

# **Establishment of a Geotechnical Information Database**

By

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**FINAL REPORT FOR PROJECT:**

**ESTABLISHMENT OF A  
GEOTECHNICAL INFORMATION DATABASE**

**Problem Statement / Need for Research**

The Delaware Department of Transportation (DelDOT) currently has numerous subsurface investigation test results for foundation studies located throughout the State of Delaware. Currently, this information is located on paper, tape, and disks. This data needs to be converted into a standard format that can be easily accessed with current technology and easily converted to future storage technology.

**Objectives**

The primary objective for this project was to assess existing geotechnical information database technology for possible utilization by the DOT, and, if deemed necessary, to create a customized geotechnical information database that could be implemented by the DOT for future data management. A secondary objective of the project was to perform data entry into the database using undergraduate students for the data entry process, under the guidance of the project PI.

**Research Results**

Assessment of existing database technology indicated that there was significant benefit to moving towards a database platform that supported integration with Geographic Information

System (GIS) technology. A GIS-based data management platform would allow for superior visualization and three-dimensional data management, which could offer significant potential benefit to DOT engineers and project managers.

After detailed discussion with the DOT Project Manager for this project during the course of this study, it was concluded that the cost of a GIS-integrated data management system was prohibitive at this time. Additionally, using existing geotechnical data management infrastructure at the DOT (a GEOSYSTEM® software platform) had some significant benefits, most notably that a large amount of data was already in this format for existing projects, and that additional training and experience would be required for DOT employees to learn and become comfortable with a new data management platform.

Consequently, as a result of work conducted in conjunction with DelDOT engineers and the Project Manager for this project, the GEOSYSTEM® software platform was selected for management of DelDOT's existing geotechnical data, and continued data entry at the University of Delaware. Three undergraduate students at the University of Delaware were trained in the use of this database: Chris Brendza, Tom Miner, and Mindy Laybourne. Additional graduate students were also involved in management and oversight of various aspects of the project.

The undergraduate students involved with this project together developed a "Quick User's Guide" that could be used to train future students and entry-level DelDOT employees in the use of the GEOSYSTEM® software platform (this guide is attached as Appendix A).

For the second phase of this project, the undergraduate students that were involved with the project obtained historical geotechnical data from the DOT, and carefully incorporated this data into the GEOSYSTEM® database, creating new database records for historical DelDOT boring log data and soil laboratory test data. New data records were created for 97 boring logs,

from 2 different projects: Rt. 113 Frederica, Contract: 24-122-03 (Appendix B, 32 records) and the SR 1 / SR 9 Interchange, Contract: 24-122-04 (Appendix C, 65 records). Appendices B and C contain the boring log data that was entered for each of these projects, which was exported in report format from the GEOSYSTEM® database.

For brevity, additional soil laboratory test data such as grain size analysis results, Atterberg limit test results, etc. is not included in these Appendices; however, this data is available in the GEOSYSTEM® database files that will be transmitted to DelDOT with this report. The soil laboratory data entry process was also quite extensive for the undergraduate students involved with this project, as numerous laboratory tests were performed in conjunction with the borings that were provided by the DOT (unfortunately, this significant effort cannot be easily reflected in this report, although it can be seen via a careful review of the database records).

Due to the potentially sensitive nature of the data that is included in this database, the data that is included in Appendices B and C will be omitted from all versions of this report that will be posted on the DCT website and available in the DCT office. This data will be made directly available only to the sponsor of this research project, the Delaware Department of Transportation. The omitted pages for Appendices B and C comprise 38 pages and 86 pages, respectively.

# **APPENDIX A**

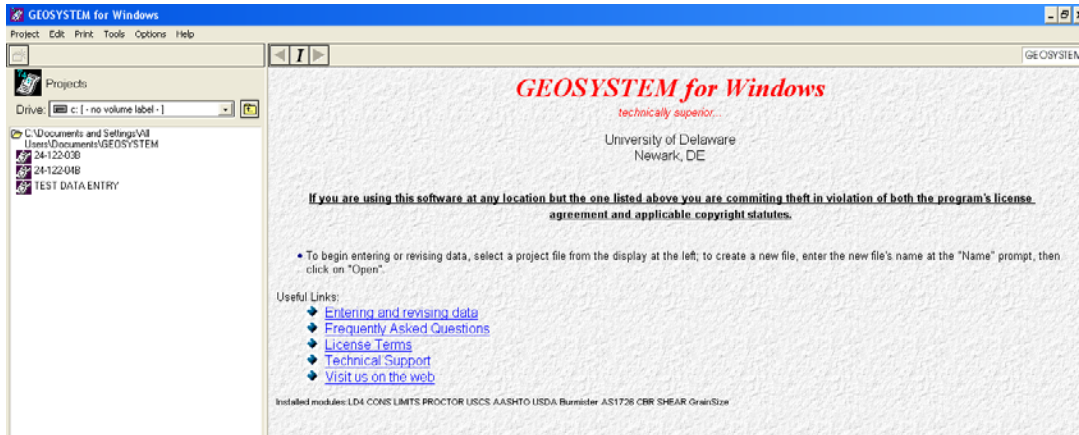
**“Quick” User’s Guide to GEOSYSTEM® for Windows**

**Written By Undergraduate Students**

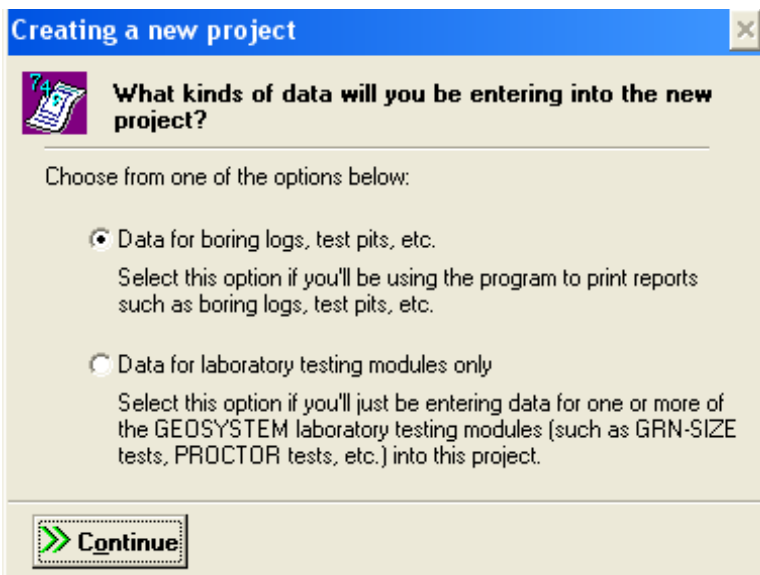
**For Undergraduate Students**

# “Quick” User’s Guide to GEOSYSTEM® for Windows

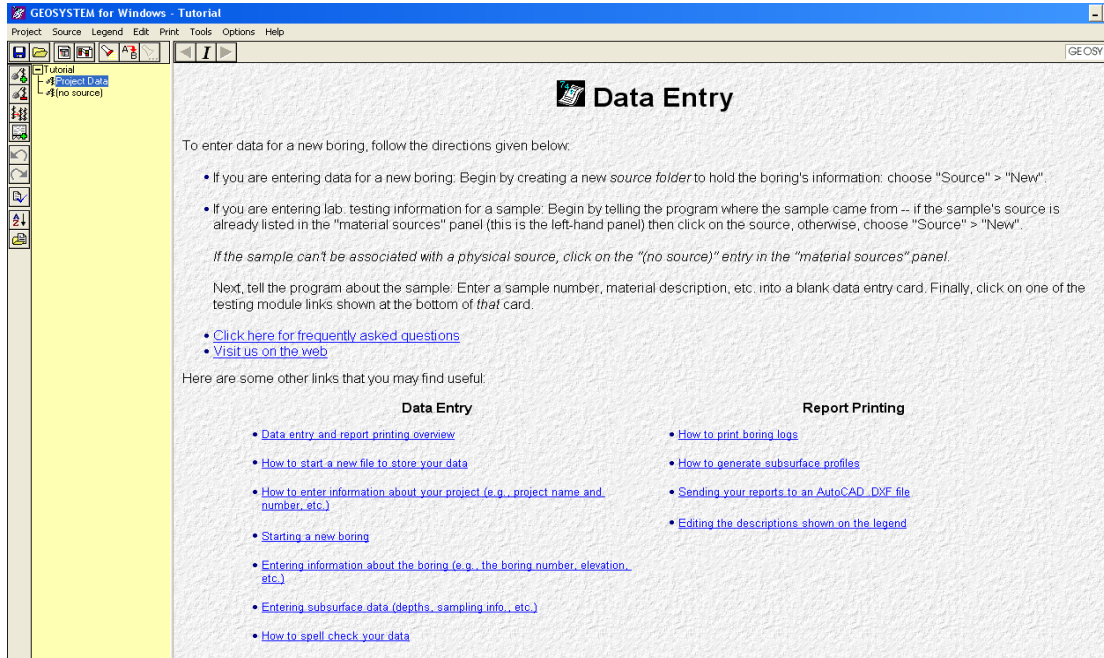
When opening GEOSYSTEM, user will be presented with the screen below providing you with a myriad of options. To open a new or existing project, use the PROJECT tab in the upper left hand corner. The previously saved files will appear on the left providing a shortcut to each individual file. In the middle of the page are several links to provide assistance for this program.



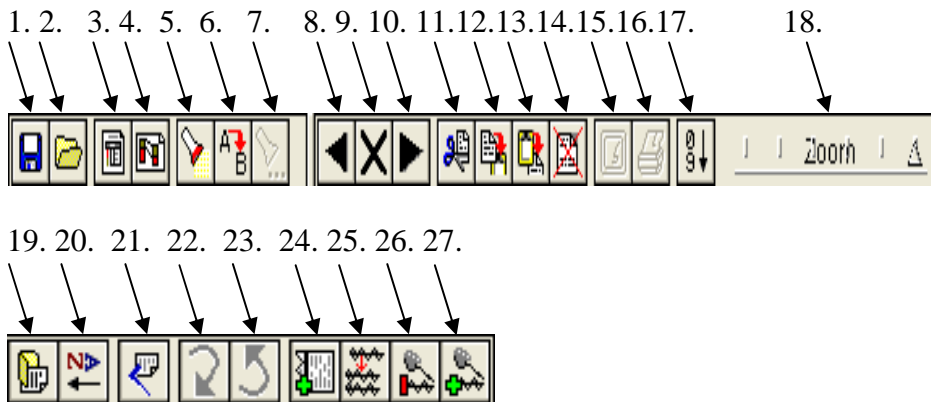
Once the user has named and created a new project, the following screen will be prompted. For most projects, including Establishment of a Geotechnical Information Database, the first option will be used. This will then present the Main Data Entry screen. The second option will also provide the user with a Data Entry screen, but will be more limited in the type of data that can be entered.



The Data Entry screen provides useful information to assist the user in this section of the program. To continue entering boring logs and other data, click Project Data.



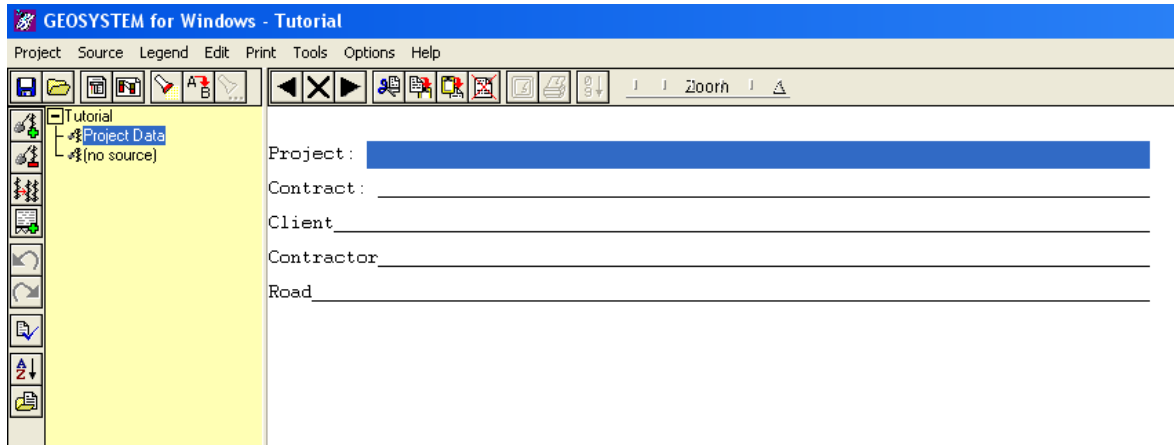
The images below are two pictures of the different options on the top of the toolbar. Included are descriptions as to the function of these buttons.



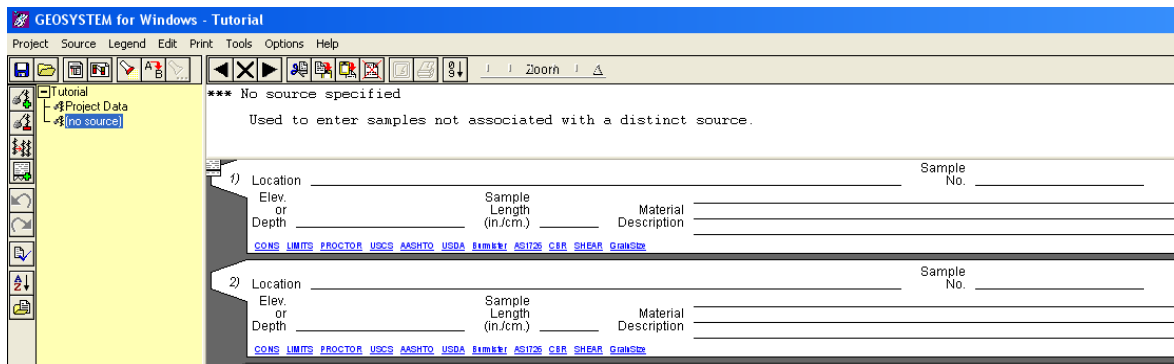
- |  |                         |                     |
|--|-------------------------|---------------------|
| 1. Save  | 2. Open Project         | 3. Print Reports    |
| 4. Print Subsurface Profile  | 5. Find Text            | 6. Replace Text     |
| 7. Find / Replace Again  | 8. Previous Source      | 9. Close Source     |
| 10. Next Source  | 11. Cut                 | 12. Copy            |
| 13. Paste  | 14. Delete              | 15. Previous Report |
| 16. Print Report   | 17. Sort by Depth       | 18. Zoom            |
| 19. Add A New Document from Another Program                        | 20. Sort on Source Name |                     |
| 21. Spell Check  | 22. Redo                | 23. Undo            |
| 24. Create a New Source and Duplicate an Existing Source's Heading | 26. Delete Source       | 27. New Source      |
| 25. Duplicate Source   |                         |                     |



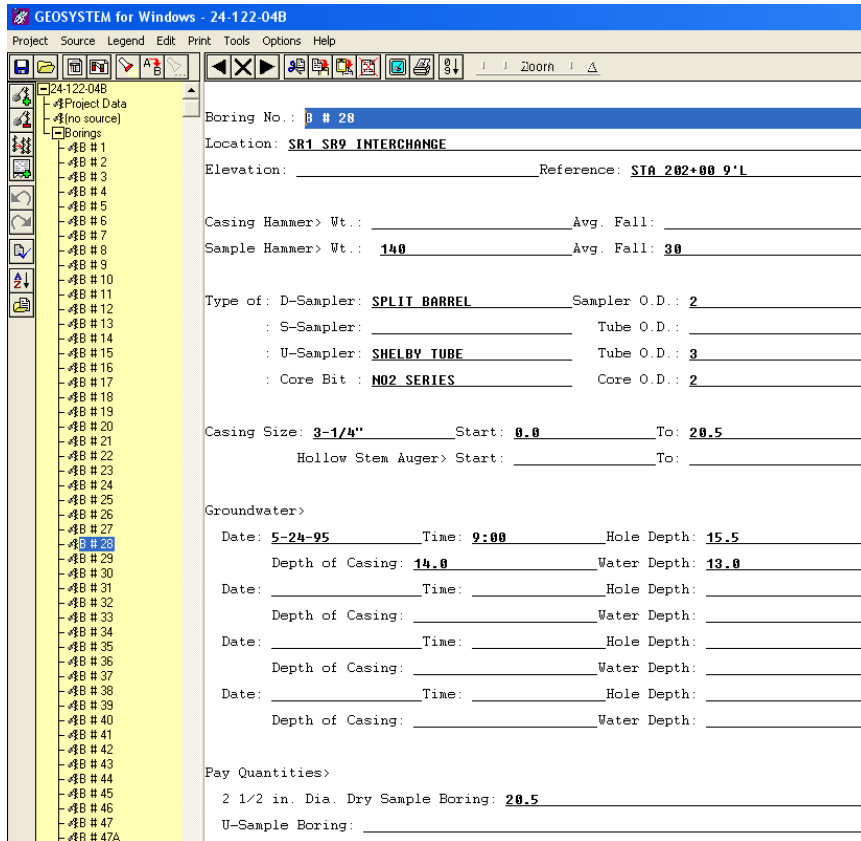
For Project Data, the following screen will be shown. Correct information is to be entered in order that the correct boring logs remain with their site information. Once the correct data is entered, click on (no source) on the left hand side to start entering the data collected from the boring logs. If needed, there are tabs in the bottom left hand corner where the user can switch between the data entry screen, the project data, and the no source screen. This provides ease for the user.



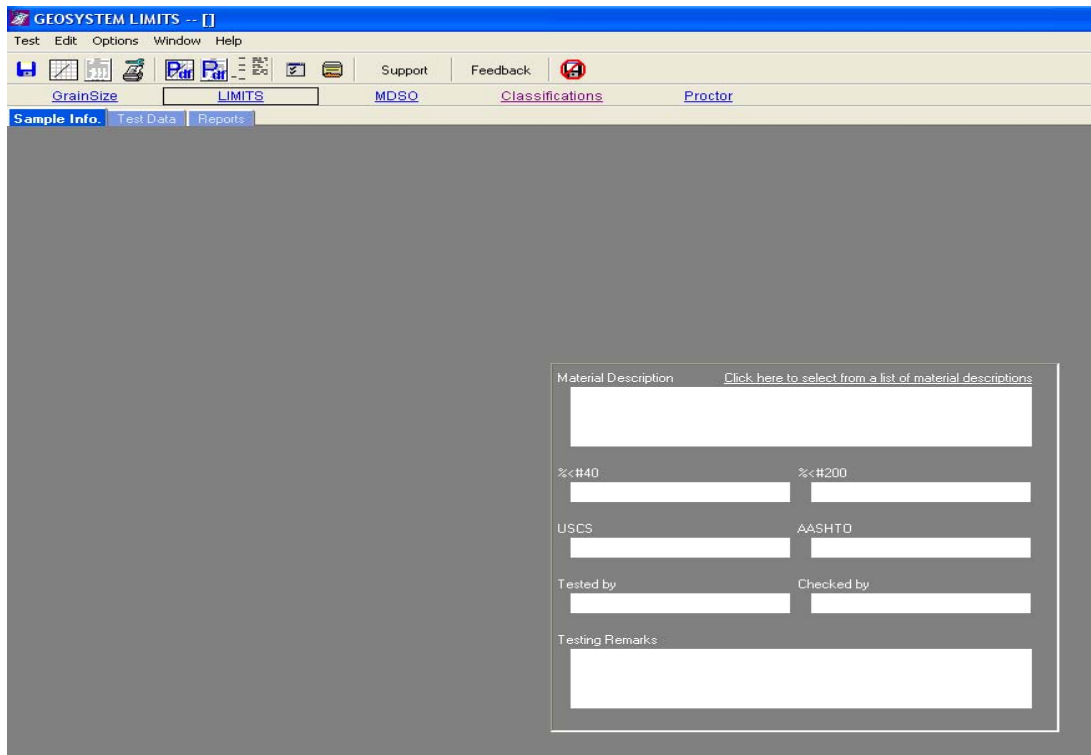
At the page below, more data is to be entered about the boring logs. There are many different boxes to add each sample data separate. Once the primary information is added, there are several different options highlighted in blue underneath the data. To the left of the first sample is an option to minimize or maximize certain data.



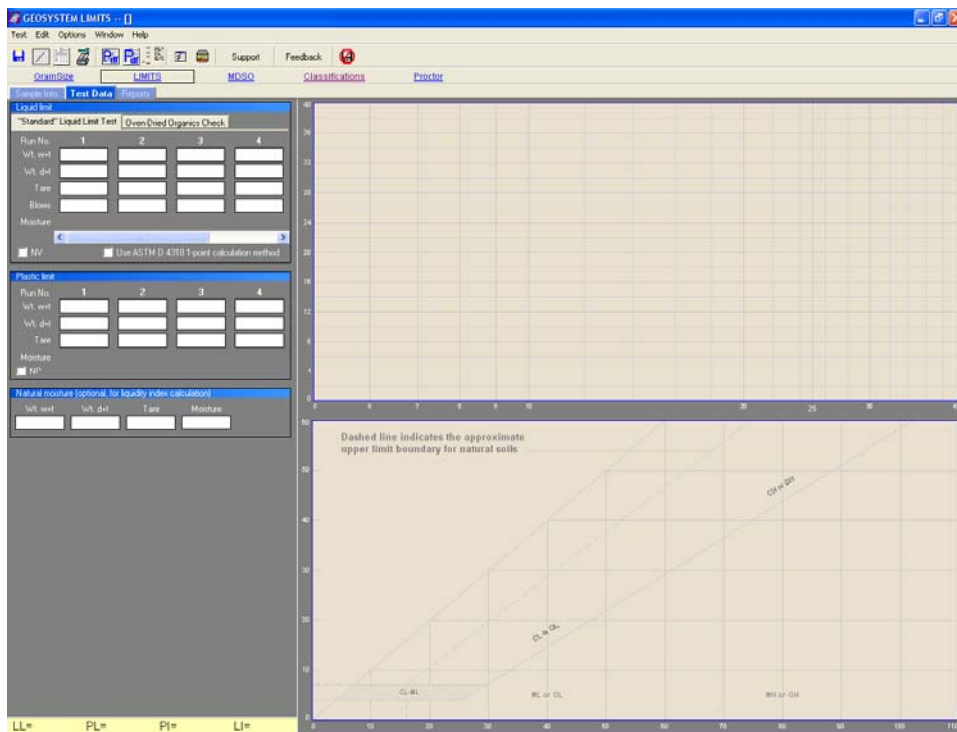
Below is a picture of the “header” for the boring log. Information included is as follows: location, boring number, type of sample, weight of hammer, etc.. Some of the information shown below will remain constant for most data unless otherwise specified. The sample hammer weight, avg. fall, D-sampler, sampler O.D., U-sampler, tube O.D., core bit, casing size, and the core O.D. all remain constant.



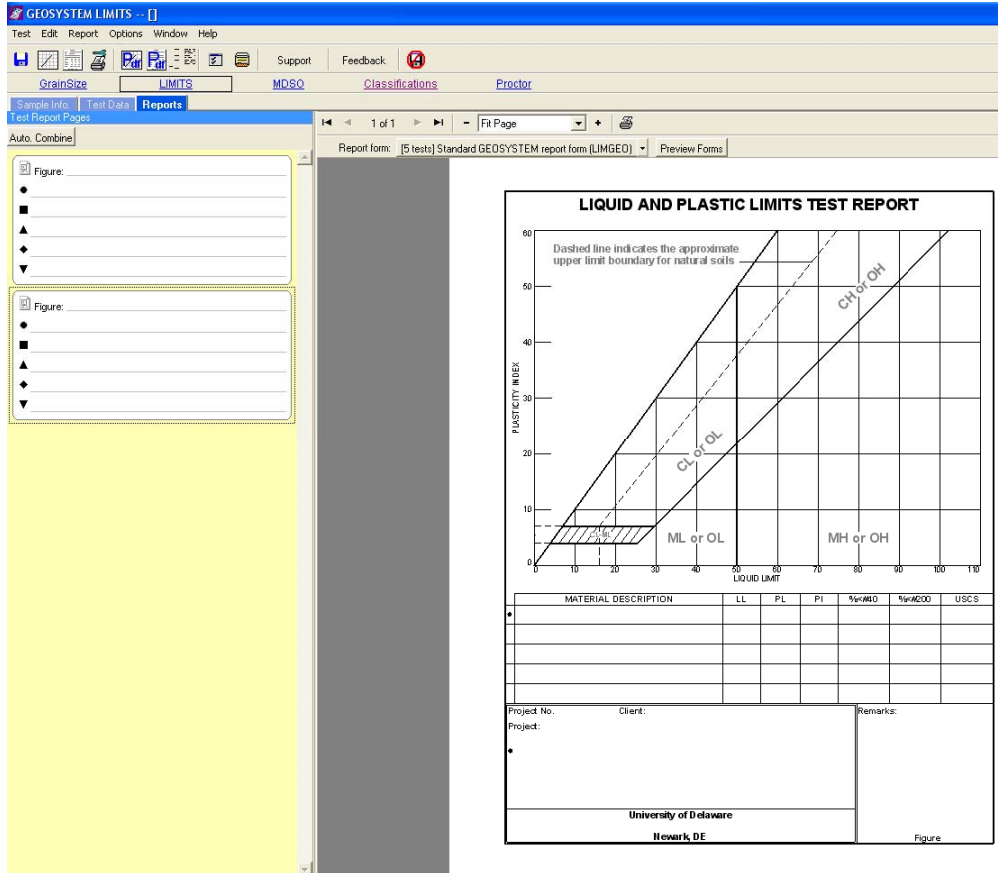
If the blue highlighted “limits” option is clicked, the following screen will appear. There are three different tabs under the limits options. They are as follows: Sample Info, Test Data, and Reports. The picture below is displaying the Sample Info tab. The information needed here is general information about the description of the sample and specifics concerning the tester. As well as the three tabs under the main limits section, there are four more sections that can be accessed at this time. They are Grain Size, MDSO, Classifications, and Proctor. All five sections are data entry, but all five sections will not necessarily contain data for each sample.



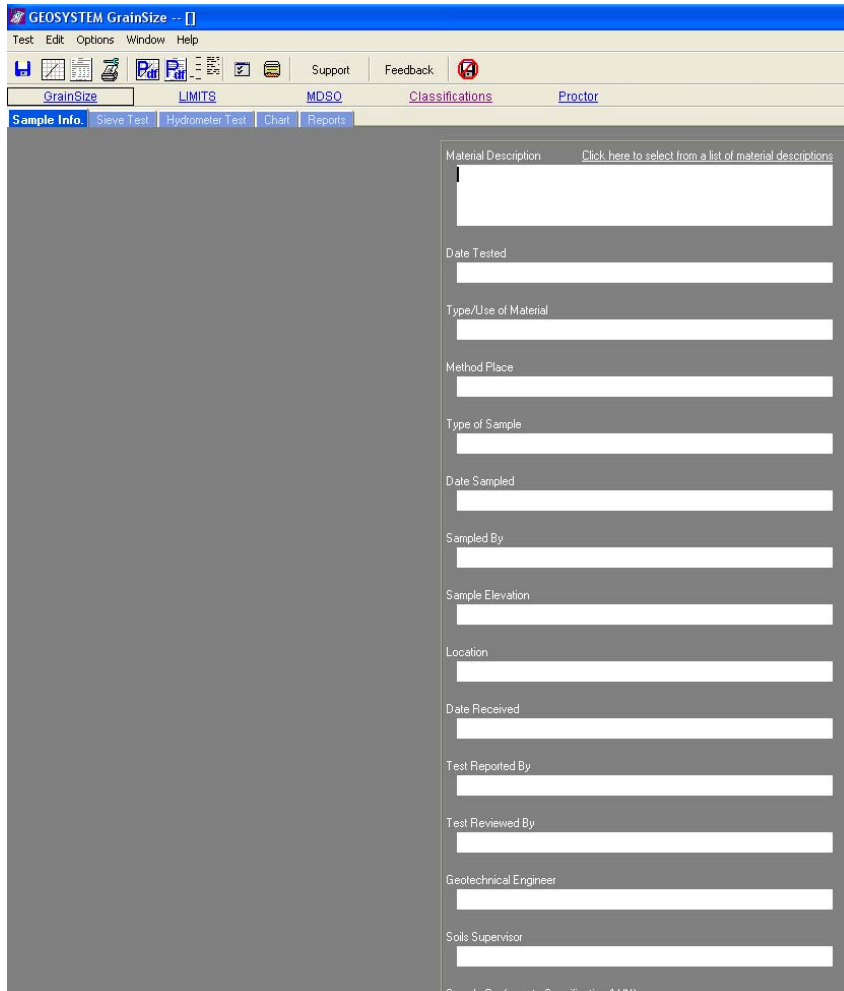
The Test Data tab contains more vital information from the testing of the sample. Here the information, such as the wet and dry weight of the sample, will be entered from the data on the actual boring log that was computed for each certain sample. A graph will be calculated based on the different limits for the data provided.



The Reports section will provide the user with a chart of the liquid and plastic limits that were calculated from the specific data. At the bottom of the report, there will be important data that will be useful when reading the test report. The data will include the description of the soil, the actual liquid and plastic limits, as well as the sample and project number. The sample number allows the user to understand from which location the boring was taken and identify other data pertinent to the sample.

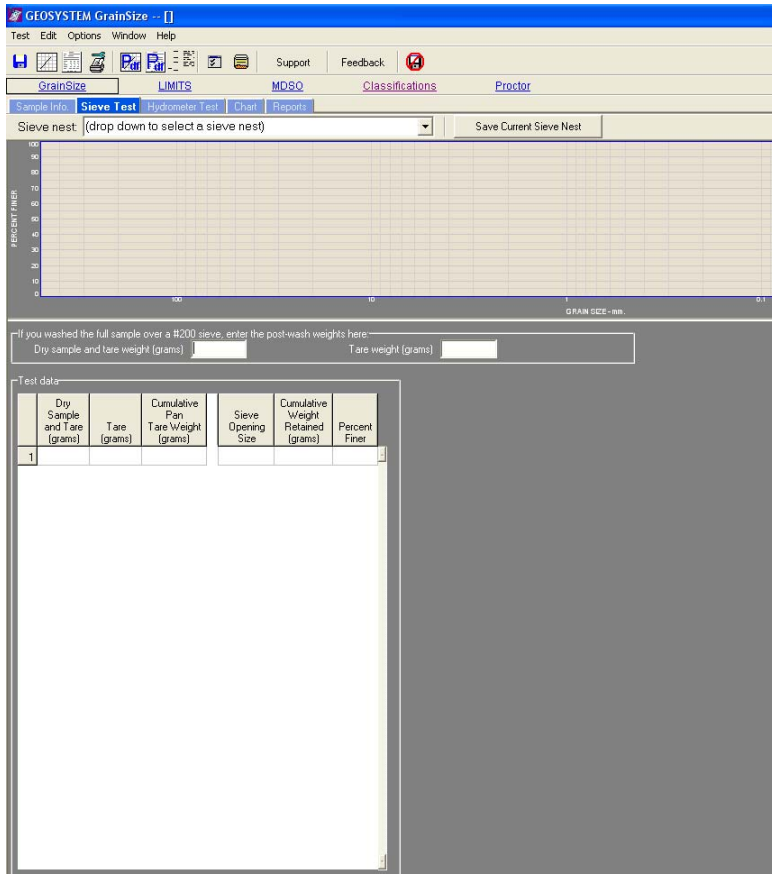


When the Grain Size tab is clicked on, the following screen will appear. More general information is needed here. This information will not actually be used to calculate any results or charts but it will give insight into how to classify and collect standards for the data. The Material Description and the Location information will appear since it was previously entered into the system. The five tabs for this section are Sample Info, Sieve Test, Hydrometer Test, Chart, and Reports.

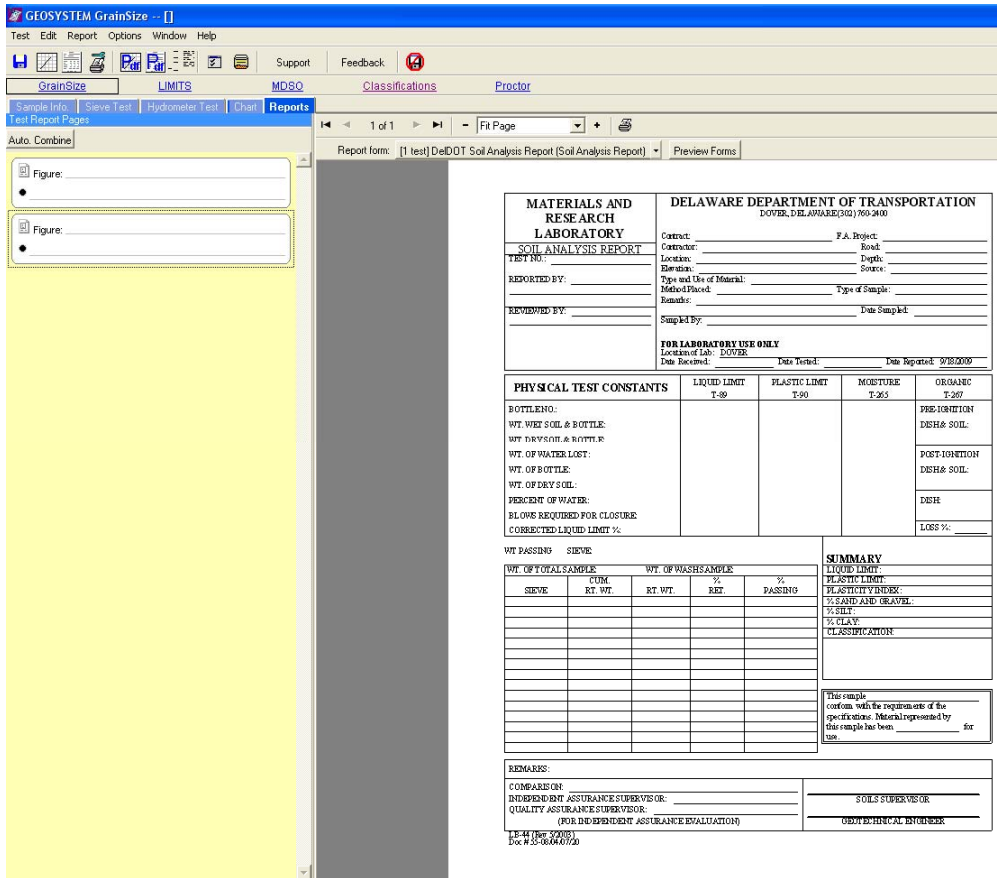


On the Sieve Test tab, the information collected is added in the columns on the left. A chart, or graph, will appear on the right to allow the data to be more visual to the user. The graph will allow the user to examine the curve and notice any outliers in the sample.

Standard sieve opening sizes are as follows: 1/2", 3/8", #4, #10, #40, and #200. Unless otherwise mentioned, these sizes should be the inputs for this section.



The final picture is shown for the Reports tab of the Grain Size main option. The Reports tab allows the user to access most of the information all at one time and create conclusions concerning the sample.



The following series of pictures are a print screen file that was a sample of data created in order to provide an example of what the different tab options are and what the graphs and charts will look like when there is data entered.

GEOSYSTEM for Windows - 24-122-03B

Project Source Legend Edit Print Tools Options Help

24-122-03B  
Project Data  
(no source)

Boring No.: **B # 1**  
Location: **N. FREDERICA**

1)	Depth (ft. or m.)	Sample number	Sample length (in. or cm.)	Sample recovery (in. or cm.)	Blow count #1	Blow count #2	Blow count #3	Blow count #4	AASHTO classification	Daily progress	
	4.0	1	18	15	2	3	4		A-4(0)	6-16	
	Graphic log patterns		Material description		General remarks or notes						
			SAT. FIRM BROWNISH GRAY SILT W/SOME F SAND, TRACE OF C SAND		H20 @ 5.0'						
CONS LIMITS PROCTOR USCS AASHTO USDA Humidity ASD26 CBR SHEAR GrainSize											
2)	Depth (ft. or m.)	Sample number	Sample length (in. or cm.)	Sample recovery (in. or cm.)	Blow count #1	Blow count #2	Blow count #3	Blow count #4	AASHTO classification	Daily progress	
	9.0	2	18	14	1	2	12	4	A-4(0)	6-16	
	Graphic log patterns		Material description		General remarks or notes						
			SAT. SOFT GRAY F SANDY SILT W/SOME CLAY, TRACE OF C SAND AND GRAVEL (10" SAMPLE) NO SIEVE ANALYSIS								
CONS LIMITS PROCTOR USCS AASHTO USDA Humidity ASD26 CBR SHEAR GrainSize											
3)	Depth (ft. or m.)	Sample number	Sample length (in. or cm.)	Sample recovery (in. or cm.)	Blow count #1	Blow count #2	Blow count #3	Blow count #4	AASHTO classification	Daily progress	
	14.0	3	18	18	3	3	2	4	A-2-4(0)	6-16	
	Graphic log patterns		Material description		General remarks or notes						
			SAT. LOOSE BROWN F TO C SAND W/SOME SILT, TRACE OF GRAVEL								
CONS LIMITS PROCTOR USCS AASHTO USDA Humidity ASD26 CBR SHEAR GrainSize											
4)	Depth (ft. or m.)	Sample number	Sample length (in. or cm.)	Sample recovery (in. or cm.)	Blow count #1	Blow count #2	Blow count #3	Blow count #4	AASHTO classification	Daily progress	
	19.0	4	18	18	2	2	2	4	A-2-4(0)	6-16	
	Graphic log patterns		Material description		General remarks or notes						
			SAT. VERY LOOSE BROWNISH GRAY SILT F SAND W/ TRACE OF C SAND								
CONS LIMITS PROCTOR USCS AASHTO USDA Humidity ASD26 CBR SHEAR GrainSize											
5)	Depth (ft. or m.)	Sample number	Sample length (in. or cm.)	Sample recovery (in. or cm.)	Blow count #1	Blow count #2	Blow count #3	Blow count #4	AASHTO classification	Daily progress	
	24.0	5	18	18	3	7	8	4	A-2-4(0)	6-16	
	Graphic log patterns		Material description		General remarks or notes						
			SAT. M. DENSE GRAY F SAND W/SOME SILT, TRACE OF C SAND AND ORGANIC MATTER								
CONS LIMITS PROCTOR USCS AASHTO USDA Humidity ASD26 CBR SHEAR GrainSize											
6)	Depth (ft. or m.)	Sample number	Sample length (in. or cm.)	Sample recovery (in. or cm.)	Blow count #1	Blow count #2	Blow count #3	Blow count #4	AASHTO classification	Daily progress	
	29.0	6	24	16	1	2	4	4	A-2-4(0)	6-16	
	Graphic log patterns		Material description		General remarks or notes						
			SAT. LOOSE GRAY SILT F SAND W/SOME C SAND, TRACE OF GRAVEL AND ORGANIC MATTER								
CONS LIMITS PROCTOR USCS AASHTO USDA Humidity ASD26 CBR SHEAR GrainSize											
7)	Depth (ft. or m.)	Sample number	Sample length (in. or cm.)	Sample recovery (in. or cm.)	Blow count #1	Blow count #2	Blow count #3	Blow count #4	AASHTO classification	Daily progress	
	34.0	7	18	14	4	5	11	4	A-3	6-16	
	Graphic log patterns		Material description		General remarks or notes						
			SAT. M. DENSE GRAY F SAND W/SOME C SAND, TRACE OF SILT, GRAVEL AND ORGANIC MATTER								
CONS LIMITS PROCTOR USCS AASHTO USDA Humidity ASD26 CBR SHEAR GrainSize											

GEOSYSTEM GrainSize - [B # 1, 1 (4.0)]

Test Edit Options Window Help

Support Feedback

GrainSize LIMITS MDSO Classifications Proctor

Sample Info. Sieve Test Hydrometer Test Chart Reports

Material Description [Click here to select from a list of material descriptions](#)  
**SAT. FIRM BROWNISH GRAY SILT W/SOME F SAND, TRACE OF C SAND**

Date Tested

Type/Use of Material

Method Place

Type of Sample

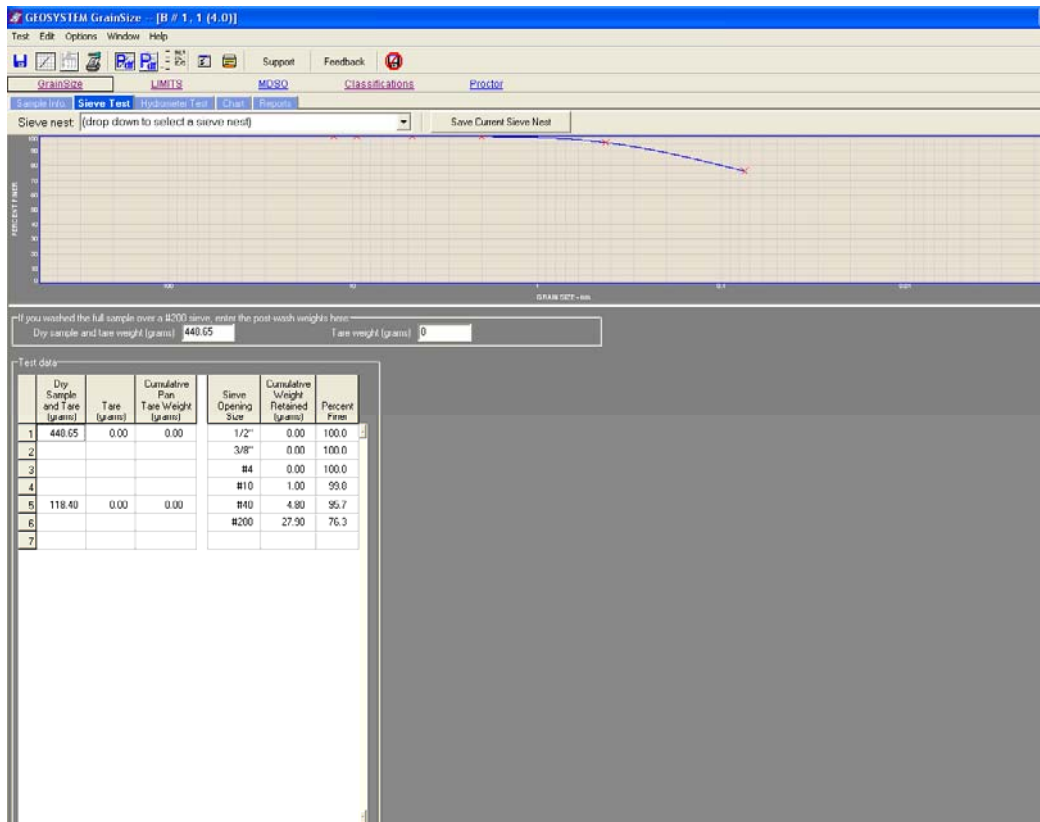
Date Sampled

Sampled By

Sample Elevation

Location





GEOSYSTEM GrainSize -- [B # 1, 1 (4.0)]

Test Edit Options Window Help

GrainSize LIMITS MDSO Classifications Proctor

Sample Info Sieve Test Hydrometer Test Chart Reports

Hydrometer sample:

Separation sieve: #10

Percent of original sample finer than the separation sieve: 99.8

Sample weight (grams):

Specific gravity:

Hygroscopic moisture:

If a hygroscopic moisture test was performed, enter the test weights below. Otherwise, leave the following fields blank.

Wet weight (gms.): Dry weight (gms.):

Container ID: Tare weight (gms.):

Hygroscopic moisture:

Corrections:

Single-point (automatic) temperature correction  
 Multi-point (linear regression) temperature correction

Hydrometer correction at 20° C: Temp. C: Hydrometer correction:

Mericus correction: *Enter 151H readings for temperature and mericus corrections as the number of thousands, e.g., 6 instead of 1,006*

Hydrometer:

151H  152H

Effective depth equation:  $L = 16.294964 - 0.164 \times R_m$

Hydrometer test readings:

	Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
1									

**GEOSYSTEM GrainSize -- [B # 1, 1 (4.0)]**

Test Edit Report Options Window Help

GrainSize LIMITS MDSO Classifications Proctor

Sample Info Sieve Test Hydrometer Test Chart Reports

Test Report Pages

Auto. Combine

Report form: [1 test] DelDOT Soil Analysis Report (Soil Analysis Report) Preview Forms

1 of 1 Page

Figure:

● B # 1, 1 (4.0)

Figure:

● B # 1, 2 (9.0)

Figure:

● B # 1, 3 (14.0)

Figure:

● B # 1, 4 (19.0)

Figure:

● B # 1, 5 (24.0)

Figure:

● B # 1, 6 (29.0)

Figure:

● B # 1, 7 (34.0)

Figure:

● B # 1, 8 (39.0)

Figure:

● B # 1, 9 (44.0)

Figure:

● B # 1, 10 (49.0)

Figure:

● B # 1, 11 (54.0)

Figure:

● B # 1, 12 (59.0)

Figure:

● B # 1, 13 (64.0)

**MATERIALS AND RESEARCH LABORATORY**

**SOIL ANALYSIS REPORT**

TEST NO.: 1

REPORTED BY: \_\_\_\_\_

REVIEWED BY: \_\_\_\_\_

**DELAWARE DEPARTMENT OF TRANSPORTATION**  
DOVER, DELAWARE (302) 860-2400

Contract: \_\_\_\_\_ F.A. Project: \_\_\_\_\_

Contractor: \_\_\_\_\_ Road: \_\_\_\_\_

Location: \_\_\_\_\_ Depth: 4.0

Station: \_\_\_\_\_ Source: B # 1

Type and Use of Material: \_\_\_\_\_ Type of Sample: \_\_\_\_\_

Method/Place: \_\_\_\_\_

Sample: \_\_\_\_\_ Date Sampled: \_\_\_\_\_

Sampled By: \_\_\_\_\_

**FOR LABORATORY USE ONLY**

Location Lab: DOVER Date Received: \_\_\_\_\_ Date Reported: 9/28/2009

PHYSICAL TEST CONSTANTS	LIQUID LIMIT		PLASTIC LIMIT		MOISTURE		ORGANIC	
	T-89	T-99	T-99	T-99	T-265	T-267	T-267	T-267
BOTTLE NO.:								
WT. WET SOIL & BOTTLE:	39.67				616.31			PRE-IONTION DISH & SOIL:
WT. DRY SOIL & BOTTLE:	36.27				526.72			
WT. OF WATER LOST:	3.30				89.59			POST-IONTION DISH & SOIL:
WT. OF BOTTLE:	21.60				78.07			
WT. OF DRY SOIL:	14.97				448.65			DISH
PERCENT OF WATER:	20.70				20.00			LOSS %:
BLOWE REQUIRED FOR CLOSURE:	25							
CORRECTED LIQUID LIMIT %:	21							

WT. OF TOTAL SAMPLE 448.6					WT. OF WASH SAMPLE 118.4					SUMMARY	
SIZE	RET. WT.	RET. WT.	% RET.	% PASSING	SIZE	RET. WT.	RET. WT.	% RET.	% PASSING	LIQUID LIMIT	PL
10"	0.0	0.0	0.0	100.0						PLASTIC LIMIT	18
30"	0.0	0.0	0.0	100.0						PLASTICITY INDEX	18
40"	0.0	0.0	0.0	100.0						% SAND AND GRAVEL	23.7
40"	0.0	0.0	0.0	100.0						% SILT	
40"	0.0	0.0	0.0	100.0						% CLAY	
#10	1.0	1.0	0.2	99.8						CLASSIFICATION	A-4(0)
#40	4.8	4.8	1.0	99.0							
#200	272	26.1	10.5	76.5							
PASS #200		80.5	76.5								

REMARKS:

COMPARISON: \_\_\_\_\_

INDEPENDENT ASSURANCE SUPERVISOR: \_\_\_\_\_

QUALITY ASSURANCE SUPERVISOR: \_\_\_\_\_

(FOR INDEPENDENT ASSURANCE EVALUATION)

SOILS SUPERVISOR: \_\_\_\_\_

DEVELOPMENTAL ENGINEER: \_\_\_\_\_

LEAD TESTER: \_\_\_\_\_

DOC # 23-8644(7/2)

**GEOSYSTEM LIMITS -- [B # 1, 1 (4.0)]**

Test Edit Options Window Help

GrainSize LIMITS MDSO Classifications Proctor

Sample Info Test Data Reports

Material Description [Click here to select from a list of material descriptions](#)

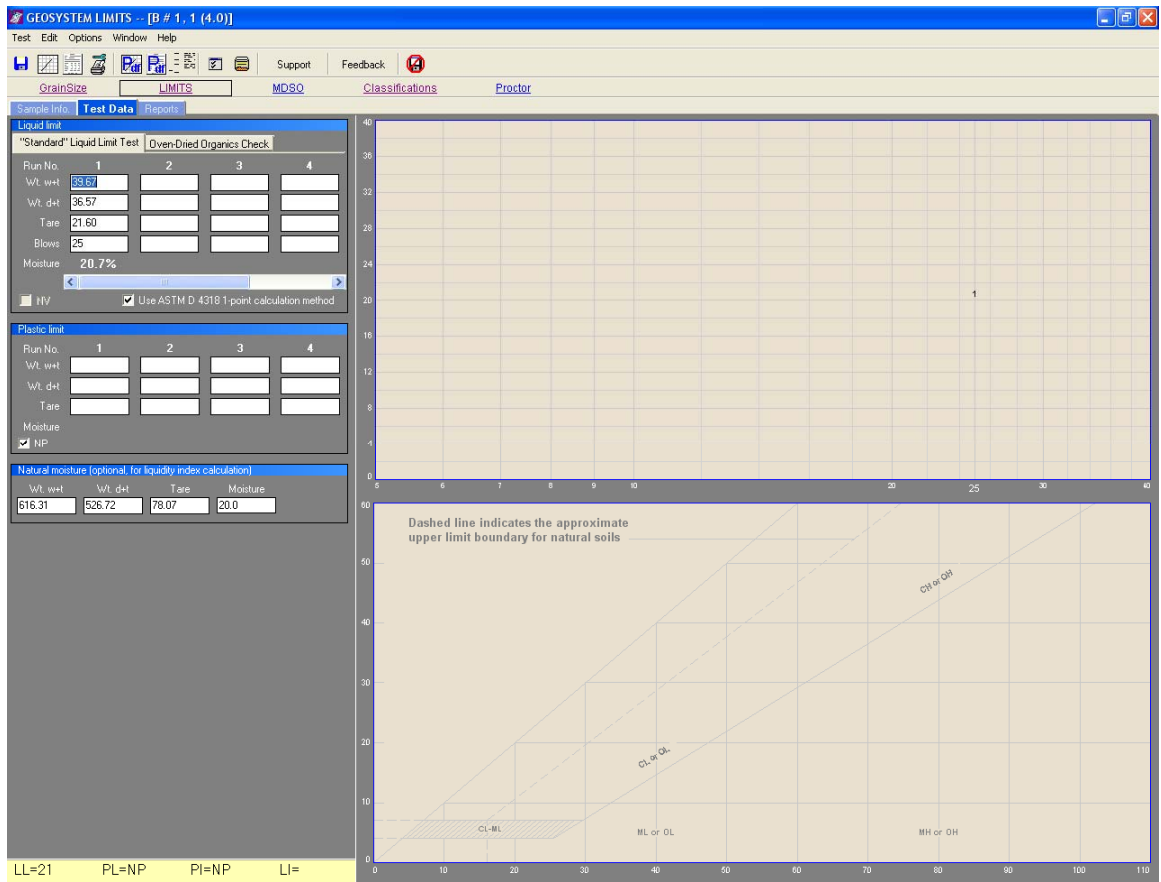
**SAT. FIRM BROWNISH GRAY SILT W/SOME F SAND, TRACE OF C SAND**

%<#40:  %<#200:

USCS:  AASHTO:

Tested by:  Checked by:

Testing Remarks:



**GEOSYSTEM LIMITS - [B # 1, 1 (4.0)]**

Test Edit Report Options Window Help

GrainSize LIMITS MDSO Classifications Proctor

Sample Info Test Data Reports

Test Report Pages

Auto. Combine

Report form: [5 tests] Standard GEOSYSTEM report form (LIMGEO) Preview Forms

Figure:

- ◆ B # 1, 1 (4.0)
- B # 1, 2 (9.0)
- ▲ B # 1, 3 (14.0)
- ◆ B # 1, 4 (19.0)
- ▼ B # 1, 5 (24.0)

Figure:

- ◆ B # 1, 6 (29.0)
- B # 1, 7 (34.0)
- ▲ B # 1, 8 (39.0)
- ◆ B # 1, 9 (44.0)
- ▼ B # 1, 10 (49.0)

Figure:

- ◆ B # 1, 11 (54.0)
- B # 1, 12 (59.0)
- ▲ B # 1, 13 (64.0)
- ◆ B # 1, 14 (69.0)
- ▼ B # 1, 15 (74.0)

Figure:

- ◆ B # 1, 16 (79.0)
- B # 1, 17 (84.0)
- ▲ B # 1, 18 (89.0)

Figure:

- ◆ B # 1A, 1 (4.0)
- B # 1A, 2 (9.0)
- ▲ B # 1A, 3 (14.0)
- ◆ B # 1A, 4 (19.0)
- ▼ B # 1A, 5 (24.0)

Figure:

- ◆ B # 1A, 6 (29.0)

### LIQUID AND PLASTIC LIMITS TEST REPORT

MATERIAL DESCRIPTION	LL	PL	PI	%wMO	%wMOO	USCS
◆ SAT. BROWN BROWN GRAY SILT W/SOME F SAND, TRACE OF C SAND	21	NP	NP	95.7	76.3	ML
■ SAT. SOFT GRAY F SANDY SILT W/SOME CLAY, TRACE OF C SAND AND GRAVEL (W/ SAMPLE NO)	20	14	6	89.3	48.8	SC-SM
▲ SAT. LOOSE BROWN F TO C SAND W/SOME SILT, TRACE OF GRAVEL	NV	NP	NP	64.3	10.9	SP-SM
◆ SAT. VERY LOOSE BROWN GRAY SILT F SAND W/ TRACE OF C SAND	NV	NP	NP	90.4	22.8	SM
▼ SAT. MEDIUM DENSE GRAY F SAND W/SOME SILT, TRACE OF C SAND AND ORGANIC MATTER	NV	NP	NP	89.6	18.6	SM

Project No. Client: Remarks:

Project:

- ◆ Source of Sample: E#1 Depth: 4.0 Sample Number: 1
- Source of Sample: E#1 Depth: 9.0 Sample Number: 2
- ▲ Source of Sample: E#1 Depth: 14.0 Sample Number: 3
- ◆ Source of Sample: E#1 Depth: 19.0 Sample Number: 4
- ▼ Source of Sample: E#1 Depth: 24.0 Sample Number: 5

**University of Delaware**

**Newark, DE**

Figure

# **APPENDIX B**

**Boring Logs Report for DelDOT Project:**

**Rt. 113 Frederica**

**Contract: 24-122-03**

**Boring Log Data Exported from the GEOSYSTEM® Database<sup>1,2</sup>**

**Data from 32 Borings are Included**

**Notes:**

<sup>1</sup>Additional soil laboratory test data such as grain size analysis results, Atterberg limit test results, etc. is not included in this Appendix, but is available in the GEOSYSTEM® database files that will be transmitted to the project sponsor with this report.

<sup>2</sup>Due to the potentially sensitive nature of the data that is included in this database, the data included in these Appendix files will be omitted from all versions of this report that will be posted on the DCT website and available in the DCT office. This data will be made directly available only to the sponsor of this research project, the Delaware Department of Transportation. The omitted pages for this Appendix comprise 38 pages.

# **APPENDIX C**

**Boring Logs Report for DelDOT Project:**

**SR 1 / SR 9 Interchange**

**Contract: 24-122-04**

**Boring Log Data Exported from the GEOSYSTEM® Database<sup>1,2</sup>**

**Data from 65 Borings are Included**

**Notes:**

<sup>1</sup>Additional soil laboratory test data such as grain size analysis results, Atterberg limit test results, etc. is not included in this Appendix, but is available in the GEOSYSTEM® database files that will be transmitted to the project sponsor with this report.

<sup>2</sup>Due to the potentially sensitive nature of the data that is included in this database, the data included in these Appendix files will be omitted from all versions of this report that will be posted on the DCT website and available in the DCT office. This data will be made directly available only to the sponsor of this research project, the Delaware Department of Transportation. The omitted pages for this Appendix comprise 86 pages.

# Delaware Center for Transportation University of Delaware Newark, Delaware 19716

## **AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER**

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