INDIANA DEPARTMENT OF TRANSPORTATION
Division of Materials Management

Directive No. 502

Soil Laboratory Testing for Dynamic Cone Penetrometer Criteria

The criteria for Dynamic Cone Penetrometer (DCP) acceptance of compaction includes testing of a construction jobsite sample to determine the Soil Classification of the material. From the Soil Classification, the required blow counts with the DCP are determined for the soil. Approved Structure Backfills from CAPP sources will not be subject to the soil classification criteria. Flow charts for the sample reduction, testing process, and reporting of test results are shown in Attachments I, II, and III.

APPARATUS

Balance — The balance shall conform to the requirements of AASHTO M 231 for the class of general purpose balance required for the principle sample weight of the sample being tested.

Sieves — A series of sieves of the following sizes: 1 1/2 in., 1 in., 3/4 in., 1/2 in., 3/8 in., No.4, No.10, No.40, and No.200

Pulverizing — Initial pulverization shall be done by a revolving drum having rubber-covered rollers. Subsequent pulverization shall be done in a pan by a mortar with a rubber covered pestle or wood block that does not retain material. Other methods of pulverization are satisfactory if soil particles are separated by a procedure that will not reduce the natural size of the individual particles.

Splitting — A suitable riffle splitter for proportional splitting of the sample, capable of obtaining representative portions of the sample without appreciable loss of fines, shall be used. The width of the container used to feed the riffle splitter shall be approximately the same width as the total combined width of the riffle chutes. A clean hard surface or canvas may be used to quarter the sample.

SAMPLING AND DRY PREPARATION OF SAMPLE

- A 30 to 50 lb sample of each soil type is obtained from the construction jobsite. The sample is reduced to testing size in accordance with the following procedures:

  1. Reduce the sample by means of quartering or splitting in accordance with AASHTO T 248 to approximately 10,000 g

  2. If the sample is damp when received, dry the sample until the sample becomes easily separated with a trowel. Drying will be done in an oven at a temperature

not exceeding 140° F.

3. Pulverize the dry material in a revolving drum with rubber-covered rollers. If particles are not reduced to a size that will dissolve during deflocculation and decant, then subsequent pulverization may be done in a pan by a mortar with a rubber covered pestle or wood block that does not retain material.

4. Split the sample by quartering to obtain the following weights for testing. After quartering, additional splitting for non-cohesive soils may be done with a riffle splitter. If a riffle splitter is used for non-cohesive soils, the splitter may be used only two times and only on soils that have little or no fines.

Test Method	Size of Test Sample
AASHTO T 11 (Decant) and T 27 (Coarse Sieve Analysis)	*
AASHTO T 21 (Organic Impurities in Fine Aggregate)	450 g minus No.10 material prepared per R 58, Section 7
AASHTO T 89, Method A (LL)	Use remainder of sample after T 90
AASHTO T 90 (PL)	100 g minus No.40 material prepared per R 58 Section 7
AASHTO T 99, Method A or C (Moisture/Density Proctor Test)	Minimum of 4000 g**
AASHTO T 265 (Hygroscopic Moisture)	50 g minus No.10
AASHTO T 267 (Loss on Ignition for Organics)	10 - 40 g oven dried minus No.10 material
ITM 512 One Point Proctor	Minimum of 4000 g**
ITM 507 (Sequential LOI for Calcium Carbonate)	10 - 40 g oven dried minus No.10 material
ITM 510 (Sulfate Test)	Prepared per R 58 Section 7 ***
ASTM D1140, Method B (Deflocculation)	100 g - clay/silt 500 g - sandy
* Entire sample remaining after D 1140 Testing plus the coarse fraction	
** A larger amount may be necessary to compensate for a high % retained on the No. 4 sieve or to use Method C	
*** 200 g of minus No. 40 material will be sent to Materials and Tests	

Figure 1

TESTING

Coordinate all tests in accordance with Attachments I and II. Details for each of the specific tests in test method numerical order are as follows:

AASHTO T 89, Method A – Liquid Limit using pulverized sample in Figure 1

1. Determine the Liquid Limit in accordance with AASHTO T 89 on the remaining AASHTO T 90 prepared material

2. Record the test data on the Excel spreadsheet

AASHTO T 90 – Plastic Limit using pulverized material in Figure 1

1. Prepare 100 g minus No. 40 material in accordance with AASHTO R 58 Section 7 and AASHTO T 90 to the moisture content for starting a Plastic Limit test

2. Determine the Plastic Limit in accordance with AASHTO T 90 using an 8 g sample from the prepared material

3. Record the Plastic Limit test data on the Excel spreadsheet

AASHTO T 99, Method A or C, or with ITM 512 – Max Dry Density and Optimum Moisture Content using pulverized sample in Figure 1

1. Prepare the sample in accordance with AASHTO T 99, Method A or C, as applicable

2. Perform the One Point Proctor test using ITM 512 or perform the four point Proctor test using AASHTO T 99, Method A or C. The max dry density and optimum moisture content are ~~is~~ determined at the point that free water is evident at the bottom of the mold while performing AASHTO T 99, Method C. For granular soils, the bottom plate is kept on the compaction mold to ensure no material loss during the test procedure.

3. Report the Maximum Wet Density, Maximum Dry Density, and Optimum Moisture Content (OMC) on the Excel form to the nearest whole number

AASHTO T 265 - Laboratory Determination of Moisture Content of Soils (Hygroscopic Moisture)

1. AASHTO T 265 is required to be performed at approximately the same time as ASTM D1140.

2. Determine the moisture content of the 50 g of material passing the No. 10 sieve in accordance with AASHTO T 265

3. Record the results on the Excel spreadsheet

AASHTO T 267 – Organic Content by Loss on Ignition using material split from Figure 1

1. Perform AASHTO T 267 when one of the following soil properties occurs:

   a) The maximum dry density is less than 105 lb/ft^3

   b) The optimum moisture content is 25% or greater

   c) Organic material, black soil, or fibrous materials are visible

2. Report the % organic on Excel spreadsheet (if performed)

ITM 507 – Calcium Carbonate Content by Sequential Loss on Ignition

1. Perform ITM 507 on tested AASHTO T 267 material when shells are visible

2. Report Marl* on the Excel spreadsheet, if performed
   * Sequential Loss on Ignition is recommended when max dry density is <105 pcf or moisture is > 25%.

ITM 510 – Determining Sulfate Content in Soils

1. Use material split from the pulverized sample in Figure 1

2. Sieve the material through the No. 4 sieve until approximately 500 g of minus No. 4 material is accumulated

3. Pulverize the sample to obtain a sample that is passing the No. 40 sieve

4. Submit 200 g of the minus No. 40 material to Materials and Tests for sulfate testing

5. Materials and Tests will record the test results in Site Manager and send an e-mail to District testing when test results are failing.

6. Report the test results on the Excel spreadsheet

ASTM D1140 Method B – Amount of Material in Soils Finer than the #200 Sieve (Deflocculation); AASHTO T 11, and AASHTO T 27 for Soil Sieve Analysis

1. Use the test sample size from Figure 1

2. Record the initial dry weight

3. Remove by sieving plus No. 4 material and retain for sieve analysis

4. Deflocculate the minus No. 4 material and soak a minimum of 2h. Soaking overnight is preferred and may be necessary for clay materials.

5. Wet sieve the minus No.4 (deflocculated) material through the No. 10, No. 40, and No. 200 sieves

6. Decant the entire remaining original sample in accordance with AASHTO T 11

7. Dry the sample in a 230° F oven to constant weight. Constant weight is defined as the weight at which further drying at the required drying temperature does not alter the weight by more than 0.1 percent.

8. Perform the gradation in accordance with AASHTO T 27 including sieves 1 1/2 in., 1 in., 3/4 in., 1/2 in., 3/8 in., No. 4, No. 10, No. 40, and No. 200 (larger size sieves may be eliminated depending on material)

9. Record data on lab worksheet or Excel Spreadsheet

REPORT

All data is entered on the Excel Worksheets for Sieve Analysis, LL, and PL Tests and the Lab DCP Target (Figures 2 and 3) as applicable. Final data is automatically reported on the Excel DCP Field Target Worksheet (Figure 4).

a) Complete all lab test data entries

b) If no soil type and corresponding blow count targets appear on the Field Target Worksheet, submit the Lab DCP Target worksheet (Figure 3) with the data noted with an asterisk and the DCP Field Target worksheet (Figure 4) to the Geotechnical Engineering Division for assignment of the Soil Type and DCP Blow Count Target values. The Geotechnical Engineering Division will assign the soil type and DCP blow count targets, add any other notes, and return the worksheet to the District for distribution.

c) If the soil type and corresponding blow count targets appear on the Field Target Worksheet (or determined by the Geotechnical Engineering Division), the District may distribute the completed DCP Field Target worksheet (Figure 4) to the submitter.

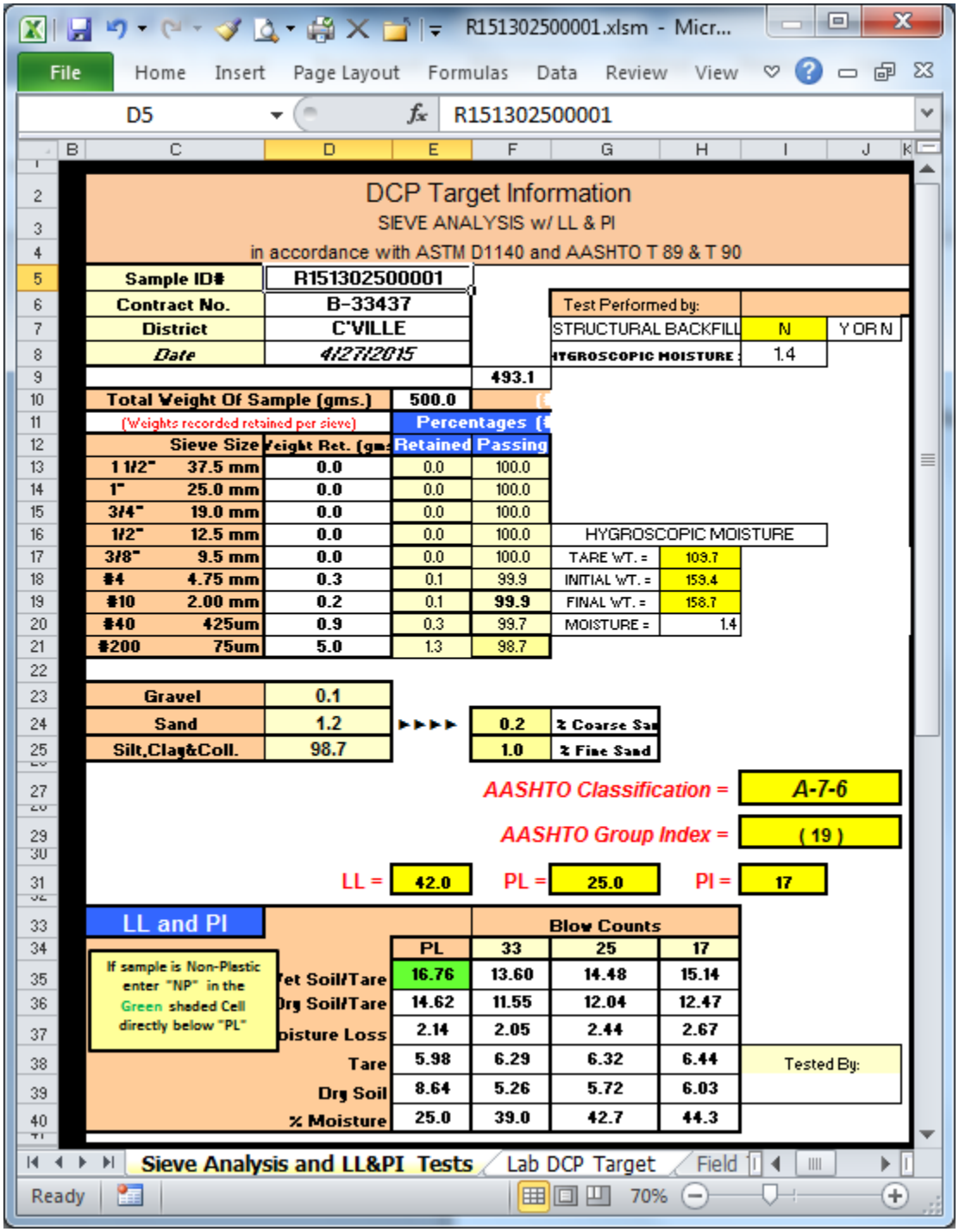


Figure 2. Excel Worksheet for Sieve Analysis, LL, and PL Tests

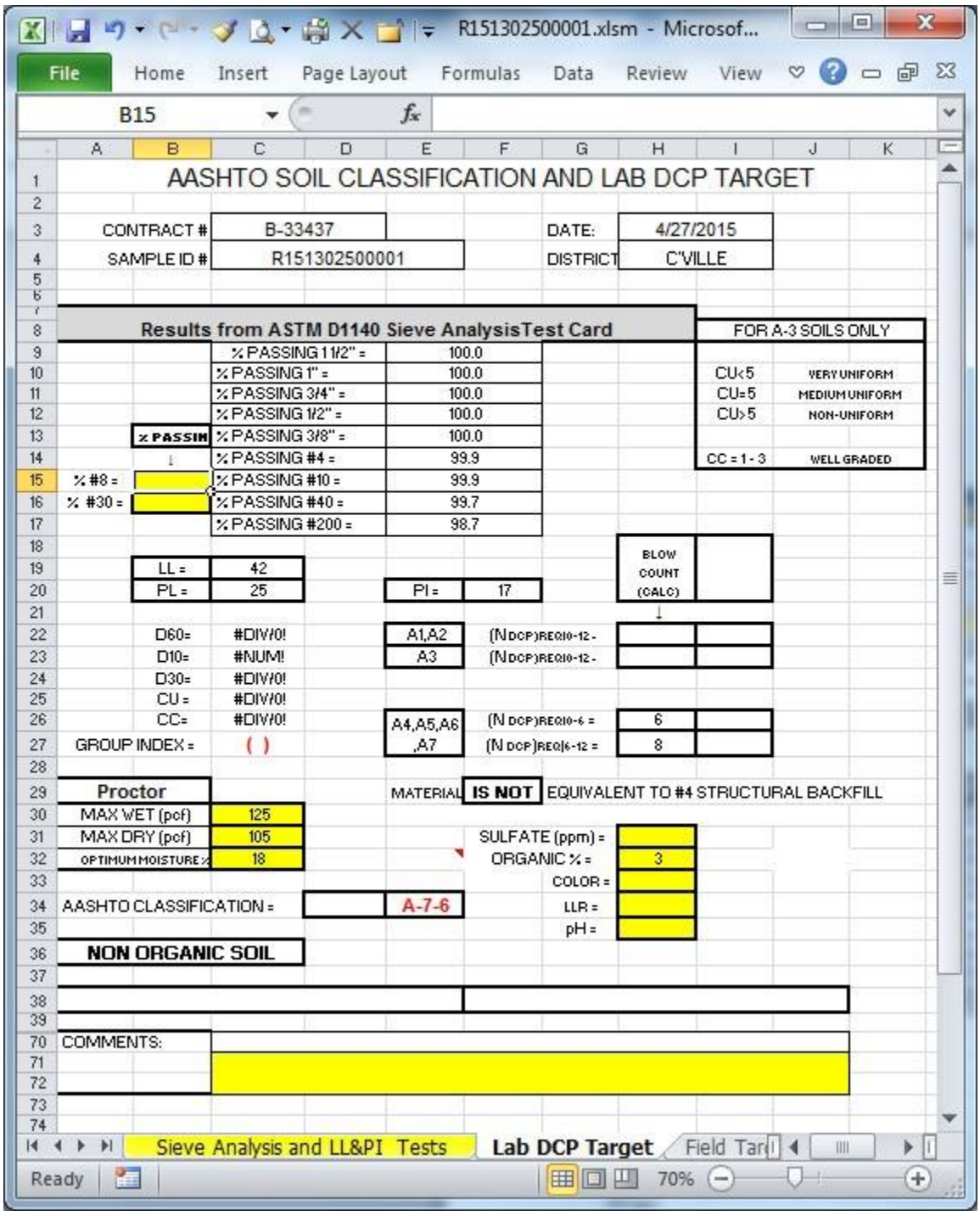


Figure 3. AASHTO Soil Classification and Lab DCP Target

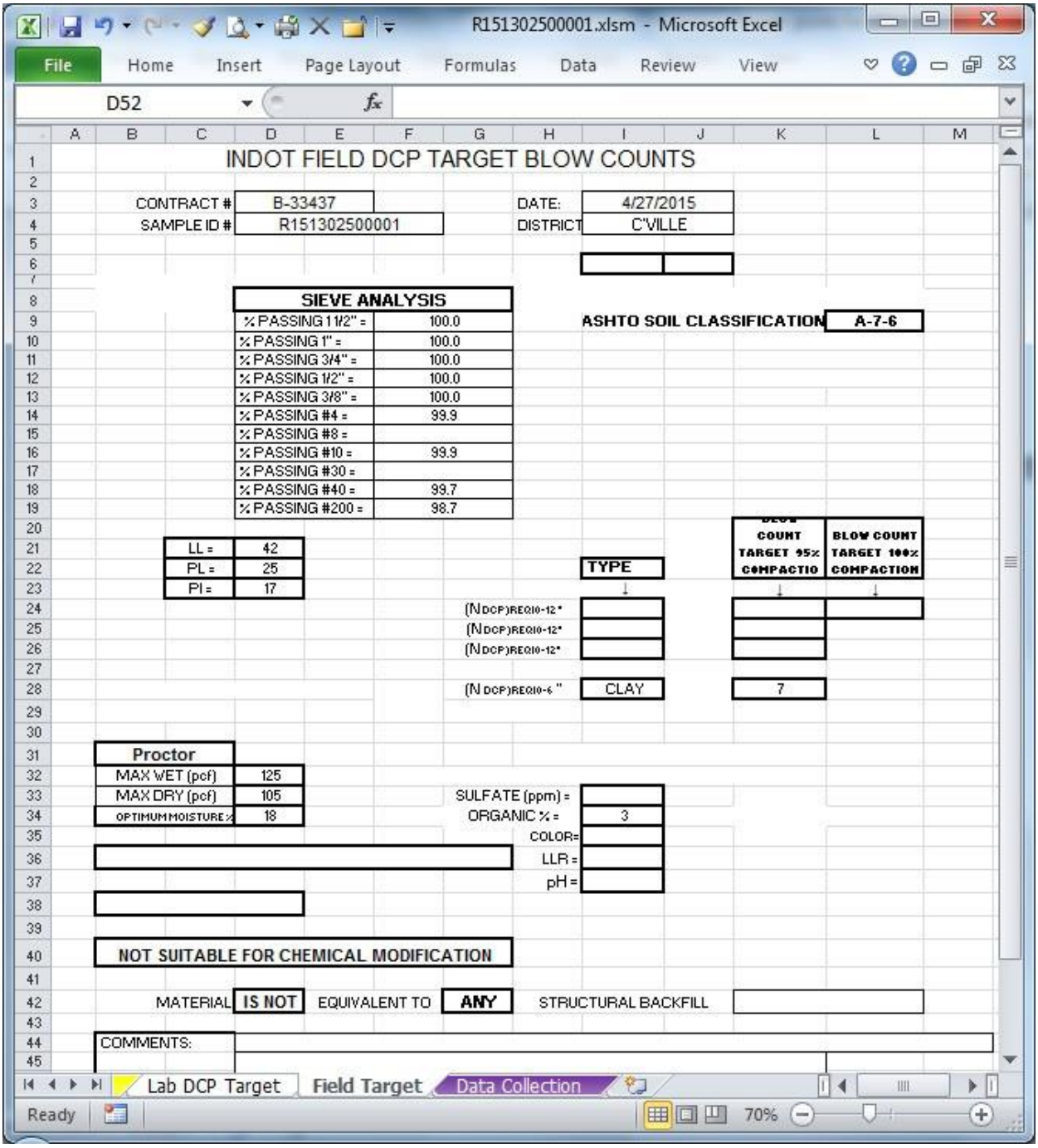


Figure 4. DCP Field Target

a) The District lab will transfer all data from the DCP Lab Data Collection worksheet to the District DCP Target Data Collection Excel spreadsheet on the S-Drive. Instructions imbedded in the spreadsheet comments box (Figure 5) should be followed.

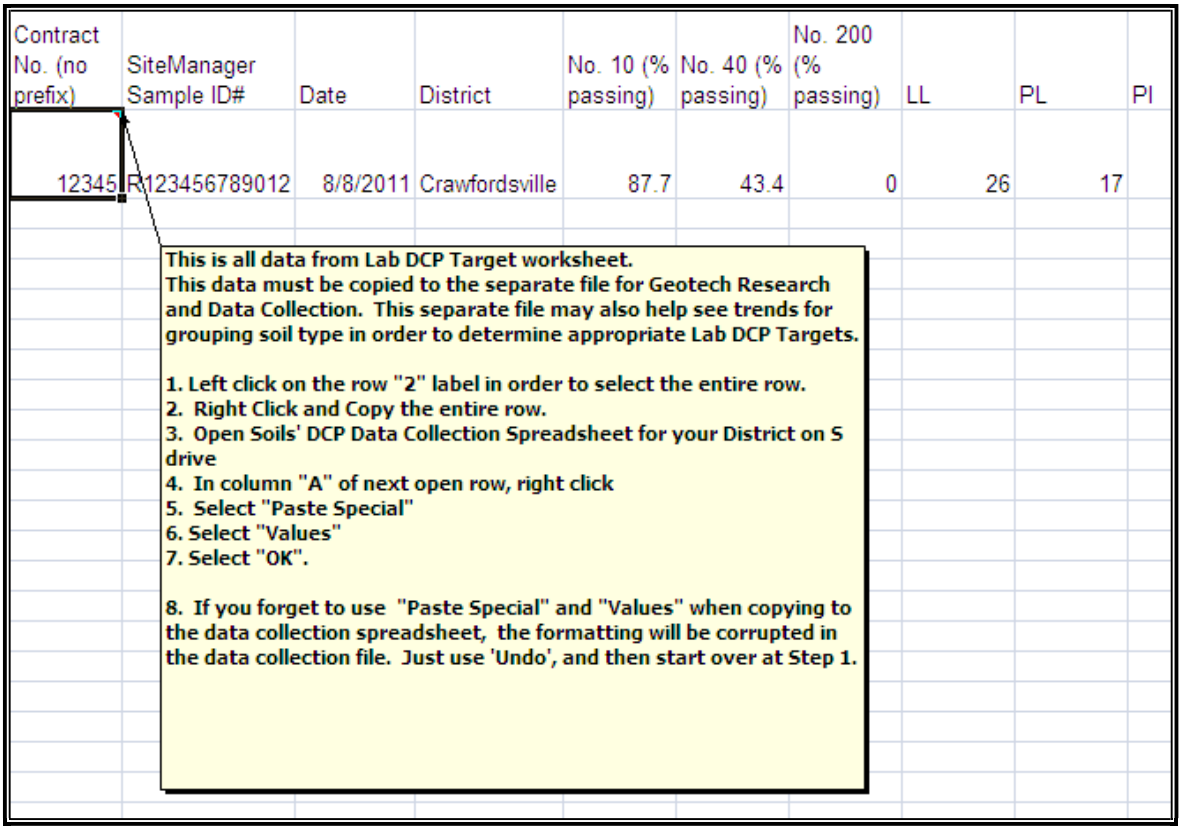
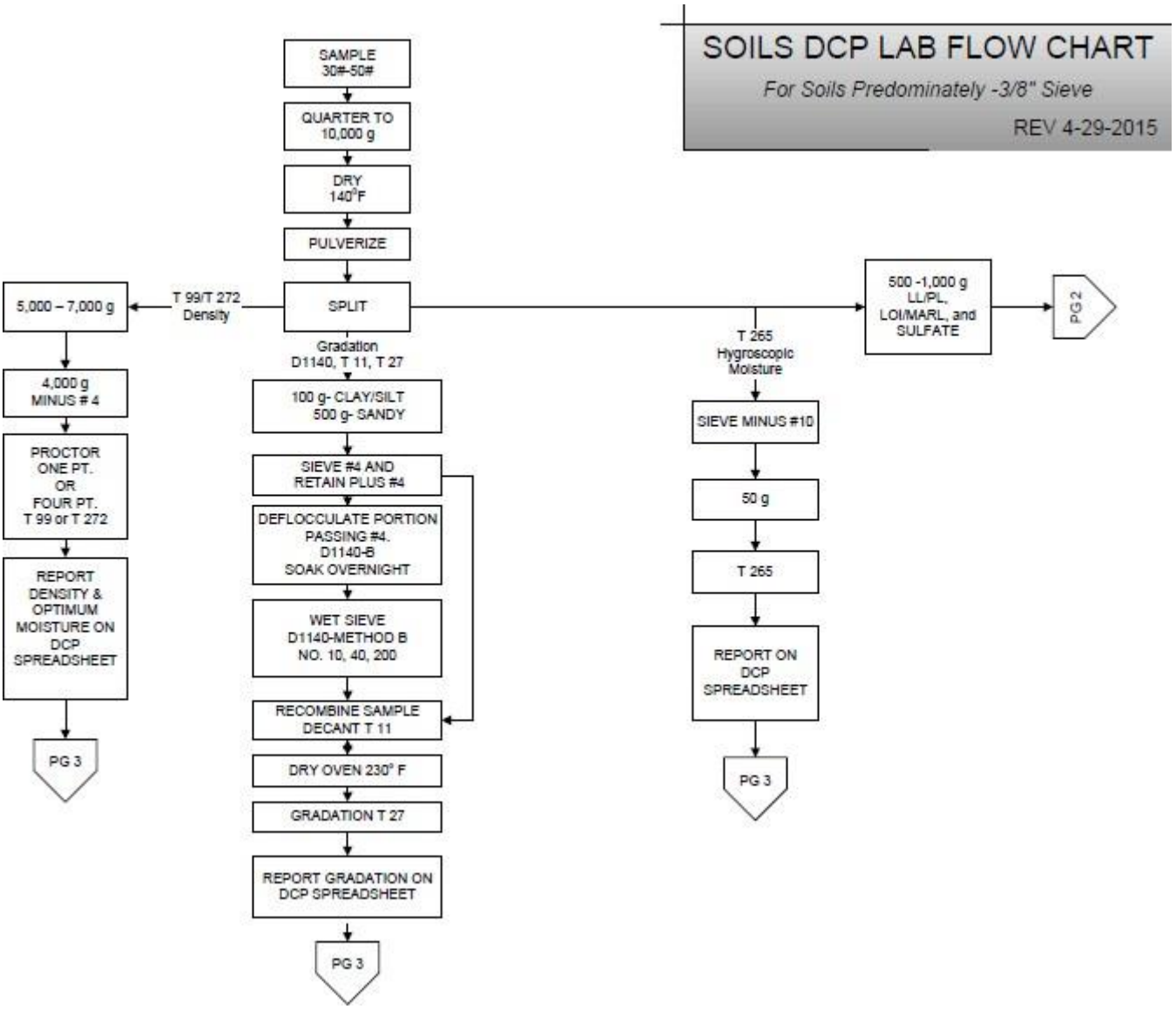
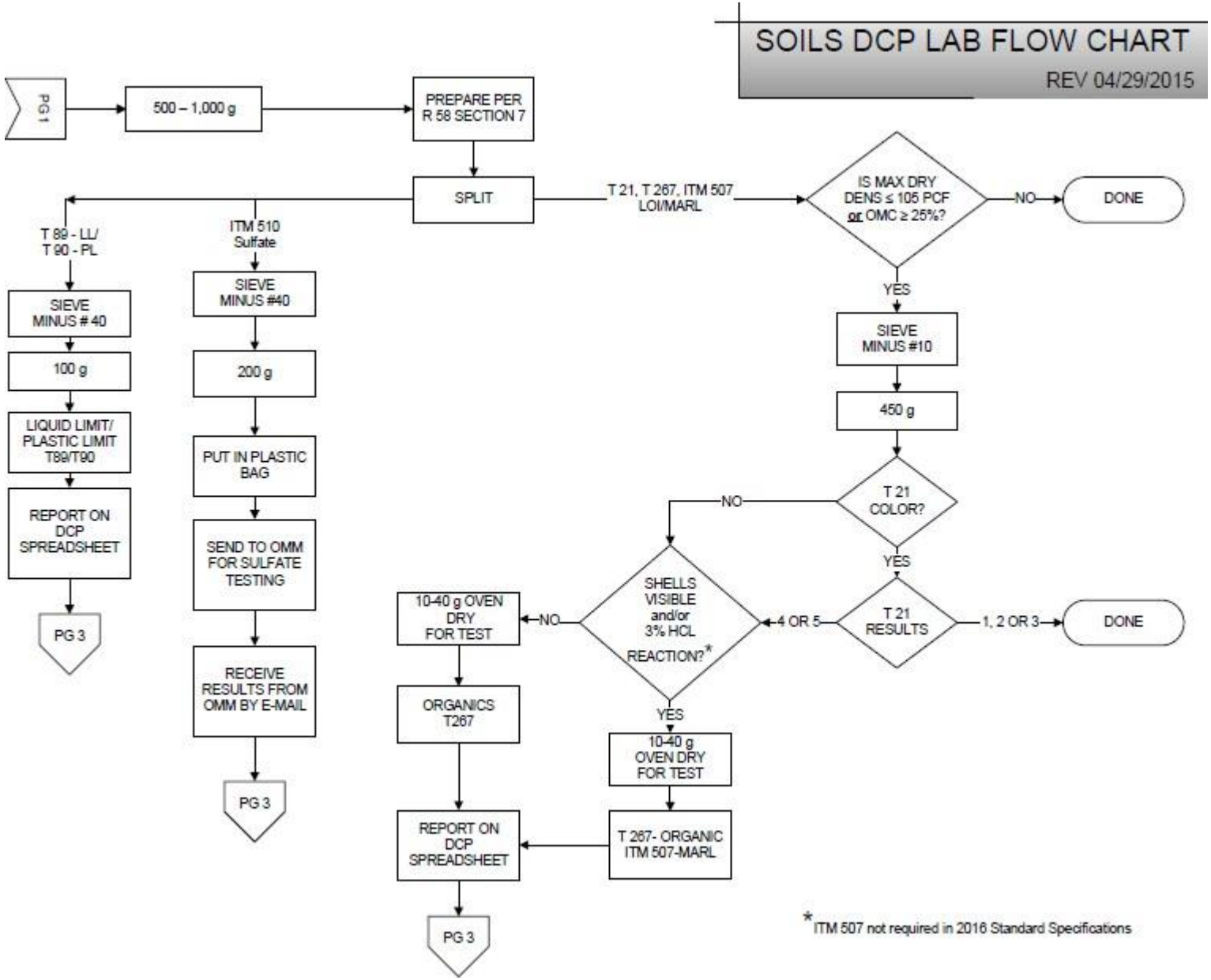


Figure 5. DCP Lab Data Collection Instructions


SOILS DCP LAB FLOW CHART
For Soils Predominately -3/8" Sieve
REV 4-29-2015
SAMPLE 30#-50#
QUARTER TO 10,000 g
DRY 140°F
PULVERIZE
SPLIT
5,000 – 7,000 g
T 99/T 272 Density
4,000 g MINUS # 4
PROCTOR ONE PT. OR FOUR PT. T 99 or T 272
REPORT DENSITY & OPTIMUM MOISTURE ON DCP SPREADSHEET
PG 3
Gradation D1140, T 11, T 27
100 g- CLAY/SILT 500 g- SANDY
SIEVE #4 AND RETAIN PLUS #4
DEFLOCCULATE PORTION PASSING #4. D1140-B SOAK OVERNIGHT
WET SIEVE D1140-METHOD B NO. 10, 40, 200
RECOMBINE SAMPLE DECANT T 11
DRY OVEN 230° F
GRADATION T 27
REPORT GRADATION ON DCP SPREADSHEET
PG 3
T 265 Hygroscopic Moisture
SIEVE MINUS #10
50 g
T 265
REPORT ON DCP SPREADSHEET
PG 3
500 -1,000 g LL/PL, LOI/MARL, and SULFATE
PG 2


SOILS DCP LAB FLOW CHART
REV 04/29/2015
PG 1
500 – 1,000 g
PREPARE PER R 58 SECTION 7
SPLIT
T 21, T 267, ITM 507 LOI/MARL
IS MAX DRY DENS ≤ 105 PCF or OMC ≥ 25%?
NO
DONE
YES
T 89 - LL/ T 90 - PL
SIEVE MINUS # 40
100 g
LIQUID LIMIT/ PLASTIC LIMIT T89/T90
REPORT ON DCP SPREADSHEET
PG 3
ITM 510 Sulfate
SIEVE MINUS #40
200 g
PUT IN PLASTIC BAG
SEND TO OMM FOR SULFATE TESTING
RECEIVE RESULTS FROM OMM BY E-MAIL
PG 3
SIEVE MINUS #10
450 g
T 21 COLOR?
NO
YES
T 21 RESULTS
1, 2 OR 3
DONE
4 OR 5
SHELLS VISIBLE and/or 3% HCL REACTION?*
NO
YES
10-40 g OVEN DRY FOR TEST
ORGANICS T267
REPORT ON DCP SPREADSHEET
PG 3
10-40 g OVEN DRY FOR TEST
T 267- ORGANIC ITM 507-MARL
* ITM 507 not required in 2016 Standard Specifications

DCP REPORTING FLOW CHART

REV 4/30/2015