DIAGRAMS

**Table 6.1:** Hold Times

**Figure 18.1:** USDA Textural Classification Guide

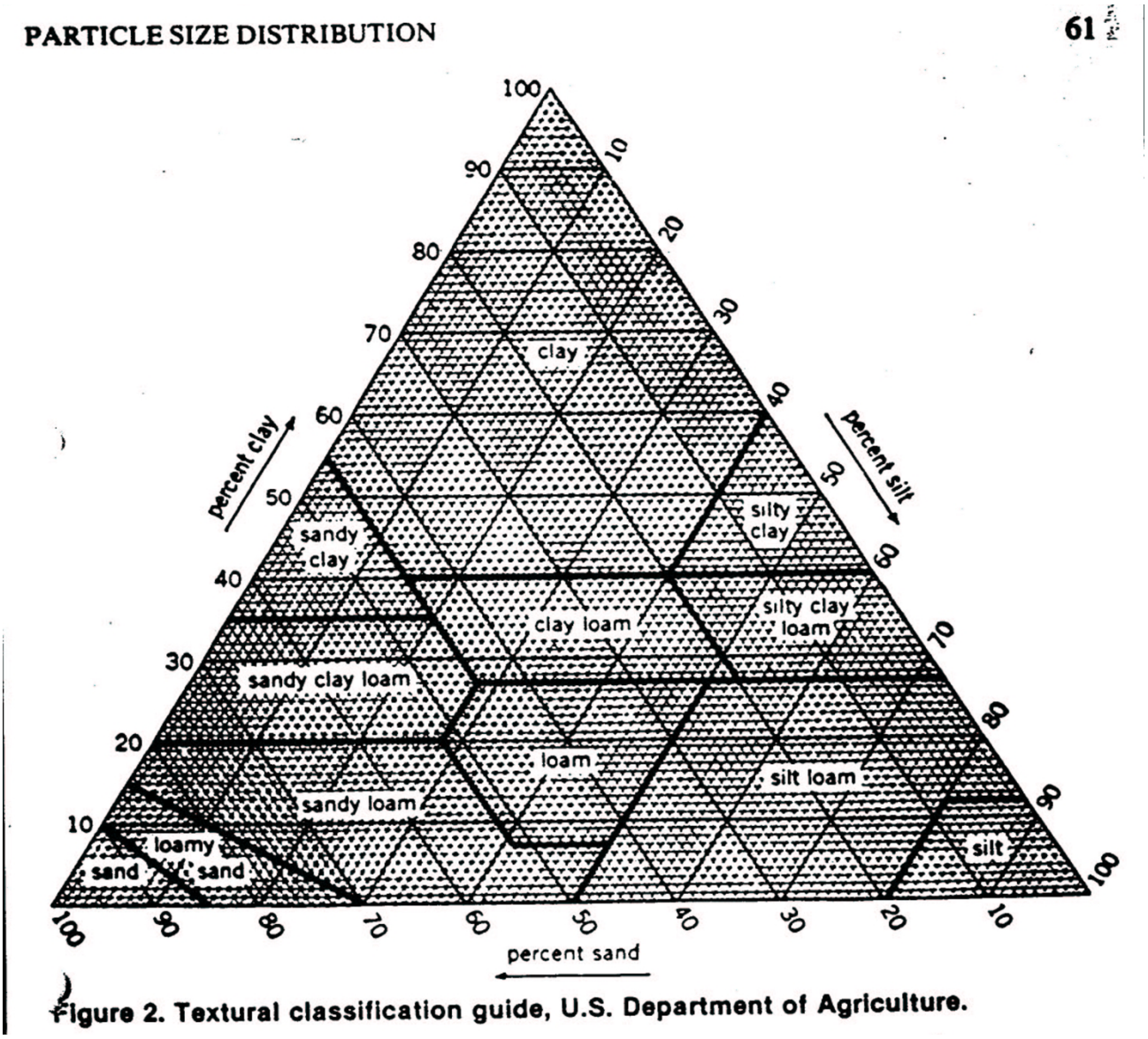


Figure 2. Textural classification guide, U.S. Department of Agriculture.

## 19.0 CORRECTIVE ACTION

19.1 For QC samples that do not meet the method acceptance criteria, refer to section §12.0. For retests that will occur past the method hold time, check first with the department supervisor to determine if the reanalysis should be conducted. Refer also to CAR344 memo for additional information regarding non-conformances. A copy is available from the QA/QC Officer.

19.2 For any SOP/method deviation fill out section 1 of a corrective action report (FRMQA001). If necessary, the department supervisor and/or project manager may provide additional information in the appropriate sections; however, QA/QC does not need to close a minor corrective action. Attach a copy of the minor corrective action report to all workgroups affected. A minor corrective action is for documentation purposes –any SOP or method deviation may be noted on the data review checklist or on the workgroup bench sheet in lieu of using FRMQA001.

19.3 For any system failure a major corrective must be opened and the problem investigated. A department supervisor or the QA/QC Officer can open a major corrective action. The corrective action will be assigned a unique tracking number by the QA/QC Officer and will be closed by the QA/QC Officer once the failure has been resolved. Use FRMQA001 (in LabWeb).