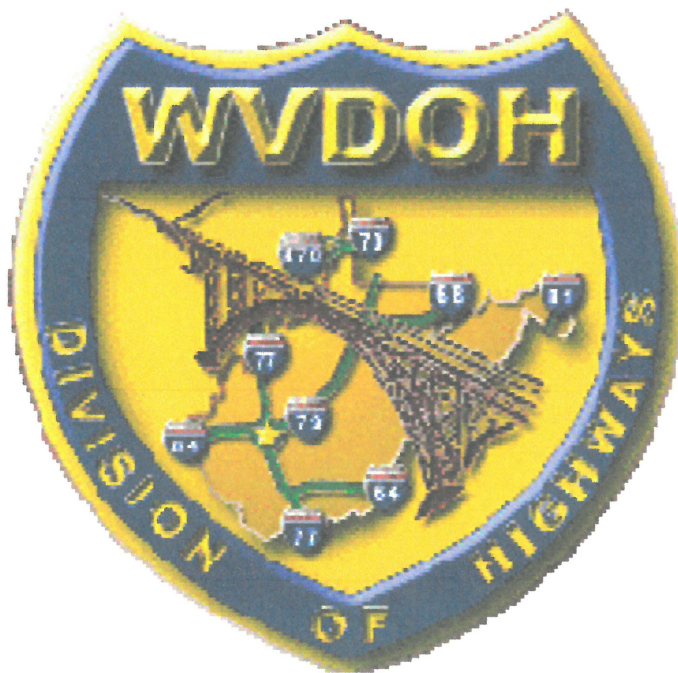


AGGREGATE TECHNICIAN

WORKSHOP

EXERCISES



CHAPTER 2

SAMPLING

1. Exercise #1: You are required to sample a base course material 30 ft. wide placed from station 8+25 to 23+50. Working from the right side of the lane, use the Random Number Table, starting with the first random number (0.221), in the middle of column two of Attachment 1. Locate the sampling unit using Diagram 1 and the required increment positions using Diagram 2.

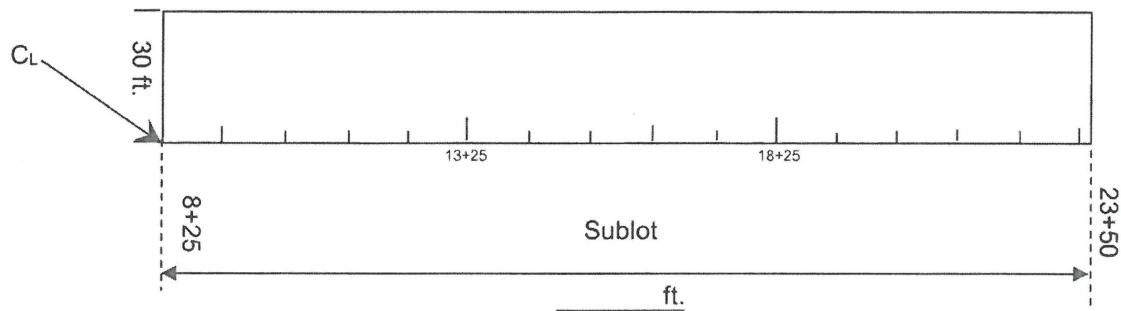


Diagram 1: Sampling subplot.

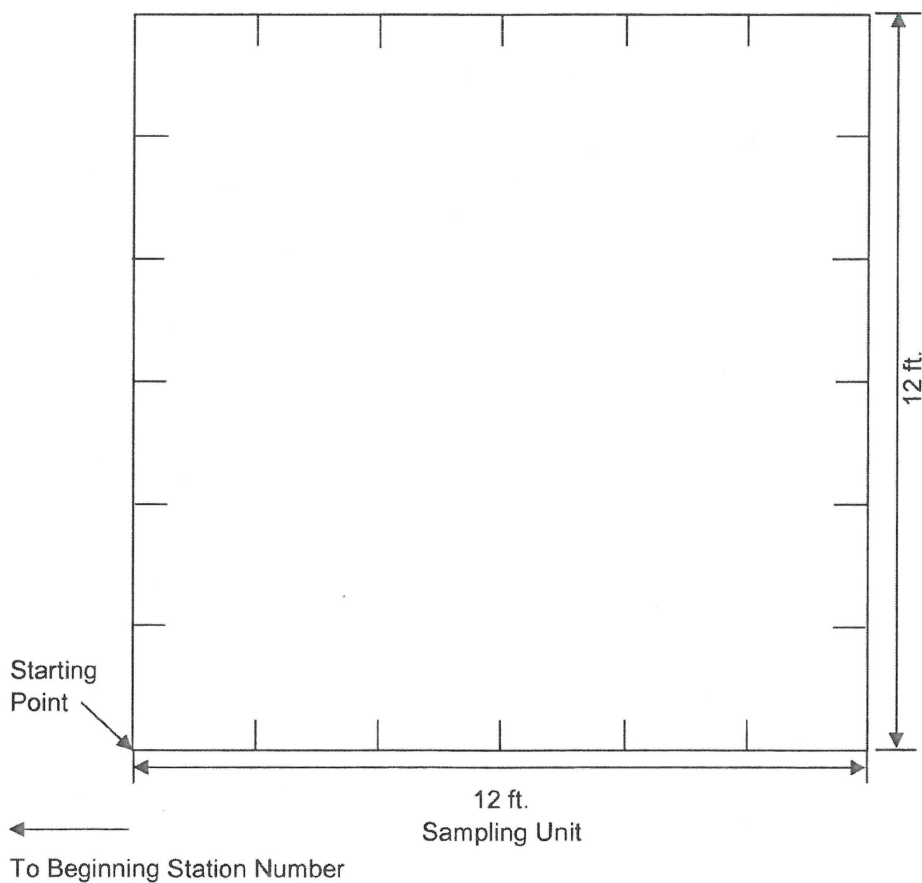
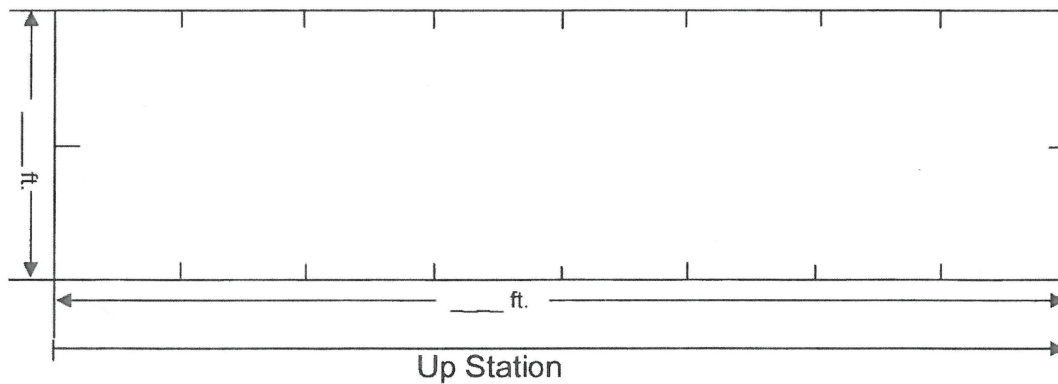
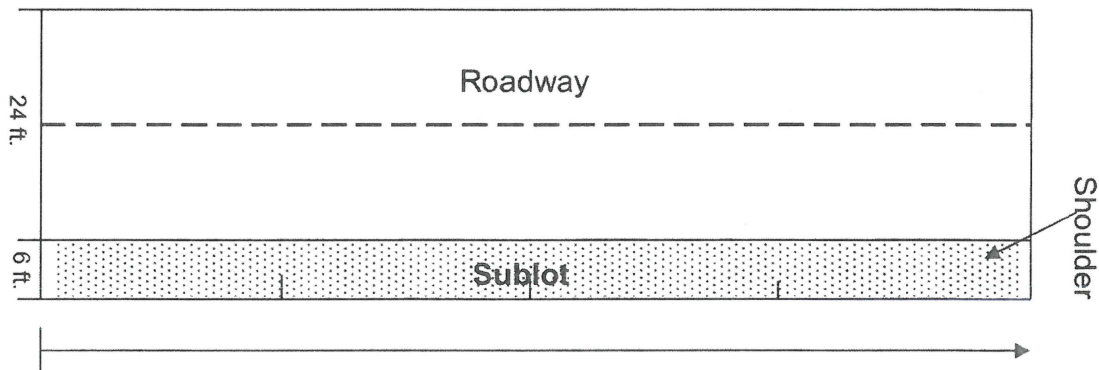


Diagram 2: Sampling Unit

2. Exercise #2: You are required to sample a coarse aggregate from an 80 ft. long conveyor belt. The plant will operate from 7:30 A. M. until 5:00 P. M. Beginning with the same random number as Exercise 1 (0.221), develop your sampling plan for one sample per day and another sampling plan for two half-day samples.

3. Exercise #3: You are required to sample shoulder material 6 ft. wide placed from station 120+00 to station 160+00. Working from the right side of the shoulder, going up station and starting with the first random number (.551) in column four of Attachment 1, locate the sampling unit and the required increment positions.
- a. In exercise #1 the stations were already labeled, in this problem you are required to label the stations.

Note: Drawing not to scale.



ATTACHMENT I

TABLE OF RANDOM NUMBERS

1	2	3	4	5					
0.858	0.082	0.886	0.125	0.263	0.176	0.551	0.711	0.355	0.698
0.576	0.417	0.242	0.316	0.960	0.879	0.444	0.323	0.331	0.179
0.587	0.288	0.835	0.636	0.596	0.174	0.866	0.685	0.066	0.170
0.068	0.391	0.139	0.002	0.159	0.423	0.629	0.631	0.979	0.399
0.140	0.324	0.215	0.358	0.663	0.193	0.215	0.667	0.627	0.595
0.574	0.601	0.623	0.855	0.339	0.486	0.065	0.627	0.458	0.137
0.966	0.589	0.751	0.308	0.025	0.836	0.200	0.055	0.510	0.656
0.608	0.910	0.944	0.281	0.539	0.371	0.217	0.882	0.324	0.284
0.215	0.355	0.645	0.450	0.719	0.057	0.287	0.146	0.135	0.903
0.761	0.883	0.711	0.388	0.928	0.654	0.815	0.570	0.539	0.600
0.869	0.222	0.115	0.447	0.658	0.989	0.921	0.924	0.560	0.447
0.562	0.036	0.302	0.673	0.911	0.512	0.972	0.576	0.838	0.014
0.481	0.791	0.454	0.731	0.770	0.500	0.980	0.183	0.385	0.012
0.599	0.966	0.356	0.183	0.797	0.503	0.180	0.657	0.077	0.165
0.464	0.747	0.299	0.530	0.675	0.646	0.385	0.109	0.780	0.699
0.675	0.654	0.221	0.777	0.172	0.738	0.324	0.669	0.079	0.587
0.269	0.707	0.372	0.486	0.340	0.680	0.928	0.397	0.337	0.564
0.338	0.917	0.942	0.985	0.838	0.805	0.278	0.898	0.906	0.939
0.130	0.575	0.195	0.887	0.142	0.488	0.316	0.935	0.403	0.629
0.011	0.283	0.762	0.988	0.102	0.068	0.902	0.850	0.569	0.977
0.683	0.441	0.572	0.486	0.732	0.721	0.275	0.023	0.088	0.402
0.493	0.155	0.530	0.125	0.841	0.171	0.794	0.850	0.797	0.367
0.059	0.502	0.963	0.055	0.128	0.655	0.043	0.293	0.792	0.739
0.996	0.729	0.370	0.139	0.306	0.858	0.183	0.464	0.457	0.863
0.240	0.972	0.495	0.696	0.350	0.642	0.188	0.135	0.470	0.765

CHAPTER 3

SIEVE ANALYSIS

1. **Exercise #1:** The following sieve analysis was conducted on an AASHTO No. 57 Limestone, for Portland Cement Concrete (PCC). Complete the attached blank T300 beginning with the data given in Table 1.
 - a. Fill in the identification information about the sample.
 1. Field Sample # (C1Z5555), Tech. + Lab, and Date.
 2. Aggregate Type in the appropriate section (No. 57 Lmst).
 - b. Enter the sieves in the appropriate column.
 - c. Enter the "Materials Specifications" from West Virginia specifications Section 703.
 - d. Record the initial and after T-11 weights on the appropriate lines.
 - e. Record the weights retained for each sieve and pan in the coarse aggregate section.
 - f. Complete the necessary calculations and enter the data on the T300.
 - g. Evaluate the sample for specification compliance.
 - h. Indicate "pass" or "fail" for the sample using the #57 specification with the appropriate No. 200 specification.

Table 1. Sieve Analysis of AASHTO No. 57 Lmst. for Concrete.

Initial & After T-11 Weights	
Initial Oven Dry Weight of Total Sample	10256.4
Oven Dry Weight of Total Sample After T-11	10135.7
Mass Retained-Coarse Gradation	
Sieve Size	Weight
1 1/2 inch	0.0
1 inch	161.3
3/4 inch	3133.3
1/2 inch	4275.1
3/8 inch	1497.5
No. 4	989.3
No. 8	23.6
No. 200	24.9
Pan	21.4

WEST VIRGINIA DIVISION OF HIGHWAYS
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATE (AASHTO T-27)
MATERIALS FINER THAN No. 200 SIEVE BY WASHING (AASHTO T-11)

Site Manager I.D.#:	Aggregate Size: Class 1	Sieve Type Coarse: 12 Inch	Sieve Type Fine: 12 Inch	Material Type: Lime Stone	Spec Sieve Sizes	% Pass	Pass /Fail
Lab Reference Number:	Contract #:	Project #:	Auth #:	Item #:			
Technician:							
Producer / Supplier Code:							
Producer / Supplier Name:							
Site Manager Material Code:							
Date Sampled:							
Date Tested:							
	Tons / CY						

- | | |
|--|-----------|
| (A) Initial Oven Dry Mass of Total Sample..... | (A) _____ |
| (B) Oven Dry mass of Total Sample After T-11..... | (B) _____ |
| (C) Oven Dry Mass of Plus No. 4 Material..... | (C) _____ |
| (D) Oven Dry Mass of Plus No. 4 Material After T-11..... | (D) _____ |
| (E) Oven Dry Mass of Minus No. 4 Material Used in Split..... | (E) _____ |
| (F) Combination Gradation Coarse Fraction Pan Material After Dry Sieving (K)..... | (F) _____ |
| (G) Total Oven Dry Mass of Minus No. 4 Material (E+F)..... | (G) _____ |
| (H) Initial Oven Dry Mass of Total Fine Sample or Mass of Minus No. 4 Material..... | (H) _____ |
| (I) Oven Dry Mass of Total Fine Sample or Mass of Minus No. 4 Material After T-11..... | (I) _____ |

Sieve Analysis of Coarse Aggregate

Sieve Size	Mass Retained M_R		Over Loading	% Retained $(M_R/A) \times 100$	Percent Passing	Reported Percent Passing	Material Specifications	
	Regular	Combination					Low	High
(J) Pan								
(K) Combination Grad. Pan								
(L) Loss By T-11.....								
(M) Final Total (ΣM_R)								

C. F. = $\frac{(G)}{(P)} \div$ _____

C. F. = _____

C. F. = _____

Sieve Analysis of Fine Aggregate

Sieve Size	Mass Retained M_R		Over Loading	% Retained $(M_R/(H+R)) \times 100$	Percent Passing	Reported Percent Passing	Material Specifications	
	Regular	Combination					Low	High
(N) Pan.....								
(O) Loss By T-11.....								
(P) Final Total Fine Sample (ΣM_R).....								
(Q) Final Total - No. 4 (ΣM_R).....								
(R) Combined Total (M+Q).....								
(S) Sample Loss or Gain	(A-M) or (M-A).....							
	(H-P) or (P-H).....							
	(A-R) or (R-A).....							
(T) Percentage of Initial OD Mass $((S/A) \times 100)$ or $((S/H) \times 100)$								

Coarse - No. 200 Dry Fine - No. 200 Dry

Coarse - No. 200 Wet Fine - No. 200 Wet

Total - No. 200 + Init. Mass (A) or (H)

x 100 = %

Name: _____

Signature: _____

Date: _____

Remarks:	Pass/Fail	Lab Info Only: ☐	

2. **Exercise #2:** The following sieve analysis was conducted on fine aggregate manufactured silica sand for Portland Cement Concrete (PCC). Complete the attached blank T300 beginning with the data given in Table 2.
- Fill in the identification information about the sample.
 - Field Sample # (C2Z5555), Tech. + Lab, and Date.
 - Aggregate Type in the appropriate section (manufactured silica sand).
 - Enter the sieves in the appropriate column.
 - Enter the "Materials Specifications" from West Virginia specification Section 702.
 - Record the initial and after T-11 weights on the appropriate lines.
 - Record the weights retained for each sieve and pan in the fine aggregate section.
 - Complete the necessary calculations and enter the data on the T300.
 - Evaluate the sample for specification compliance.
 - Indicate "pass" or "fail" for the sample.

Table 2. Sieve Analysis of Manufactured Silica Sand for PCC.

Initial & After T-11 Weights	
Initial Oven Dry Weight of Total Fine Sample	375.2
Oven Dry Weight of Total Fine Sample after T-11	373.9
Mass Retained-Fine Gradation	
Sieve Size	Weight
3/8 inch	0.0
No. 4	1.8
No. 8	43.1
No. 16	55.6
No. 30	81.3
No. 50	138.7
No. 100	48.6
No. 200	4.0
Pan	0.2

WEST VIRGINIA DIVISION OF HIGHWAYS
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATE (AASHTO T-27)
MATERIALS FINER THAN No. 200 SIEVE BY WASHING (AASHTO T-11)

Site Manager I.D.#:	Aggregate Size: Class 1	Spec Sieve Sizes	% Pass	Pass /Fail
Lab Reference Number:	Sieve Type Coarse: 12 Inch			
Technician:	Sieve Type Fine: 12 Inch			
Producer / Supplier Code:	Material Type: Lime Stone			
Producer / Supplier Name:	Contract #:			
Site Manager Material Code:	Project #:			
Date Sampled:	Auth #:			
Date Tested:	Item #:			
	Tons / CY			

- | | |
|--|-----------|
| (A) Initial Oven Dry Mass of Total Sample..... | (A) _____ |
| (B) Oven Dry mass of Total Sample After T-11..... | (B) _____ |
| (C) Oven Dry Mass of Plus No. 4 Material..... | (C) _____ |
| (D) Oven Dry Mass of Plus No. 4 Material After T-11..... | (D) _____ |
| (E) Oven Dry Mass of Minus No. 4 Material Used in Split..... | (E) _____ |
| (F) Combination Gradation Coarse Fraction Pan Material After Dry Sieving (K)..... | (F) _____ |
| (G) Total Oven Dry Mass of Minus No. 4 Material (E+F)..... | (G) _____ |
| (H) Initial Oven Dry Mass of Total Fine Sample or Mass of Minus No. 4 Material..... | (H) _____ |
| (I) Oven Dry Mass of Total Fine Sample or Mass of Minus No. 4 Material After T-11..... | (I) _____ |

Sieve Analysis of Coarse Aggregate

Sieve Size	Mass Retained M_R		Over Loading	% Retained $(M_R/A) \times 100$	Percent Passing	Reported Percent Passing	Material Specifications	
	Regular	Combination					Low	High
(J) Pan								
(K) Combination Grad. Pan								
(L) Loss By T-11.....								
(M) Final Total (ΣM_R)								

C. F. = (G) ÷ (P)

C. F. = ÷

C. F. =

Sieve Analysis of Fine Aggregate

Sieve Size	Mass Retained M_R		Over Loading	% Retained $(M_R/(H+R)) \times 100$	Percent Passing	Reported Percent Passing	Material Specifications	
	Regular	Combination					Low	High
(N) Pan.....								
(O) Loss By T-11.....				Coarse - No. 200 Dry		Fine - No. 200 Dry		
(P) Final Total Fine Sample (ΣM_R).....				Coarse - No. 200 Wet		Fine - No. 200 Wet		
(Q) Final Total - No. 4 (ΣM_R).....				Total - No. 200		+ Init. Mass (A) or (H)		
(R) Combined Total (M+Q).....				x 100 =		%		
(S) Sample Loss or Gain	(A-M) or (M-A).....							
	(H-P) or (P-H).....							
	(A-R) or (R-A).....							
(T) Percentage of Initial OD Mass $((S/A) \times 100)$ or $((S/H) \times 100)$								

Name:

Signature:

Date:

Remarks:	Pass/Fail	Lab Info Only: ☐	
----------	------------------	---	--

3. **Exercise #3:** The following sieve analysis was conducted on a Class 1 Limestone, base course material. Complete the attached blank T300 using table 3.
- Fill in the identification information about the sample.
 - Field Sample # (C3Z5555), Tech. + Lab, and Date.
 - Aggregate Type in the appropriate section (Class 1 Lmst).
 - Enter the sieves in the appropriate column.
 - Enter the "Materials Specifications".
 - Record the initial and after T-11 weights on the appropriate lines.
 - Record the weights retained for each sieve and pan in the coarse and fine sections.
 - Complete the necessary calculations and enter the data on the T300.
 - Evaluate the sample for specification compliance.
 - Indicate "pass" or "fail" for the sample.

Table 3. Sieve Analysis of Class 1 Lmst. Base Course Material.

Initial & After T-11 Weights			
Initial oven dry weight of total sample		10559.8	
Oven dry weight of plus No. 4 material		6738.3	
Oven dry weight of plus No. 4 material after T-11		6697.1	
Oven dry weight of minus No. 4 material used in split		3795.7	
Oven dry weight of minus No. 4 material		350.2	
Oven dry weight of minus No. 4 material after T-11		335.8	
Mass Retained-Coarse Gradation		Mass Retained-Fine Gradation	
Sieve Size	Weight	Sieve Size	Weight
1 1/2 inch	0.0	No. 8	148.1
1 inch	112.0	No. 16	82.0
3/4 inch	737.0	No. 40	58.4
1/2 inch	1982.0	No. 200	43.1
3/8 inch	1159.0	Pan	4.4
No. 4	2577.0		
Pan	130.0		

T301E
Rev. 12-01

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION
A CALCULATION WORKSHEET

F. S. # C4Z5555
Tech. Your Name + Lab
Date Today's Date

Lab Number Exercise #4	Project and Contract C					Date Sampled		Transmit Date	
Test Sequence	Material Code		Quantity		Item Number	Plant Source Code		Aggregate Source Code	
Sieves:	1st	2nd	3rd	4th	5th	6th	7th	8th	No. 200
Design Number				Unit Weight	Face Fracture % One % Two		LL	PL	PI
AASHTO Size		Smallest Sieve 100%	Target A-bar	Actual A-bar	FA A-bar	CA No. 200	FA No. 200	Total No. 200	P/F/N

Plant Name _____ Source Coarse Agg. _____
 Technician _____ Date _____ Source Fine Agg. _____
 Class of Concrete _____ Cmmt Fact _____ Field Sample # _____

Sieves	CA #57 Lmst	FA Silica Sand Man	Cement	Total Mass of Each Solid at SSD in One yd ³ of Concrete From Mix Design
1 1/2 in. % pass			100	M _{ca} _____ lb
3/4 in. % pass			100	M _{fa} _____ lb
3/8 in. % pass			100	M _{ca} + M _{fa} _____ lb
No. 4 % pass			100	*M _c _____ lb
No. 8 % pass			100	M _t _____ lb
No. 16 % pass			100	Fractional Part of Each Solid (0.001)
No. 30 % pass			100	$\frac{M_{ca}}{M_t} = \frac{\quad}{\quad} = \frac{\quad}{\quad}$
No. 50 % pass			100	$\frac{M_{fa}}{M_t} = \frac{\quad}{\quad} = \frac{\quad}{\quad}$
No. 100 % pass			100	$\frac{*M_c}{M_t} = \frac{\quad}{\quad} = \frac{\quad}{\quad}$
No. 200 % pass			100	
Total			1000.0	
Solid A's			10.00	

Solid Fraction x Each Solid A				Fractional Part of Coarse and Fine Agg. (0.001)			
Coarse Agg	x	=	A _{ca}	F _{ca}	=	$\frac{M_{ca}}{M_{ca} + M_{fa}}$	=
Fine Agg	x	=	A _{fa}	F _{fa}	=	$\frac{M_{fa}}{M_{ca} + M_{fa}}$	=
Cement	x 10.00	=	A _c				

Adjusted and Maximum Minus No. 200 Based on Fractional Part of
Total Aggregate (0.01)

- No. 200 % pass x F_{ca} or F_{fa} = Adjusted
Total - 200
CA + FA

CA _____ x _____ =
FA _____ x _____ =

- No. 200 Spec Limit x F_{ca} or F_{fa} = Max. Allowed

CA _____ x _____ =
FA _____ x _____ =

Total - 200
CA + FA

A Total Solids A_{ca} + A_{fa} + A_c _____

Target A _____

A Tolerance ± _____

Total A P/F _____

5. **Exercise #5 (A-Bar):** Complete the attached blank T301 using Table 5 below for item 601 concrete. The information in table was derived from an actual mix design and from an actual sieve analysis.
- Fill in the identification information about the sample.
 - Field Sample # (C5Z5555), Tech. + Lab, and Date.
 - Enter the percent passing for each sieve in the appropriate column.
 - Label each column with the aggregate type.
 - Enter the "Total Mass of Each Solid" on the appropriate line.
 - Record the "Target A-Bar" in the appropriate sections.
 - Determine the minus No. 200 specifications and the "A-Bar Tolerance" and record them in the appropriate sections.
 - Complete all calculations and record the results.
 - Evaluate the sample for specification compliance.
 - Complete the upper section of the T301 with the pertinent A-Bar information and indicate "pass" or "fail" for the sample.

Table 5. A-Bar Mix Design and Sieve Analysis Information

Mix Design Information			
Mass of Coarse Aggregate		1808 lb.	
Mass of Fine Aggregate		1366 lb.	
Mass of Cement		536 lb.	
Target A-Bar		4.88	
AASHTO #57 Uncrushed River Gravel		Natural Silica Sand	
Sieve Size	Percent Passing	Sieve Size	Percent Passing
1 1/2 inch	100	1 1/2 inch	100
3/4 inch	76	3/4 inch	100
3/8 inch	12	3/8 inch	100
No. 4	3	No. 4	98
No. 8	2	No. 8	83
No. 16	0	No. 16	67
No. 30	0	No. 30	55
No. 50	0	No. 50	25
No. 100	0	No. 100	5
No. 200	1.0	No. 200	2.5

T301E
Rev. 12-01WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION
" CALCULATION WORKSHEETF. S. #
Tech.
DateC4Z5556
Your Name + Lab
Today's Date

Lab Number Exercise #5	Project and Contract C					Date Sampled		Transmit Date	
Test Sequence	Material Code		Quantity	Item Number	Plant Source Code	Aggregate Source Code			
Sieves:	1st	2nd	3rd	4th	5th	6th	7th	8th	No. 200
Design Number				Unit Weight	Face Fracture % One	% Two	LL	PL	PI
AASHTO Size	Smallest Sieve 100%	Target A-bar	Actual A-bar	FA A-bar	CA No. 200	FA No. 200	Total No. 200		P/F/N

Plant Name _____ Source Coarse Agg. _____
 Technician _____ Date _____ Source Fine Agg. _____
 Class of Concrete _____ Cmmt Fact _____ Field Sample # _____

Sieves	CA #57 Gravel UC	FA Silica Sand	Cement	Total Mass of Each Solid at SSD in One yd ³ of Concrete From Mix Design
1 1/2 in. % pass	_____	_____	100	M_{ca} _____ lb
3/4 in. % pass	_____	_____	100	M_{fa} _____ lb
3/8 in. % pass	_____	_____	100	$M_{ca} + M_{fa}$ _____ lb
No. 4 % pass	_____	_____	100	$*M_c$ _____ lb
No. 8 % pass	_____	_____	100	M_t _____ lb
No. 16 % pass	_____	_____	100	Fractional Part of Each Solid (0.001)
No. 30 % pass	_____	_____	100	$\frac{M_{ca}}{M_t} = \frac{\quad}{\quad} = \frac{\quad}{\quad}$
No. 50 % pass	_____	_____	100	$\frac{M_{fa}}{M_t} = \frac{\quad}{\quad} = \frac{\quad}{\quad}$
No. 100 % pass	_____	_____	100	$\frac{*M_c}{M_t} = \frac{\quad}{\quad} = \frac{\quad}{\quad}$
No. 200 % pass	_____	_____	100	
Total	_____	_____	1000.0	
Solid $\bar{A}$'s	_____	_____	10.00	

Solid Fraction x Each Solid $\bar{A}$
 Coarse Agg _____ x _____ = _____ $\bar{A}_{ca}$
 Fine Agg _____ x _____ = _____ $\bar{A}_{fa}$
 Cement _____ x 10.00 = _____ $\bar{A}_c$

* Include Mass of Fly Ash When Used.
 Fractional Part of Coarse and Fine Agg. (0.001)
 $F_{ca} = \frac{M_{ca}}{M_{ca} + M_{fa}} = \frac{\quad}{\quad} = \frac{\quad}{\quad}$
 $F_{fa} = \frac{M_{fa}}{M_{ca} + M_{fa}} = \frac{\quad}{\quad} = \frac{\quad}{\quad}$

Adjusted and Maximum Minus No. 200 Based on Fractional Part of
Total Aggregate (0.01)

- No. 200 % pass x F_{ca} or F_{fa} =	Adjusted Total - 200 CA + FA
CA _____ x _____ =	
FA _____ x _____ =	
- No. 200 Spec Limit x F_{ca} or F_{fa} =	Max. Allowed
CA _____ x _____ =	Total - 200 CA + FA
FA _____ x _____ =	

$\bar{A}$ Total Solids $\bar{A}_{ca} + \bar{A}_{fa} + \bar{A}_c$ _____
 Target $\bar{A}$ _____
 $\bar{A}$ Tolerance $\pm$ _____
 Total $\bar{A}$ P/F _____

CHAPTER 4

SPECIFIC GRAVITY

1. **Exercise #1:** A specific gravity test for fine aggregate reveals the following information. Complete the attached blank T305 using Table 1.
 - a. Calculate the Bulk Specific Gravity (Oven Dry Basis).
 - b. Calculate the Bulk Specific Gravity (SSD Basis).
 - c. Calculate the Apparent Specific Gravity.
 - d. Calculate the absorption (percent).

Table 1. Fine specific gravity test results.

Weight of saturated-surface-dry sample in air (grams).	501.1
Weight of sample, pycnometer, and water to calibration mark (grams).	973.4
Weight of pycnometer and distilled water to calibration mark (grams).	669.8
Weight of drying pan (grams).	52.3
Weight of oven-dry sample and drying pan in air (grams).	547.6

T305
Rev. 12-01

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

BULK SPECIFIC GRAVITY AND ABSORPTION
FINE AGGREGATE

Laboratory No. **Exercise #1** _____
Field Sample No. _____
Date _____
Source _____
Tested By _____

(Record masses to 0.1 g)

A = Mass of oven-dry sample in air, grams ((a)-(b)) _____

(a) Mass of oven-dry sample
and drying pan in air, grams _____

(b) Mass of drying pan, grams _____

B = Mass of pycnometer filled to calibration mark with
distilled water, grams _____

C = Mass of pycnometer, sample, and water to calibration
mark, grams _____

D = Mass of saturated-surface-dry sample in air, grams _____

Bulk Specific Gravity = $\frac{A}{B+D-C}$ = _____
(Oven Dry Basis)

Bulk Specific Gravity = $\frac{D}{B+D-C}$ = _____
(Saturated-Surface-Dry Basis)

Apparent Specific Gravity = $\frac{A}{B+A-C}$ = _____

Absorption, percent = $\frac{D-A}{A} \times 100$ = _____

Report Specific Gravities to the nearest 0.01
Report Absorption to the nearest 0.1%

2. **Exercise #2:** A specific gravity test for fine aggregate reveals the following information. Complete the attached blank T305 using Table 2.
- a. Calculate the Bulk Specific Gravity (Oven Dry Basis).
 - b. Calculate the Bulk Specific Gravity (SSD Basis).
 - c. Calculate the Apparent Specific Gravity.
 - d. Calculate the absorption (percent).

Table 2. Fine specific gravity test results.

Weight of saturated-surface-dry sample in air (grams).	509.2
Weight of sample, pycnometer, and water to calibration mark (grams).	985.3
Weight of pycnometer and distilled water to calibration mark (grams).	676.2
Weight of drying pan (grams).	50.2
Weight of oven-dry sample and drying pan in air (grams).	555.5

T305
Rev. 12-01

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

BULK SPECIFIC GRAVITY AND ABSORPTION
FINE AGGREGATE

Laboratory No. **Exercise #2** _____
Field Sample No. _____
Date _____
Source _____
Tested By _____

(Record masses to 0.1 g)

A = Mass of oven-dry sample in air, grams ((a)-(b)) _____

(a) Mass of oven-dry sample
and drying pan in air, grams _____

(b) Mass of drying pan, grams _____

B = Mass of pycnometer filled to calibration mark with
distilled water, grams _____

C = Mass of pycnometer, sample, and water to calibration
mark, grams _____

D = Mass of saturated-surface-dry sample in air, grams _____

Bulk Specific Gravity = $\frac{A}{B+D-C}$ = _____
(Oven Dry Basis)

Bulk Specific Gravity = $\frac{D}{B+D-C}$ = _____
(Saturated-Surface-Dry Basis)

Apparent Specific Gravity = $\frac{A}{B+A-C}$ = _____

Absorption, percent = $\frac{D-A}{A} \times 100$ = _____

Report Specific Gravities to the nearest 0.01
Report Absorption to the nearest 0.1%

3. **Exercise #3:** A specific gravity test for coarse aggregate reveals the following information. Complete the attached blank T305 using Table 3.
- Calculate the Bulk Specific Gravity (Oven Dry Basis).
 - Calculate the Bulk Specific Gravity (SSD Basis).
 - Calculate the Apparent Specific Gravity.
 - Calculate the absorption (percent).

Table 3. Coarse specific gravity test results.

Weight of saturated-surface-dry sample in air (grams).	5290
Weight of saturated sample in water (grams).	3220
Weight of oven-dry sample in air (grams).	5110

T306
Rev. 4-03

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL SOILS & TESTING DIVISION

BULK SPECIFIC GRAVITY AND ABSORPTION
COARSE AGGREGATE

Laboratory No. **Exercise #3** _____
Field Sample No. _____
Date _____
Source _____
Tested By _____

(Record masses to 1 g)

A = Mass of oven-dry sample in air, grams _____

B = Mass of saturated-surface-dry sample in air, grams _____

C = Mass of saturated sample in water, grams _____

Bulk Specific Gravity = $\frac{A}{B-C}$ = _____
(Oven Dry Basis)

Bulk Specific Gravity = $\frac{B}{B-C}$ = _____
(Saturated-Surface-Dry Basis)

Apparent Specific Gravity = $\frac{A}{A-C}$ = _____

Absorption, percent = $\frac{B-A}{A} \times 100$ = _____

Report Specific Gravities to the nearest 0.01
Report Absorption to the nearest 0.1%

4. **Exercise #4:** A specific gravity test for coarse aggregate reveals the following information. Complete the attached blank T306 using Table 4.
- Calculate the Bulk Specific Gravity (Oven Dry Basis).
 - Calculate the Bulk Specific Gravity (SSD Basis).
 - Calculate the Apparent Specific Gravity.
 - Calculate the absorption (percent).

Table 4. Coarse specific gravity test results.

Weight of saturated-surface-dry sample in air (grams).	5080
Weight of saturated sample in water (grams).	3089
Weight of oven-dry sample in air (grams).	4987

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WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL SOILS & TESTING DIVISION

BULK SPECIFIC GRAVITY AND ABSORPTION
COARSE AGGREGATE

Laboratory No. **Exercise #4** _____
Field Sample No. _____
Date _____
Source _____
Tested By _____

(Record masses to 1 g)

A = Mass of oven-dry sample in air, grams _____
B = Mass of saturated-surface-dry sample in air, grams _____
C = Mass of saturated sample in water, grams _____

Bulk Specific Gravity = $\frac{A}{B-C}$ = _____
(Oven Dry Basis)

Bulk Specific Gravity = $\frac{B}{B-C}$ = _____
(Saturated-Surface-Dry Basis)

Apparent Specific Gravity = $\frac{A}{A-C}$ = _____

Absorption, percent = $\frac{B-A}{A} \times 100$ = _____

Report Specific Gravities to the nearest 0.01
Report Absorption to the nearest 0.1%

CHAPTER 5

UNIT WEIGHT

- Exercise #1: Complete the attached T303E and T304E. Calculate the calibration factor for the measure and then calculate the unit weight of a No. 57 limestone aggregate sample using **Table 1b** and Attachment 2 (Water Density).

****Note – Weights are determined to the nearest 50 grams. In this exercise the actual measured weights are recorded in Table 1a. These weights were rounded in accordance with specification and recorded in Table 1b. This is to demonstrate the degree of accuracy requirement. ****

Table 1a. Actual weights, recorded from balance reading		
Calibration Information		
Weight of measure, glass, grease and water (grams)	15041	
Weight of measure, glass and grease (grams)	5645	
Temperature of water (to the nearest 0.2°F)	76.0	
Measure size	1/3	
Unit Weight Information		
	1 st trial	2 nd trial
Weight of measure (grams)	5041	5041
Weight of measure and aggregate (grams)	20435	20561

Table 1b. Rounded weights, recorded on worksheet		
Calibration Information		
Weight of measure, glass, grease and water (grams)	15050	
Weight of measure, glass and grease (grams)	5650	
Temperature of water (to the nearest 0.2°F)	76.0	
Measure size	1/3	
Unit Weight Information		
	1 st trial	2 nd trial
Weight of measure (grams)	5050	5050
Weight of measure and aggregate (grams)	20450	20550

T303E

UNIT WEIGHT OF AGGREGATE

Rev. 12-01

AASHTO T-19

ASTM C-29

CALIBRATION OF UNIT WEIGHT MEASURE

DATE

Exercise #1

CALIBRATED BY

MEASURE SIZE

A. Weight of Measure, Glass, Grease, and Water

B. Weight of Measure, Glass, and Grease

C. Weight of Water in Measure

D. Convert g to lbs. if necessary

E. Temperature of Water (Nearest 0.2°F or 0.1°C)

F. Weight of Water at Temperature E (from Tables in

Aggregate Manual Chap. 5, AASHTO T19, or ASTM C29)

G. Factor for Measure (Round to the nearest thousandth)

All weights rounded to the nearest 0.1 lb or 50 g (0.05 kg).

$C = A - B$

$D = C \div 453.6$ (If C measured in g)

$D = C$ (If C measured in lb)

$G = F \div D$

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL SOILS & TESTING DIVISION

UNIT WEIGHT OF AGGREGATE

Lab Number		Project and Contract				Date Sampled				Transmit Date	
Test Sequence	Material Code	C				Item Number	Plant Source Code		Aggregate Source Code		
		Quantity									
Sieves:	1st	2nd	3rd	4th	5th	6th	7th	8th	No. 200		
Design Number	Bitumen Content		Unit Weight		Face Fracture		%One	LL	PL	PI	
	Target		Actual		%Two						
AASHTO Size	Smallest Sieve 100%	Target A-bar	Actual A-bar	FA A-bar	CA No. 200	FA No. 200	Total No. 200	P/F/N			

Technician **Exercise #1** _____ Rodded _____ Loose _____ Jigged _____
 Source _____ Date _____ Field Sample # _____

- | | 1st Trial | 2nd Trial |
|--|-----------|-----------|
| A. Weight of Measure and Aggregate | _____ | _____ |
| B. Weight of Measure | _____ | _____ |
| C. Weight of Aggregate | _____ | _____ |
| D. Convert weight of Aggregate from g to lbs. if necessary. | _____ | _____ |
| E. Correction Factor of Measure (Report to the nearest 0.001). | _____ | _____ |
| F. Weight per Cubic Foot (Reported to nearest lb/ft ³). | _____ | _____ |
| G. Average weight per Cubic Foot (Reported to nearest lb/ft ³). | _____ | |
| H. Average Tons/yd ³ (Reported to nearest 0.01 Tons/yd ³) | _____ | |

All weights measured to the nearest 0.1 lb or 50 g (0.05 kg).

$$C = A - B$$

$$D = C \div 453.6g \quad (\text{if } C \text{ is measured in g})$$

$$F = D \times E$$

$$G = (F_{1st} + F_{2nd}) \div 2$$

$$H = G \times 27 \div 2000$$

2. Exercise #2: Complete the attached T303E and T304E. Calculate the calibration factor for the measure and calculate the unit weight of a No. 467 limestone aggregate sample using Table 2 and Attachment 2 (Water Density).

Note: Weights are determined to the nearest 50 grams. All weights must be rounded in accordance with test procedure.

Table 2. Actual weights recorded from balance readings		
Calibration Information		
Weight of measure, glass, grease and water (grams)	21327	
Weight of Measure, Glass and Grease (grams)	6931	
Temperature of water (to the nearest 0.2°F)	74.0	
Measure size	1/2	
Unit Weight Information		
	1 st trial	2 nd trial
Weight of measure (grams)	6742	6742
Weight of measure and aggregate (grams)	30895	31002

T303E

UNIT WEIGHT OF AGGREGATE

Rev. 12-01

AASHTO T-19

ASTM C-29

CALIBRATION OF UNIT WEIGHT MEASURE

DATE

Exercise #2

CALIBRATED BY

MEASURE SIZE

A. Weight of Measure, Glass, Grease, and Water

B. Weight of Measure, Glass, and Grease

C. Weight of Water in Measure

D. Convert g to lbs.

E. Temperature of Water (to the nearest 0.2°F or 0.1°C)

F. Weight of Water at Temperature E (from Tables in

Aggregate Manual Chap. 5, AASHTO T19, or ASTM C29)

G. Factor for Measure (Round Factor to 3 decimal places)

All weights rounded to the nearest 0.1 lb or 50 g (0.05 kg).

$$C = A - B$$

$$D = C \div 453.6 \quad (\text{If } C \text{ measured in g})$$

$$D = C \quad (\text{If } C \text{ measured in lb})$$

$$G = F \div D$$

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL SOILS & TESTING DIVISION

UNIT WEIGHT OF AGGREGATE

Lab Number		Project and Contract				Date Sampled				Transmit Date	
Test Sequence	Material Code	C				Item Number	Plant Source Code		Aggregate Source Code		
		Quantity									
Sieves:	1st	2nd	3rd	4th	5th	6th	7th	8th	No. 200		
Design Number	Bitumen Content		Unit Weight		Face Fracture		%One	LL	PL	PI	
		Target	Actual			%Two					
AASHTO Size	Smallest Sieve 100%	Target A-bar	Actual A-bar	FA A-bar	CA No. 200	FA No. 200	Total No. 200	P/F/N			

Technician **Exercise #2** _____ Rodded _____ Loose _____ Jigged _____
Source _____ Date _____ Field Sample # _____

- | | 1st Trial | 2nd Trial |
|--|-----------|-----------|
| A. Weight of Measure and Aggregate | _____ | _____ |
| B. Weight of Measure | _____ | _____ |
| C. Weight of Aggregate | _____ | _____ |
| D. Convert weight of Aggregate from g to lbs. if necessary. | _____ | _____ |
| E. Correction Factor of Measure (Report to the nearest 0.001). | _____ | _____ |
| F. Weight per Cubic Foot (Reported to nearest lb/ft ³). | _____ | _____ |
| G. Average weight per Cubic Foot (Reported to nearest lb/ft ³). | _____ | |
| H. Average Tons/yd ³ (Reported to nearest 0.01 Tons/yd ³) | _____ | |

All weights measured to the nearest 0.1 lb or 50 g (0.05 kg).

$$C = A - B$$

$$D = C \div 453.6g \quad (\text{if } C \text{ is measured in g})$$

$$F = D \times E$$

$$G = (F_{1st} + F_{2nd}) \div 2$$

$$H = G \times 27 \div 2000$$

WATER DENSITY AT VARIOUS FARENHEIT TEMPERATURES

°F	lb/ft ³	°F	lb/ft ³	°F	lb/ft ³	°F	lb/ft ³	°F	lb/ft ³
60.0	62.366	65.4	62.333	70.8	62.295	76.2	62.250	81.6	62.200
60.2	62.365	65.6	62.332	71.0	62.293	76.4	62.249	81.8	62.199
60.4	62.364	65.8	62.331	71.2	62.292	76.6	62.247	82.0	62.196
60.6	62.363	66.0	62.329	71.4	62.290	76.8	62.245	82.2	62.195
60.8	62.362	66.2	62.328	71.6	62.289	77.0	62.244	82.4	62.193
61.0	62.360	66.4	62.327	71.8	62.287	77.2	62.242	82.6	62.191
61.2	62.359	66.6	62.325	72.0	62.286	77.4	62.240	82.8	62.189
61.4	62.358	66.8	62.324	72.2	62.284	77.6	62.238	83.0	62.187
61.6	62.357	67.0	62.322	72.4	62.282	77.8	62.236	83.2	62.184
61.8	62.356	67.2	62.321	72.6	62.281	78.0	62.234	83.4	62.182
62.0	62.355	67.4	62.320	72.8	62.279	78.2	62.233	83.6	62.180
62.2	62.353	67.6	62.318	73.0	62.278	78.4	62.231	83.8	62.178
62.4	62.352	67.8	62.317	73.2	62.276	78.6	62.229	84.0	62.176
62.6	62.351	68.0	62.316	73.4	62.274	78.8	62.227	84.2	62.174
62.8	62.350	68.2	62.314	73.6	62.273	79.0	62.225	84.4	62.172
63.0	62.349	68.4	62.313	73.8	62.271	79.2	62.223	84.6	62.170
63.2	62.347	68.6	62.311	74.0	62.269	79.4	62.222	84.8	62.168
63.4	62.346	68.8	62.310	74.2	62.268	79.6	62.220	85.0	62.166
63.6	62.345	69.0	62.308	74.4	62.266	79.8	62.218	85.2	62.164
63.8	62.344	69.2	62.307	74.6	62.264	80.0	62.216	85.4	62.162
64.0	62.343	69.4	62.305	74.8	62.263	80.2	62.214	85.6	62.160
64.2	62.341	69.6	62.304	75.0	62.261	80.4	62.212	85.8	62.158
64.4	62.340	69.8	62.302	75.2	62.259	80.6	62.210	86.0	62.155
64.6	62.338	70.0	62.301	75.4	62.258	80.8	62.208	86.2	62.153
64.8	62.337	70.2	62.299	75.6	62.256	81.0	62.206	86.4	62.151
65.0	62.336	70.4	62.298	75.8	62.254	81.2	62.204	86.6	62.149
65.2	62.335	70.6	62.296	76.0	62.252	81.4	62.202	86.8	62.147

CHAPTER 6
(ATTERBERG LIMITS)
LIQUID LIMIT
PLASTIC LIMIT
AND
PLASTICITY INDEX

1. Exercise #1: Use the information in Table 1, the attached T307 form and attached semilog paper to determine the liquid limit, plastic limit and the plasticity index.

Table 1. Test Results

Liquid Limit Test			
No. of Blows	Weight of Dish & Wet Soil	Weight of Dish & Dry Soil	Weight of Dish
32	42.30	38.12	20.24
24	40.29	36.45	20.45
16	41.38	36.98	20.31
Plastic Limit Test			
Weight of Dish & Wet Soil	Weight of Dish & Dry Soil	Weight of Dish	
36.93	34.33	20.37	

T307
Rev. 4-03

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL SOILS & TESTING DIVISION

LIQUID / PLASTIC LIMIT AND PLASTICITY INDEX

Lab Number		Project and Contract				Date Sampled				Transmit Date
Test Sequence	Material Code	C				Item Number	Plant Source Code	Aggregate Source Code		
		Quantity								
Sieves:	1st	2nd	3rd	4th	5th	6th	7th	8th	No. 200	
Design Number			Bitumen Content Target	Actual	Unit Weight	Face Fracture %One	%Two	LL	PL	PI
AASHTO Size	Smallest Sieve 100%		Target A-bar		Actual A-bar	FA A-bar	CA No. 200	FA No. 200	Total No. 200	P/F/N

Technician **Exercise #1** Date _____ Field Sample # _____

Source _____

Report all masses to nearest 0.01 g.
Calculate % of Water to nearest 0.1%.

LIQUID LIMIT

		A	B	C	D	E	F	G
Dish No.	No. of Blows	Mass of Dish & Wet Soil	Mass of Dish & Dry Soil	Mass of Dish	Mass of Water	Mass of Dry Soil	% of Water	Liquid Limit

PLASTIC LIMIT AND PLASTICITY INDEX

	H	K	L	M	N	P	R	S
Dish No.	Mass of Dish & Wet Soil	Mass of Dish & Dry Soil	Mass of Dish	Mass of Water	Mass of Dry Soil	% of Water	Plastic Limit	Plasticity Index

Liquid Limit

$$D = A - B$$

$$E = B - C$$

$$F = (D / E) \times 100$$

G = VALUE FROM FLOW CURVE (Nearest Whole No.) (3 pt. method)

G = F X (CORR. FACTOR) (Nearest Whole No.) (1 pt. method)

Plasticity Index

$$S = G - R$$

Plastic Limit

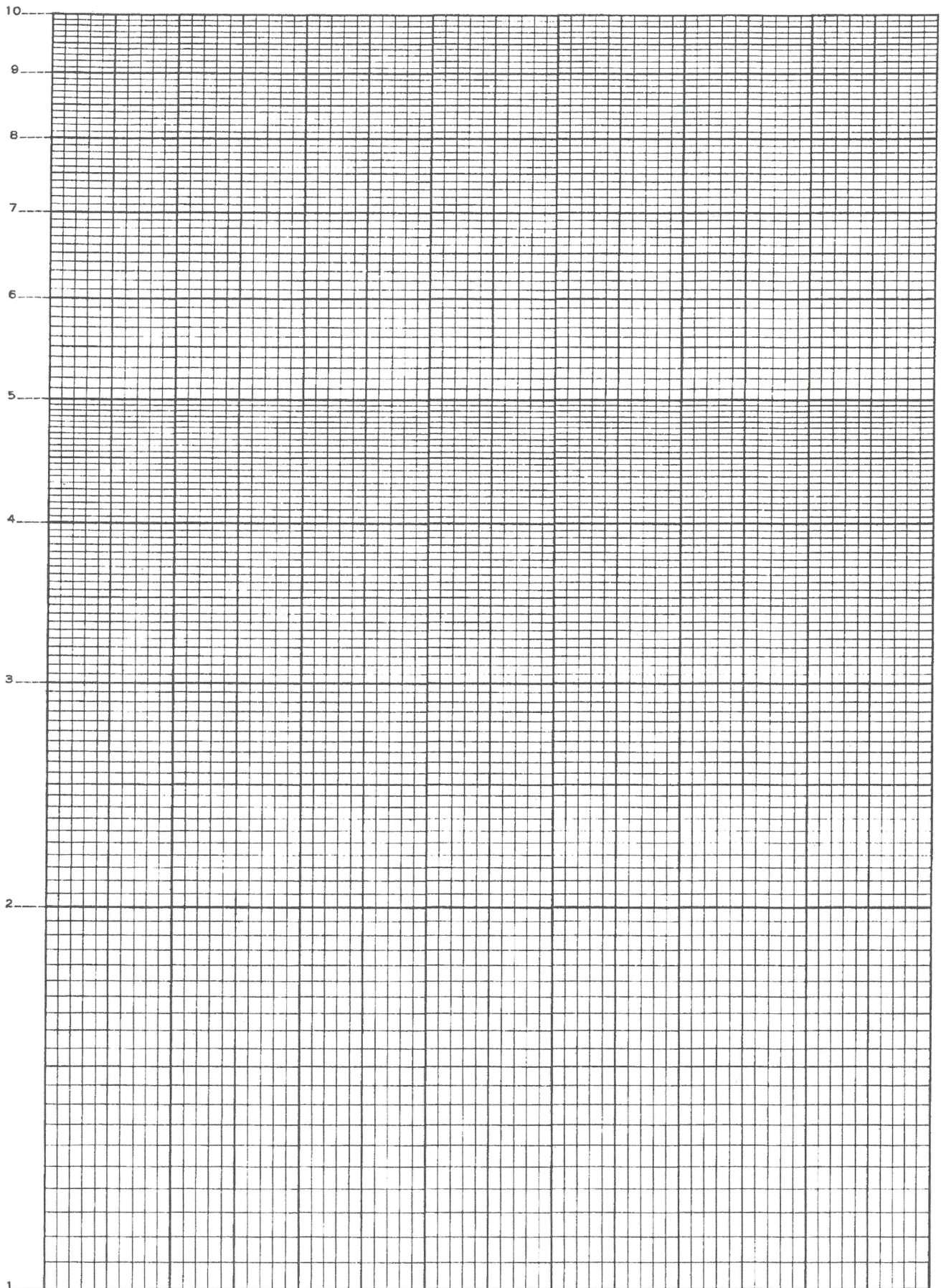
$$M = H - K$$

$$N = K - L$$

$$P = (M / N) \times 100$$

R = P (Nearest Whole No.)

Exercise #1



2. Exercise #2: Use the information in Table 2, the attached T307 form and attached semilog paper to determine the liquid limit, plastic limit and the plasticity index.

Table 2. Test Results

Liquid Limit Test			
No. of Blows	Weight of Dish & Wet Soil	Weight of Dish & Dry Soil	Weight of Dish
34	62.78	59.32	47.33
26	65.94	61.74	47.92
18	63.27	59.41	48.22
Plastic Limit Test			
Weight of Dish & Wet Soil	Weight of Dish & Dry Soil	Weight of Dish	
29.31	27.51	20.37	

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Rev. 4-03

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL SOILS & TESTING DIVISION

LIQUID / PLASTIC LIMIT AND PLASTICITY INDEX

Lab Number		Project and Contract					Date Sampled			Transmit Date	
Test Sequence	Material Code	C					Item Number	Plant Source Code	Aggregate Source Code		
		Quantity									
Sieves:	1st	2nd	3rd	4th	5th	6th	7th	8th	No. 200		
Design Number	Bitumen Content		Unit		Face Fracture		LL	PL	PI		
		Target	Actual	Weight	%One	%Two					
AASHTO Size	Smallest Sieve 100%	Target A-bar	Actual A-bar	FA A-bar	CA No. 200	FA No. 200	Total No. 200	P/F/N			

Technician **Exercise #2** Date _____ Field Sample # _____

Source _____

Report all masses to nearest 0.01 g.
Calculate % of Water to nearest 0.1%.

LIQUID LIMIT

		A	B	C	D	E	F	G
Dish No.	No. of Blows	Mass of Dish & Wet Soil	Mass of Dish & Dry Soil	Mass of Dish	Mass of Water	Mass of Dry Soil	% of Water	Liquid Limit

PLASTIC LIMIT AND PLASTICITY INDEX

	H	K	L	M	N	P	R	S
Dish No.	Mass of Dish & Wet Soil	Mass of Dish & Dry Soil	Mass of Dish	Mass of Water	Mass of Dry Soil	% of Water	Plastic Limit	Plasticity Index

Liquid Limit

$$D = A - B$$

$$E = B - C$$

$$F = (D / E) \times 100$$

G = VALUE FROM FLOW CURVE (Nearest Whole No.) (3 pt. method)

G = F X (CORR. FACTOR) (Nearest Whole No.) (1 pt. method)

Plasticity Index

$$S = G - R$$

Plastic Limit

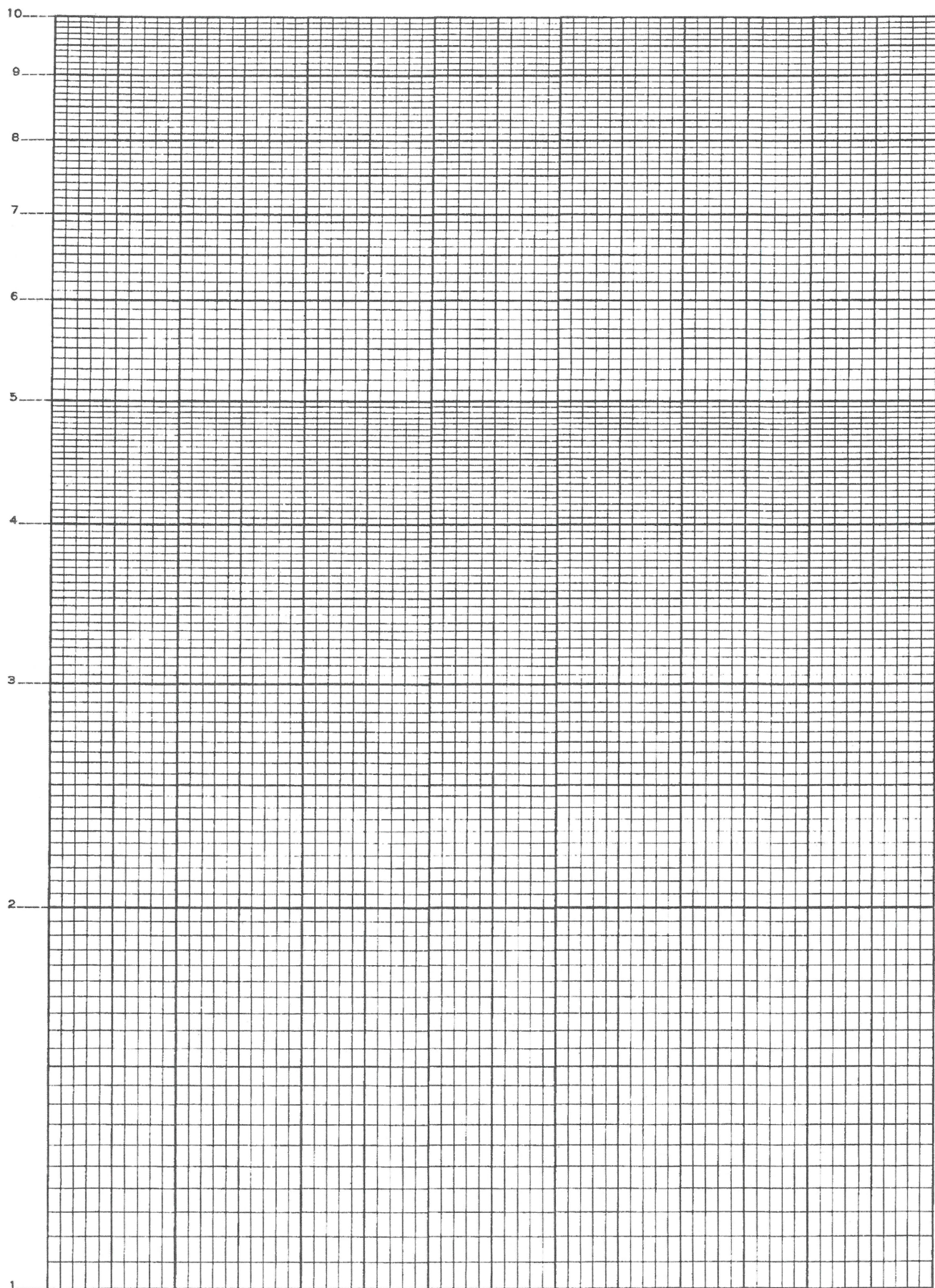
$$M = H - K$$

$$N = K - L$$

$$P = (M / N) \times 100$$

R = P (Nearest Whole No.)

Exercise #1



CHAPTER 7

FACE FRACTURE

1. Exercise #1: A face fracture test was conducted on a sample of AASHTO #57 crushed gravel and the results were recorded in Table 1. Use the information from Table 1 to complete the attached T302 form for Technician 1, Technician 2 and Final Results.

Table 1. Test Results

Technician 1	
Initial Mass	2013 grams
No Face Fracture	302 grams
Single-face Fracture	226 grams
Multiple-face Fracture	1485 grams
Technician 2	
Initial Mass	2013 grams
No Face Fracture	305 grams
Single-face Fracture	176 grams
Multiple-face Fracture	1532 grams

T302E
Rev. 4-03

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL SOILS & TESTING DIVISION
FACE FRACTURE
MP 703.00.21

Lab Number		Project and Contract				Date Sampled				Transmit Date
Test Sequence	Material Code	C				Item Number	Plant Source Code	Aggregate Source Code		
		Quantity								
Sieves:	1st	2nd	3rd	4th	5th	6th	7th	8th	No. 200	
Design Number	Bitumen Content		Unit Weight		Face Fracture		LL	PL	PI	
		Target	Actual			%One	%Two			
AASHTO Size	Smallest Sieve 100%	Target A-bar	Actual A-bar	FA A-bar	CA No. 200	FA No. 200	Total No. 200	P/F/N		

Technician 1: Exercise #1 Technician 2: _____

Source _____ Date _____ Field Sample # _____

Technician 1. Initial Mass _____

	Mass (Nearest 1g)	Percent of Sample (Nearest 0.1 %)
0 Face	_____	_____
1 Face	_____	_____
2 or More Face	_____	_____
Final Mass	_____	
Total Crushed Particles	_____	_____

Technician 2. Initial Mass _____

	Mass (Nearest 1g)	Percent of Sample (Nearest 0.1 %)
0 Face	_____	_____
1 Face	_____	_____
2 or More Face	_____	_____
Final Mass	_____	
Total Crushed Particles	_____	_____

Final Results	Tech 1	Tech 2	Difference (Must be 2% or less)	Tech 1 & Tech 2 Average to Nearest 1 %
0 Face	_____	_____	_____	_____
1 Face	_____	_____	_____	_____
2 or More Face	_____	_____	_____	_____
Total Crushed Particles	_____	_____	_____	_____

2. Exercise #2: A face fracture test was conducted on a sample of AASHTO #8 crushed gravel and the results were recorded in Table 2. Use the information from Table 2 to complete the attached T302 form for Technician 1, Technician 2 and Final Results.

Table 2. Test Results

Technician 1	
Initial Mass	519 grams
No Face Fracture	84 grams
Single-face Fracture	149 grams
Multiple-face Fracture	286 grams
Technician 2	
Initial Mass	519 grams
No Face Fracture	96 grams
Single-face Fracture	153 grams
Multiple-face Fracture	270 grams

T302E
Rev. 4-03

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL SOILS & TESTING DIVISION
FACE FRACTURE
MP 703.00.21

Lab Number		Project and Contract				Date Sampled				Transmit Date
Test Sequence	Material Code	C				Item Number	Plant Source Code	Aggregate Source Code		
		Quantity								
Sieves:	1st	2nd	3rd	4th	5th	6th	7th	8th	No. 200	
Design Number	Bitumen Content		Unit Weight		Face Fracture		LL	PL	PI	
	Target	Actual			%One	%Two				
AASHTO Size	Smallest Sieve 100%	Target A-bar	Actual A-bar	FA A-bar	CA No. 200	FA No. 200	Total No. 200	P/F/N		

Technician 1: Exercise #2 Technician 2: _____

Source _____ Date _____ Field Sample # _____

Technician 1. Initial Mass _____

	Mass (Nearest 1g)	Percent of Sample (Nearest 0.1 %)
0 Face	_____	_____
1 Face	_____	_____
2 or More Face	_____	_____
Final Mass	_____	
Total Crushed Particles	_____	_____

Technician 2. Initial Mass _____

	Mass (Nearest 1g)	Percent of Sample (Nearest 0.1 %)
0 Face	_____	_____
1 Face	_____	_____
2 or More Face	_____	_____
Final Mass	_____	
Total Crushed Particles	_____	_____

Final Results	Tech 1	Tech 2	Difference (Must be 2% or less)	Tech 1 & Tech 2 Average to Nearest 1 %
0 Face	_____	_____	_____	_____
1 Face	_____	_____	_____	_____
2 or More Face	_____	_____	_____	_____
Total Crushed Particles	_____	_____	_____	_____

ANSWERS

CHAPTER 2

SAMPLING

1. Exercise #1 Answer

- a. Total length of subplot is 2350 ft. minus 825 ft., which equal 1525 ft. To locate the sampling unit, multiply the length by the first random number.

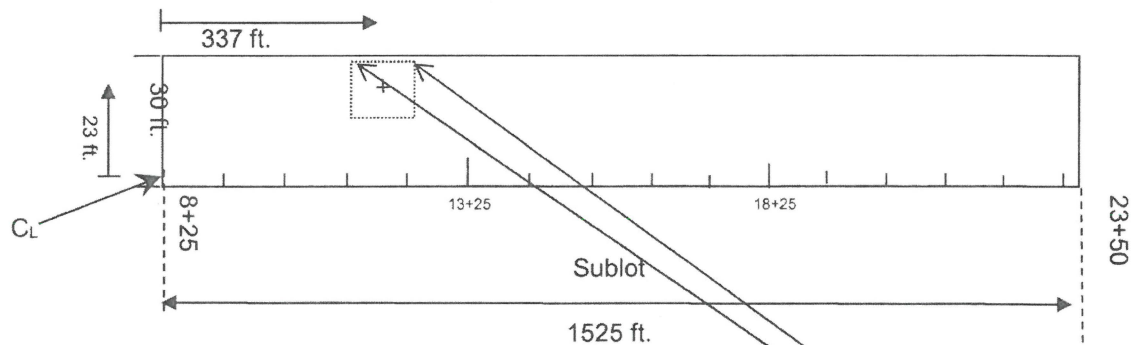
$$1525 \text{ ft.} \times 0.221 = 337 \text{ ft.}$$

- b. The mate to 0.221 in Attachment 1 is 0.777. The offset is calculated by multiplying the lane width by 0.777.

$$30 \text{ ft.} \times 0.777 = 23 \text{ ft.}$$

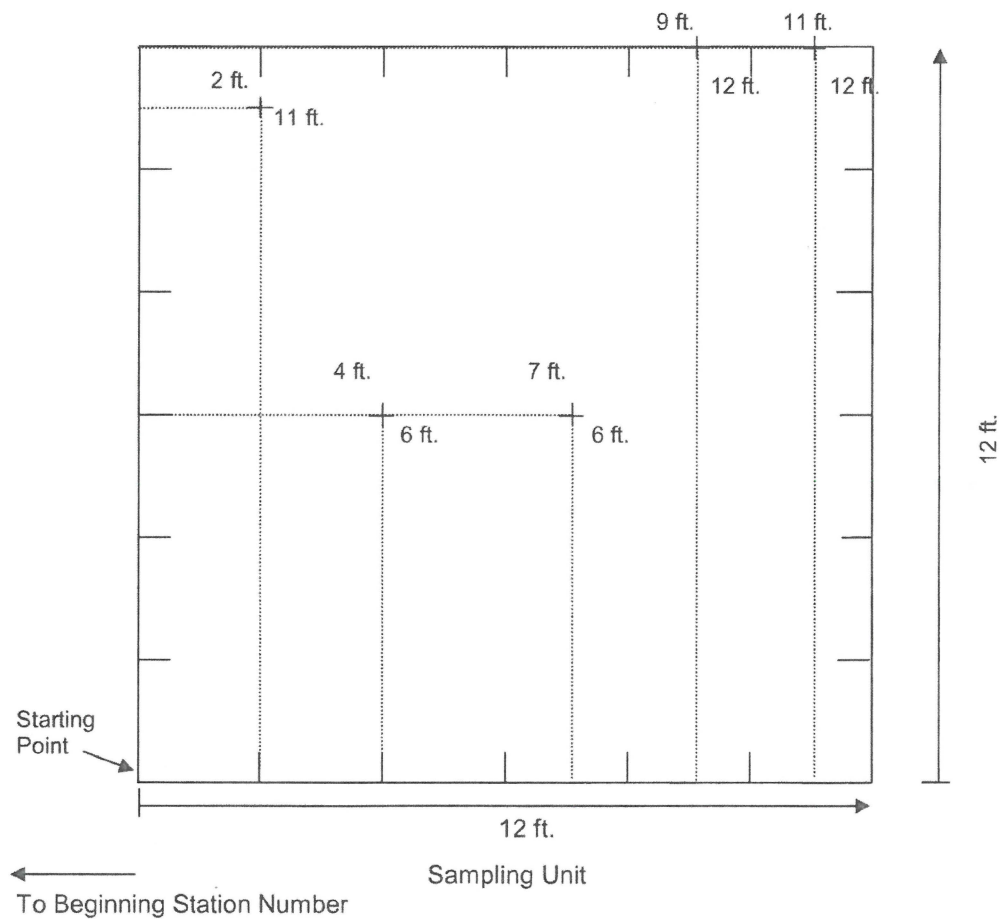
- c. To locate the random point for the sampling unit add 337 ft. to the lower station number 8+25, which equals station 11+ 62. The offset equals 23 ft.

$$337 \text{ ft.} + 825 \text{ ft.} = 1162 \text{ ft.}$$



- d. The sampling unit could be located with any corner or the center placed at the random point, however the sampling unit must remain completely within the subplot. In this exercise the center of the sampling unit was placed at the offset, however either of the two left corners (up station) could have been used as well.

- | | |
|-------------------------|-------------------------|
| 0.372 X 12 ft. = 4 ft. | 0.486 X 12 ft. = 6 ft. |
| 0.942 X 12 ft. = 11 ft. | 0.985 X 12 ft. = 12 ft. |
| 0.195 X 12 ft. = 2 ft. | 0.887 X 12 ft. = 11 ft. |
| 0.762 X 12 ft. = 9 ft. | 0.988 X 12 ft. = 12 ft. |
| 0.572 X 12 ft. = 7 ft. | 0.486 X 12 ft. = 6 ft. |



2. Exercise #2 Answer

- a. Sampling Unit Location: If your sampling frequency requires one sample per day, you can multiply the total operating time by your random number to locate the sampling unit. The plant would be operating 9 hours and 30 minutes, or a total of 570 minutes.

$$\begin{aligned}0.221 \times 570 &= 125.97 \text{ minutes} \\ &\text{rounded to 126 minutes} \\ &\text{(2 hr and 6 min)}\end{aligned}$$

You should be prepared to get a sample at 9:36 A.M. (7:30 + 2 hr 6 min).
The distance for locating the increments along the conveyor would be:

Increment Location

$$\begin{aligned}0.372 \times 80 \text{ ft.} &= 30 \text{ ft.} \\ 0.942 \times 80 \text{ ft.} &= 75 \text{ ft.} \\ 0.195 \times 80 \text{ ft.} &= 16 \text{ ft.} \\ 0.762 \times 80 \text{ ft.} &= 61 \text{ ft.} \\ 0.572 \times 80 \text{ ft.} &= 46 \text{ ft.}\end{aligned}$$

- b. Sampling Unit Locations: If you were required to two half-day samples. You could proceed as follows:

1st. Half Day

7:30 A.M. to 12:00 P.M.

$$4.5 \text{ hr.} \times 60 \text{ min.} \times 0.221 = 60 \text{ min.}$$

$$7:30 \text{ A.M.} + 1 \text{ hr.} = 8:30 \text{ A.M.}$$

2nd. Half Day

12:00 P.M. to 5:00 P.M.

$$5 \text{ hr.} \times 60 \text{ min.} \times 0.777 = 233 \text{ min.}$$

$$12:00 \text{ P.M.} + 3 \text{ hr. } 53 \text{ min.} = 3:53 \text{ P.M.}$$

In this case we would take the first sample at 8:30 A.M. and the second sample at 3:53 P.M., along the conveyor belt as indicated.

Increment Locations

1st. Half Day

$$\begin{aligned}0.372 \times 80 \text{ ft.} &= 30 \text{ ft.} \\ 0.942 \times 80 \text{ ft.} &= 75 \text{ ft.} \\ 0.195 \times 80 \text{ ft.} &= 16 \text{ ft.} \\ 0.762 \times 80 \text{ ft.} &= 61 \text{ ft.} \\ 0.572 \times 80 \text{ ft.} &= 46 \text{ ft.}\end{aligned}$$

2nd. Half Day

$$\begin{aligned}0.486 \times 80 \text{ ft.} &= 39 \text{ ft.} \\ 0.985 \times 80 \text{ ft.} &= 79 \text{ ft.} \\ 0.887 \times 80 \text{ ft.} &= 71 \text{ ft.} \\ ~~0.988 \times 80 \text{ ft.} &= 79 \text{ ft.}~~ \\ ~~0.486 \times 80 \text{ ft.} &= 39 \text{ ft.}~~ \\ *0.125 \times 80 \text{ ft.} &= 10 \text{ ft.} \\ *0.055 \times 80 \text{ ft.} &= 4 \text{ ft.}\end{aligned}$$

* Note: Because the numbers following 0.887 produce the same location as two numbers previously used, and two samples cannot be taken from the same location on the conveyor belt, it is required to continue down the chart utilizing the next number/s in sequence until a different sample location is established.

3. Exercise #3 Answer

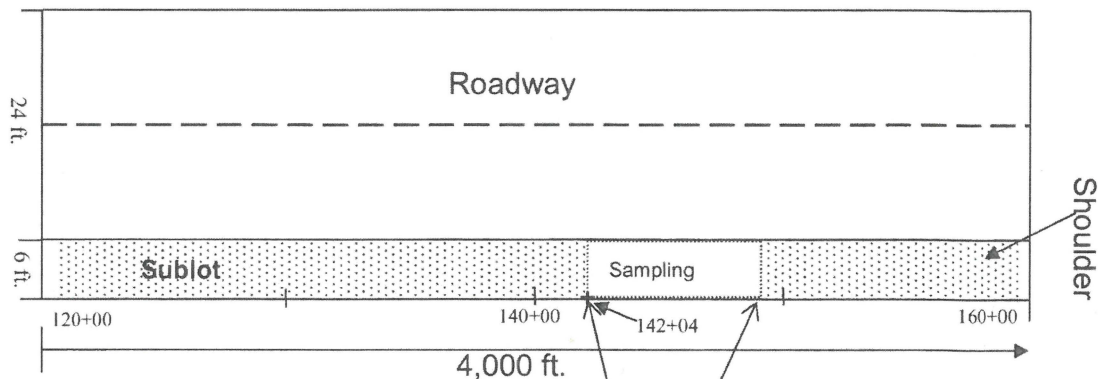
- a. Total length of subplot is 16,000 ft. minus 12,000 ft., which equals 4,000 ft. To locate the sampling unit, multiply the length by the first random number in the pair.

$$4,000 \text{ ft.} \times 0.551 = 2,204 \text{ ft.}$$

- b. The mate to 0.551 in Attachment 1 is 0.711. The shoulder is only 6 ft. wide so there is no offset and the number 0.711 is not used.
- c. To locate the random point for the sampling unit, add 2,204 ft. to the lower station number 120+00, which equals station 142+04.

$$2,204 \text{ ft.} + 12,000 \text{ ft.} = 14,204 \text{ ft.}$$
$$14204 \text{ ft.} = \text{station } 142+04$$

- d. A "SAMPLING UNIT" as defined in MP 700.00.06, paragraph 6.1.1 "an area having dimensions of approximately 12 ft. by 12 ft., or an area of approximately 144 square ft. in locations having any dimension less than 12 ft.". In this problem the shoulder is 6 ft. wide and requires a sampling unit that spans the entire width of the shoulder. To determine the length of the sampling unit divide 144 square ft. by 6 ft., which equal 24 ft. Therefore the sampling unit is 6 ft. wide by 24 ft. long.

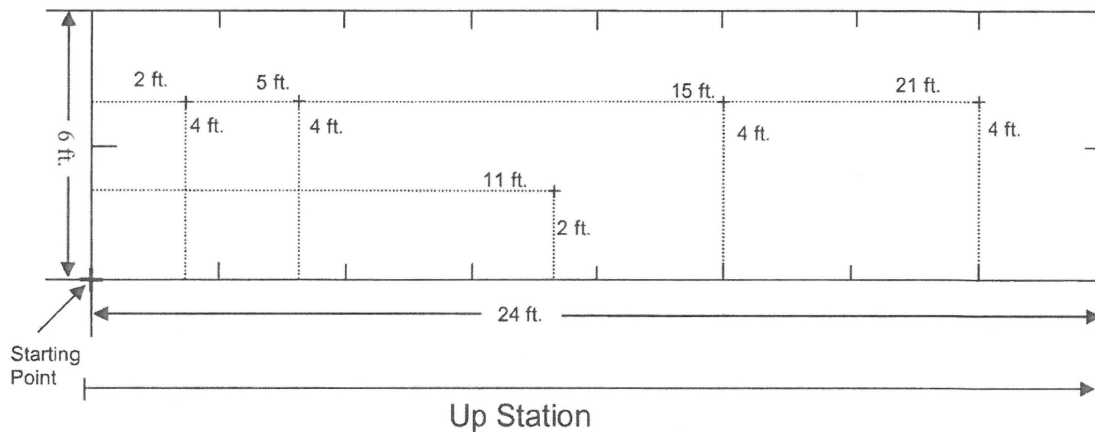


Note: Drawing not to scale.

- e. The sampling unit must remain completely within the subplot, so it could be placed with either of the right corners, facing up station, placed at the random point. In this case the sampling unit's lower right corner was placed at the random point.

- f. To locate the increments within the sampling unit, use the five pairs of random numbers following 0.551 and 0.771. Multiply the first set by the length (24 ft.) and multiply the second set by the width (6 ft.).

$0.444 \times 24 \text{ ft.} = 11 \text{ ft.}$	$0.323 \times 6 \text{ ft.} = 2 \text{ ft.}$
$0.866 \times 24 \text{ ft.} = 21 \text{ ft.}$	$0.685 \times 6 \text{ ft.} = 4 \text{ ft.}$
$0.629 \times 24 \text{ ft.} = 15 \text{ ft.}$	$0.631 \times 6 \text{ ft.} = 4 \text{ ft.}$
$0.215 \times 24 \text{ ft.} = 5 \text{ ft.}$	$0.667 \times 6 \text{ ft.} = 4 \text{ ft.}$
$0.065 \times 24 \text{ ft.} = 2 \text{ ft.}$	$0.627 \times 6 \text{ ft.} = 4 \text{ ft.}$



Note: Drawing not to scale.

CHAPTER 3

SIEVE ANALYSIS

WEST VIRGINIA DIVISION OF HIGHWAYS
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATE (AASHTO T-27)
MATERIALS FINER THAN No. 200 SIEVE BY WASHING (AASHTO T-11)

Site Manager I.D. #:	Aggregate Size: No. 57	Spec Sieve Sizes	%	Pass
Lab Reference Number:	Sieve Type Coarse: Large Screen Sieve	1-1/2 in. (37.5mm)	100	Pass
Technician:	Sieve Type Fine:	1 in. (25mm)	98	Pass
Producer / Supplier Code:	Material Type: Lime Stone	1/2 in. (12.5mm)	26	Pass
Producer / Supplier Name:	Contract #:	No. 4 (4.75mm)	2	Pass
Site Manager Material Code:	Project #:	No. 8 (2.36mm)	2	Pass
Date Sampled:	Auth #:	No. 200 (75µm)	1.4	Pass
Date Tested:	Item #:			
	Tons / CY			

- | | | |
|--|-----|---------|
| (A) Initial Oven Dry Mass of Total Sample..... | (A) | 10256.4 |
| (B) Oven Dry mass of Total Sample After T-11..... | (B) | 10135.7 |
| (C) Oven Dry Mass of Plus No. 4 Material..... | (C) | |
| (D) Oven Dry Mass of Plus No. 4 Material After T-11..... | (D) | |
| (E) Oven Dry Mass of Minus No. 4 Material Used in Split..... | (E) | |
| (F) Combination Gradation Coarse Fraction Pan Material After Dry Sieving (K)..... | (F) | |
| (G) Total Oven Dry Mass of Minus No. 4 Material (E+F)..... | (G) | |
| (H) Initial Oven Dry Mass of Total Fine Sample or Mass of Minus No. 4 Material..... | (H) | |
| (I) Oven Dry Mass of Total Fine Sample or Mass of Minus No. 4 Material After T-11..... | (I) | |

Sieve Analysis of Coarse Aggregate

Sieve Size	Mass Retained M_R		Over Loading	% Retained $(M_R/A) \times 100$	Percent Passing	Reported Percent Passing	Material Specifications	
	Regular	Combination					Low	High
1-1/2 in. (37.5mm)	0.0		ok	0.0	99.78	100	100	100
1 in. (25mm)	161.3		ok	1.6	98.18	98	95	100
3/4 in. (19mm)	3133.3		ok	30.5	67.68	68		
1/2 in. (12.5mm)	4275.1		ok	41.7	25.98	26	25	60
3/8 in. (9.5mm)	1497.5		ok	14.6	11.38	11		
No. 4 (4.75mm)	989.3		ok	9.6	1.78	2	0	10
No. 8 (2.36mm)	23.6		ok	0.2	1.58	2	0	5
No. 200 (75µm)	24.9		ok	0.2	1.38	1	0	1.5
(J) Pan	21.4							
(K) Combination Grad. Pan								
(L) Loss By T-11.....	120.7							
(M) Final Total (ΣM_R)	10,247.1							

C. F. = (G) ÷ (P)

C. F. = ÷

C. F. =

Sieve Analysis of Fine Aggregate

Sieve Size	Mass Retained M_R		Over Loading	% Retained $(M_R/(H+R)) \times 100$	Percent Passing	Reported Percent Passing	Material Specifications	
	Regular	Combination					Low	High
(N) Pan.....								
(O) Loss By T-11.....				Coarse - No. 200 Dry	21.4	Fine - No. 200 Dry		
(P) Final Total Fine Sample (ΣM_R).....				Coarse - No. 200 Wet	120.7	Fine - No. 200 Wet		
(Q) Final Total - No. 4 (ΣM_R).....				Total - No. 200	142.1	+ Init. Mass (A) or (H)	10256.4	
(R) Combined Total (M+Q).....				x 100 =	1.38547	%		
(S) Sample Loss or Gain	(A-M) or (M-A).....	9.3						
	(H-P) or (P-H).....							
	(A-R) or (R-A).....							
(T) Percentage of Initial OD Mass ($(S/A) \times 100$) or $((S/H) \times 100)$		0.1						

Name:

Signature:

Date:

Remarks:	Pass	Lab Info Only: ☐	

WEST VIRGINIA DIVISION OF HIGHWAYS
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATE (AASHTO T-27)
MATERIALS FINER THAN No. 200 SIEVE BY WASHING (AASHTO T-11)

Site Manager I.D.#:	Aggregate Size: Manufactured Sands	Spec Sieve Sizes	%	Pass	Pass / Fail
Lab Reference Number:	Sieve Type Coarse:	3/8 in. (9.5mm)	100	Pass	
Technician:	Sieve Type Fine: 12 Inch	No. 4 (4.75mm)	99	Pass	
Producer / Supplier Code:	Material Type: Sand Stone	No. 16 (1.18mm)	73	Pass	
Producer / Supplier Name:	Contract #:	No. 50 (300µm)	14	Pass	
Site Manager Material Code:	Project #:	No. 100 (150µm)	1	Fail	
Date Sampled:	Auth #:	No. 200 (75µm)	0.4	Pass	
Date Tested:	Item #:				
	Tons / CY				

- | | | |
|--|-----|-------|
| (A) Initial Oven Dry Mass of Total Sample..... | (A) | |
| (B) Oven Dry mass of Total Sample After T-11..... | (B) | |
| (C) Oven Dry Mass of Plus No. 4 Material..... | (C) | |
| (D) Oven Dry Mass of Plus No. 4 Material After T-11..... | (D) | |
| (E) Oven Dry Mass of Minus No. 4 Material Used in Split..... | (E) | |
| (F) Combination Gradation Coarse Fraction Pan Material After Dry Sieving (K)..... | (F) | |
| (G) Total Oven Dry Mass of Minus No. 4 Material (E+F)..... | (G) | |
| (H) Initial Oven Dry Mass of Total Fine Sample or Mass of Minus No. 4 Material..... | (H) | 375.2 |
| (I) Oven Dry Mass of Total Fine Sample or Mass of Minus No. 4 Material After T-11..... | (I) | 373.9 |

Sieve Analysis of Coarse Aggregate

Sieve Size	Mass Retained M_R		Over Loading	% Retained $(M_R/A) \times 100$	Percent Passing	Reported Percent Passing	Material Specifications	
	Regular	Combination					Low	High
(J) Pan								
(K) Combination Grad. Pan								
(L) Loss By T-11.....								
(M) Final Total (ΣM_R)								

C. F. = (G) ÷ (P)

C. F. = ÷ 374.6

C. F. =

Sieve Analysis of Fine Aggregate

Sieve Size	Mass Retained M_R		Over Loading	% Retained $(M_R/(H+R)) \times 100$	Percent Passing	Reported Percent Passing	Material Specifications	
	Regular	Combination					Low	High
3/8 in. (9.5mm)	0.0		ok	0.0	99.99	100	100	100
No. 4 (4.75mm)	1.8		ok	0.5	99.49	99	95	100
No. 8 (2.36mm)	43.1		ok	11.5	87.99	88		
No. 16 (1.18mm)	55.6		ok	14.8	73.19	73	45	80
No. 30 (600µm)	81.3		ok	21.7	51.49	51		
No. 50 (300µm)	138.7		ok	37.0	14.49	14	10	30
No. 100 (150µm)	48.6		ok	13.0	1.49	1	2	10
No. 200 (75µm)	4.0		ok	1.1	0.39	0.4	0	5
(N) Pan.....	0.2							
(O) Loss By T-11.....	1.300		Coarse - No. 200 Dry			Fine - No. 200 Dry	0.2	
(P) Final Total Fine Sample (ΣM_R).....	374.6		Coarse - No. 200 Wet			Fine - No. 200 Wet	1.3	
(Q) Final Total - No. 4 (ΣM_R).....			Total - No. 200	1.5	+	Init. Mass (A) or (H)	375.2	
(R) Combined Total (M+Q).....				x 100 =	0.39978	%		
(S) Sample Loss or Gain	(A-M) or (M-A).....							
	(H-P) or (P-H).....	0.6						
	(A-R) or (R-A).....							
(T) Percentage of Initial OD Mass ($(S/A) \times 100$) or ($(S/H) \times 100$)		0.2						

Name:

Signature:

Date:

Remarks:	Fail	Lab Info Only: ☐	
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WEST VIRGINIA DIVISION OF HIGHWAYS
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATE (AASHTO T-27)
MATERIALS FINER THAN No. 200 SIEVE BY WASHING (AASHTO T-11)

Site Manager I.D.#:	Aggregate Size: Class 1	Spec Sieve Sizes	%	Pass	Pass /Fail
Lab Reference Number:	Sieve Type Coarse: Large Screen Sieve	1-1/2 in. (37.5mm)	100	Pass	
Technician:	Sieve Type Fine: 12 Inch	3/4 in. (19mm)	92	Fail	
Producer / Supplier Code:	Material Type: Lime Stone	No. 4 (4.75mm)	38	Pass	
Producer / Supplier Name:	Contract #:	No. 40 (425µm)	7	Pass	
Site Manager Material Code:	Project #:	No. 200 (75µm)	2.4	Pass	
Date Sampled:	Auth #:				
Date Tested:	Item #:				
	Tons / CY				

(A) Initial Oven Dry Mass of Total Sample.....	(A)	10559.8
(B) Oven Dry mass of Total Sample After T-11.....	(B)	
(C) Oven Dry Mass of Plus No. 4 Material.....	(C)	6738.3
(D) Oven Dry Mass of Plus No. 4 Material After T-11.....	(D)	6697.1
(E) Oven Dry Mass of Minus No. 4 Material Used in Split.....	(E)	3795.7
(F) Combination Gradation Coarse Fraction Pan Material After Dry Sieving (K).....	(F)	130.0
(G) Total Oven Dry Mass of Minus No. 4 Material (E+F).....	(G)	3925.7
(H) Initial Oven Dry Mass of Total Fine Sample or Mass of Minus No. 4 Material.....	(H)	350.2
(I) Oven Dry Mass of Total Fine Sample or Mass of Minus No. 4 Material After T-11.....	(I)	335.8

Sieve Analysis of Coarse Aggregate

Sieve Size	Mass Retained M _R		Over Loading	% Retained (M _R /A)x100	Percent Passing	Reported Percent Passing	Material Specifications	
	Regular	Combination					Low	High
1-1/2 in. (37.5mm)		0.0	ok	0.0	99.88	100	100	100
1 in. (25mm)		112.0	ok	1.1	98.78	99		
3/4 in. (19mm)		737.0	ok	7.0	91.78	92	50	90
1/2 in. (12.5mm)		1,982.0	ok	18.8	72.98	73		
3/8 in. (9.5mm)		1,159.0	ok	11.0	61.98	62		
No. 4 (4.75mm)		2,577.0	ok	24.4	37.58	38	20	50

(J) Pan					
(K) Combination Grad. Pan	130.0			C. F. = (G) ÷ (P)	
(L) Loss By T-11	41.2			C. F. = 3,925.7 ÷ 350.4	
(M) Final Total (Σ M _R)	6,608.2			C. F. = 11.2035	

Sieve Analysis of Fine Aggregate

Sieve Size	Mass Retained M _R		Over Loading	% Retained (M _R /(H+R))x100	Percent Passing	Reported Percent Passing	Material Specifications	
	Regular	Combination					Low	High
No. 8 (2.36mm)	148.1	1659.2	ok	15.7	21.88	22		
No. 16 (1.18mm)	82.0	918.7	ok	8.7	13.18	13		
No. 40 (425µm)	58.4	654.3	ok	6.2	6.98	7	5	20
No. 200 (75µm)	43.1	482.9	ok	4.6	2.38	2.4	0	7

(N) Pan.....	4.4	49.3			
(O) Loss By T-11.....	14.400	161.3	Coarse - No. 200 Dry		Fine - No. 200 Dry 49.3
(P) Final Total Fine Sample (Σ M _R).....	350.4		Coarse - No. 200 Wet	41.2	Fine - No. 200 Wet 161.3
(Q) Final Total - No. 4 (Σ M _R).....		3925.7	Total - No. 200	251.8	+ Init. Mass (A) or (H) 10559.8
(R) Combined Total (M+Q).....		10533.9		x 100 = 2.38451	%
(S) Sample Loss or Gain	(A-M) or (M-A).....				
	(H-P) or (P-H).....				
	(A-R) or (R-A).....	25.9			
(T) Percentage of Initial OD Mass ((S/A)x100) or ((S/H)x100)		0.2			

Name:

Signature:

Date:

Remarks:	Fail	Lab Info Only: ☐	

T301E
Rev. 4-03

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOIL AND TESTING
A CALCULATION WORKSHEET

F. S. #
Tech.
Date

C4Z5555

Your Name + Lab

Today's Date

Lab Number Exercise #4	Project and Contract C					Date Sampled		Transmit Date	
Test Sequence	Material Code	Quantity			Item Number	Plant Source Code	Aggregate Source Code		
Sieves:	1st	2nd	3rd	4th	5th	6th	7th	8th	No. 200
Design Number				Unit Weight	Face Fracture % One	% Two	LL	PL	PI
AASHTO Size		Smallest Sieve 100%	Target A-bar 4.90	Actual A-bar 4.65	FA A-bar 6.26	CA No. 200 1.4	FA No. 200 0.4	Total No. 200 1.0	P/F/N P

Plant Name _____ Source Coarse Agg. _____

Technician _____ Date _____ Source Fine Agg. _____

Class of Concrete _____ Cmnt Fact _____ Field Sample # _____

Sieves CA #57 1mst FA Silica Sand Man Cement Total Mass of Each Solid at SSD in One yd³ of Concrete From Mix Design

1 1/2" % pass	100	100	100	M _{ca}	1720	lb
3/4" % pass	68	100	100	M _{fa}	1264	lb
3/8" % pass	11	100	100	M _{ca} + M _{fa}	2984	lb
No. 4 % pass	2	99	100	*M _c	521	lb
No. 8 % pass	2	88	100	M _t	3505	lb
No. 16 % pass	0	73	100	Fractional Part of Each Solid (0.001)		
No. 30 % pass	0	51	100	$\frac{M_{ca}}{M_t} = \frac{1720}{3505} =$	0.491	
No. 50 % pass	0	14	100	$\frac{M_{fa}}{M_t} = \frac{1264}{3505} =$	0.361	
No. 100 % pass	0	1	100	$\frac{*M_c}{M_t} = \frac{521}{3505} =$	0.149	
No. 200 % pass	1.4	0.4	100			
Total	184.4	626.4	1000.0			
Solid A's	1.84	6.26	10.00			

Solid Fraction x Each Solid A				Fractional Part of Coarse and Fine Agg. (0.001)		
Coarse Agg	0.491	x	1.84	=	0.90	A _{ca}
Fine Agg	0.361	x	6.26	=	2.26	A _{fa}
Cement	0.149	x	10.00	=	1.49	A _c
				$F_{ca} = \frac{M_{ca}}{M_{ca} + M_{fa}} = \frac{1720}{2984} =$	0.576	
				$F_{fa} = \frac{M_{fa}}{M_{ca} + M_{fa}} = \frac{1264}{2984} =$	0.424	

Adjusted and Maximum Minus No. 200 Based on Fractional Part of Total Aggregate (0.01)

- No. 200 % pass x F _{ca} or F _{fa} =				Adjusted Total - 200 CA + FA	
CA	1.4	x	0.576	=	0.81
FA	0.4	x	0.424	=	0.17
- No. 200 Spec Limit x F _{ca} or F _{fa} =				Max. Allowed Total - 200 CA + FA	
CA	1.5	x	0.576	=	0.86
FA	5.0	x	0.424	=	2.12
A Total Solids A _{ca} + A _{fa} + A _c				4.65	
Target A				4.90	
A Tolerance ±				0.25	
Total A P/F				P	

T301E
Rev. 4-03

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOIL AND TESTING
A CALCULATION WORKSHEET

F. S. #
Tech.
Date

C5Z5555
Your Name + Lab
Today's Date

Lab Number Exercise #5	Project and Contract C					Date Sampled		Transmit Date	
Test Sequence	Material Code		Quantity		Item Number	Plant Source Code		Aggregate Source Code	
Sieves:	1st	2nd	3rd	4th	5th	6th	7th	8th	No. 200
Design Number				Unit Weight	Face Fracture % One	% Two	LL	PL	PI
AASHTO Size	Smallest Sieve 100%		Target A-bar 4.88	Actual A-bar 4.72	FA A-bar 6.36	CA No. 200 1.0	FA No. 200 2.5	Total No. 200 1.6	P/F/N P

Plant Name _____ Source Coarse Agg. _____
 Technician _____ Date _____ Source Fine Agg. _____
 Class of Concrete _____ Cmnt Fact _____ Field Sample # _____

Sieves	CA #57 Uncr grvl	FA silica sand	Cement
1 1/2" % pass	100	100	100
3/4" % pass	76	100	100
3/8" % pass	12	100	100
No. 4 % pass	3	98	100
No. 8 % pass	2	83	100
No. 16 % pass	0	67	100
No. 30 % pass	0	55	100
No. 50 % pass	0	25	100
No. 100 % pass	0	5	100
No. 200 % pass	1.0	2.5	100
Total	194.0	635.5	1000.0
Solid A's	1.94	6.36	10.00

Total Mass of Each Solid at SSD in One
yd³ of Concrete From Mix Design

$M_{ca} = 1808$ lb
 $M_{fa} = 1366$ lb
 $M_{ca} + M_{fa} = 3174$ lb
 $*M_c = 536$ lb
 $M_t = 3710$ lb

Fractional Part of Each Solid (0.001)

$$\frac{M_{ca}}{M_t} = \frac{1808}{3710} = 0.487$$

$$\frac{M_{fa}}{M_t} = \frac{1366}{3710} = 0.368$$

$$\frac{*M_c}{M_t} = \frac{536}{3710} = 0.144$$

* Include Mass of Fly Ash When Used.

Fractional Part of Coarse and Fine Agg. (0.001)

$$F_{ca} = \frac{M_{ca}}{M_{ca} + M_{fa}} = \frac{1808}{3174} = 0.570$$

$$F_{fa} = \frac{M_{fa}}{M_{ca} + M_{fa}} = \frac{1366}{3174} = 0.430$$

Adjusted and Maximum Minus No. 200 Based on Fractional Part of
Total Aggregate (0.01)

- No. 200 % pass x F_{ca} or F_{fa} =			Adjusted Total - 200 CA + FA
CA	1.0	x 0.570 = 0.57	
FA	2.5	x 0.430 = 1.08	1.6
- No. 200 Spec Limit x F_{ca} or F_{fa} =			Max. Allowed Total - 200 CA + FA
CA	1.0	x 0.570 = 0.57	
FA	3.0	x 0.430 = 1.29	1.9

A Total Solids	$\bar{A}_{ca} + \bar{A}_{fa} + \bar{A}_c$	4.72
Target A		4.88
A Tolerance $\pm$		0.25
Total A P/F		P

CHAPTER 4

SPECIFIC GRAVITY

T305

Rev. 12-01

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

BULK SPECIFIC GRAVITY AND ABSORPTION
FINE AGGREGATE

Laboratory No. **Exercise #1**

Field Sample No. _____

Date _____

Source _____

Tested By _____

(Record masses to 0.1 g)

A = Mass of oven-dry sample in air, grams ((a)-(b)) 495.3

(a) Mass of oven-dry sample
and drying pan in air, grams 547.6

(b) Mass of drying pan, grams 52.3

B = Mass of pycnometer filled to calibration mark with
distilled water, grams 669.8

C = Mass of pycnometer, sample, and water to calibration
mark, grams 973.4

D = Mass of saturated-surface-dry sample in air, grams 501.1

Bulk Specific Gravity (Oven Dry Basis) = $\frac{A}{B+D-C}$ = 2.51

Bulk Specific Gravity (Saturated-Surface-Dry Basis) = $\frac{D}{B+D-C}$ = 2.54

Apparent Specific Gravity = $\frac{A}{B+A-C}$ = 2.58

Absorption, percent = $\frac{D-A}{A} \times 100$ = 1.2

Report Specific Gravities to the nearest 0.01

Report Absorption to the nearest 0.1%

T305
Rev. 12-01

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

BULK SPECIFIC GRAVITY AND ABSORPTION
FINE AGGREGATE

Laboratory No. Exercise #2

Field Sample No. _____

Date _____

Source _____

Tested By _____

(Record masses to 0.1 g)

A = Mass of oven-dry sample in air, grams ((a)-(b)) 505.3

(a) Mass of oven-dry sample
and drying pan in air, grams 555.5

(b) Mass of drying pan, grams 50.2

B = Mass of pycnometer filled to calibration mark with
distilled water, grams 676.2

C = Mass of pycnometer, sample, and water to calibration
mark, grams 985.3

D = Mass of saturated-surface-dry sample in air, grams 509.2

Bulk Specific Gravity = $\frac{A}{B+D-C}$ = 2.53
(Oven Dry Basis)

Bulk Specific Gravity = $\frac{D}{B+D-C}$ = 2.54
(Saturated-Surface-Dry Basis)

Apparent Specific Gravity = $\frac{A}{B+A-C}$ = 2.58

Absorption, percent = $\frac{D-A}{A} \times 100$ = 0.8

Report Specific Gravities to the nearest 0.01
Report Absorption to the nearest 0.1%

T306
Rev. 4-03

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL SOILS & TESTING DIVISION

BULK SPECIFIC GRAVITY AND ABSORPTION
COARSE AGGREGATE

Laboratory No. Exercise #3

Field Sample No. _____

Date _____

Source _____

Tested By _____

(Record masses to 1 g)

A = Mass of oven-dry sample in air, grams 5110

B = Mass of saturated-surface-dry sample in air, grams 5290

C = Mass of saturated sample in water, grams 3220

Bulk Specific Gravity = $\frac{A}{B-C}$ = 2.47
(Oven Dry Basis)

Bulk Specific Gravity = $\frac{B}{B-C}$ = 2.56
(Saturated-Surface-Dry Basis)

Apparent Specific Gravity = $\frac{A}{A-C}$ = 2.70

Absorption, percent = $\frac{B-A}{A} \times 100$ = 3.5

Report Specific Gravities to the nearest 0.01
Report Absorption to the nearest 0.1%

T306
Rev. 4-03

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL SOILS & TESTING DIVISION

BULK SPECIFIC GRAVITY AND ABSORPTION
COARSE AGGREGATE

Laboratory No. Exercise #4

Field Sample No. _____

Date _____

Source _____

Tested By _____

(Record masses to 1 g)

A = Mass of oven-dry sample in air, grams 4987

B = Mass of saturated-surface-dry sample in air, grams 5080

C = Mass of saturated sample in water, grams 3089

Bulk Specific Gravity = $\frac{A}{B-C}$ = 2.50
(Oven Dry Basis)

Bulk Specific Gravity = $\frac{B}{B-C}$ = 2.55
(Saturated-Surface-Dry Basis)

Apparent Specific Gravity = $\frac{A}{A-C}$ = 2.63

Absorption, percent = $\frac{B-A}{A} \times 100$ = 1.9

Report Specific Gravities to the nearest 0.01
Report Absorption to the nearest 0.1%

CHAPTER 5

UNIT WEIGHT

T303E

UNIT WEIGHT OF AGGREGATE

Rev. 12-01

AASHTO T-19

ASTM C-29

CALIBRATION OF UNIT WEIGHT MEASURE

DATE

Exercise #1

CALIBRATED BY

MEASURE SIZE

1/3

A. Weight of Measure, Glass, Grease, and Water

15050

B. Weight of Measure, Glass, and Grease

5650

C. Weight of Water in Measure

9400

D. Convert g to lbs. if necessary

20.7

E. Temperature of Water (Nearest 0.2°F or 0.1°C)

76.0

F. Weight of Water at Temperature E (from Tables in

62.252

Aggregate Manual Chap. 5, AASHTO T19, or ASTM C29)

G. Factor for Measure (Round to the nearest thousandth)

3.007

All weights rounded to the nearest 0.1 lb or 50 g (0.05 kg).

$C = A - B$

$D = C \div 453.6$ (If C measured in g)

$D = C$ (If C measured in lb)

$G = F \div D$

T304E
Rev.12-01

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL SOILS & TESTING DIVISION

UNIT WEIGHT OF AGGREGATE

Lab Number		Project and Contract					Date Sampled			Transmit Date	
Test Sequence	Material Code	C					Item Number	Plant Source Code	Aggregate Source Code		
		Quantity							Source Code		
Sieves:	1st	2nd	3rd	4th	5th	6th	7th	8th	No. 200		
Design Number	Bitumen Content		Target	Actual	Unit Weight	Face Fracture %Two		%One	LL	PL	PI
AASHTO Size	Smallest Sieve 100%	Target A-bar	102		Actual A-bar	FA A-bar	CA No. 200	FA No. 200	Total No. 200	P/F/N	

Technician **Exercise #1** Rodded _____ Loose _____ Jigged _____
Source _____ Date _____ Field Sample # _____

A. Weight of Measure and Aggregate	1st Trial 20450	2nd Trial 20550
B. Weight of Measure	5050	5050
C. Weight of Aggregate	15400	15500
D. Convert Weight of Aggregate from g to lbs.	34.0	34.2
E. Correction Factor of Measure (Report to the nearest 0.001)	3.007	3.007
F. Weight per Cubic Foot (Reported to nearest lb/ft ³)	102	103
G. Average Weight per Cubic Foot (Reported to nearest lb/ft ³)	103	
H. Average Tons/yd ³ (Reported to nearest 0.01 Tons/yd ³)	1.39	

All weights measured to the nearest 0.1 lb or 50 g (0.05 kg).

$$C = A - B$$

$$D = C \div 453.6g \quad (\text{if } C \text{ is measured in g})$$

$$F = D \times E$$

$$G = (F_{1st} + F_{2nd}) \div 2$$

$$H = G \times 27 \div 2000$$

T303E

UNIT WEIGHT OF AGGREGATE

Rev. 12-01

AASHTO T-19

ASTM C-29

CALIBRATION OF UNIT WEIGHT MEASURE

DATE

Exercise #2

CALIBRATED BY

MEASURE SIZE

1/2

A. Weight of Measure, Glass, Grease, and Water

21350

B. Weight of Measure, Glass, and Grease

6950

C. Weight of Water in Measure

14400

D. Convert g to lbs. if necessary

31.7

E. Temperature of Water (Nearest 0.2°F or 0.1°C)

74.0

F. Weight of Water at Temperature E (from Tables in

62.269

Aggregate Manual Chap. 5, AASHTO T19, or ASTM C29)

G. Factor for Measure (Round to the nearest thousandth)

1.964

All weights rounded to the nearest 0.1 lb or 50 g (0.05 kg).

$C = A - B$

$D = C \div 453.6$ (If C measured in g)

$D = C$ (If C measured in lb)

$G = F \div D$

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL SOILS & TESTING DIVISION

UNIT WEIGHT OF AGGREGATE

Lab Number		Project and Contract				Date Sampled				Transmit Date	
Test Sequence	Material Code	C				Item Number	Plant Source Code	Aggregate Source Code			
		Quantity									
Sieves:	1st	2nd	3rd	4th	5th	6th	7th	8th	No. 200		
Design Number			Bitumen Content Target	Actual	Unit Weight	Face Fracture %Two	%One	LL	PL	PI	
AASHTO Size	Smallest Sieve 100%		Target A-bar		104 Actual A-bar	FA A-bar	CA No. 200	FA No. 200	Total No. 200	P/F/N	

Technician **Exercise #2** Rodded _____ Loose _____ Jigged _____
Source _____ Date _____ Field Sample # _____

	1st Trial	2nd Trial
A. Weight of Measure and Aggregate	30900	31000
B. Weight of Measure	6750	6750
C. Weight of Aggregate	24150	24250
D. Convert Weight of Aggregate from g to lbs.	53.2	53.5
E. Correction Factor of Measure (Report to the nearest 0.001)	1.964	1.964
F. Weight per Cubic Foot (Reported to nearest lb/ft ³)	104	105
G. Average Weight per Cubic Foot (Reported to nearest lb/ft ³)	105	
H. Average Tons/yd ³ (Reported to nearest 0.01 Tons/yd ³)	1.42	

All weights measured to the nearest 0.1 lb or 50 g (0.05 kg).

$$C = A - B$$

$$D = C \div 453.6g \quad (\text{if } C \text{ is measured in } g)$$

$$F = D \times E$$

$$G = (F_{1st} + F_{2nd}) \div 2$$

$$H = G \times 27 \div 2000$$

CHAPTER 6
(ATTERBERG LIMITS)
LIQUID LIMIT
PLASTIC LIMIT
AND
PLASTICITY INDEX

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL SOILS & TESTING DIVISION

LIQUID / PLASTIC LIMIT AND PLASTICITY INDEX

Lab Number		Project and Contract					Date Sampled			Transmit Date	
Test Sequence	Material Code		C					Item Number	Plant Source Code	Aggregate Source Code	
			Quantity								
Sieves:	1st	2nd	3rd	4th	5th	6th	7th	8th	No. 200		
Design Number			Bitumen Content Target Actual		Unit Weight	Face %One	Fracture %Two	LL	PL	PI	
								24	19	5	
AASHTO Size	Smallest Sieve 100%		Target A-bar		Actual A-bar	FA A-bar	CA No. 200	FA No. 200	Total No. 200	P/F/N	

Technician **Exercise #1** Date _____ Field Sample # _____

Source _____

Report all masses to nearest 0.01 g.
Calculate % of Water to nearest 0.1%.

LIQUID LIMIT

		A	B	C	D	E	F	G
Dish No.	No. of Blows	Mass of Dish & Wet Soil	Mass of Dish & Dry Soil	Mass of Dish	Mass of Water	Mass of Dry Soil	% of Water	Liquid Limit
1	32	42.30	38.12	20.24	4.18	17.88	23.4	
2	24	40.29	36.45	20.45	3.84	16.00	24.0	24
3	16	41.38	36.98	20.31	4.40	16.67	26.4	

PLASTIC LIMIT AND PLASTICITY INDEX

	H	K	L	M	N	P	R	S
Dish No.	Mass of Dish & Wet Soil	Mass of Dish & Dry Soil	Mass of Dish	Mass of Water	Mass of Dry Soil	% of Water	Plastic Limit	Plasticity Index
4	36.93	34.33	20.37	2.60	13.96	18.6	19	5

Liquid Limit

$$D = A - B$$

$$E = B - C$$

$$F = (D / E) \times 100$$

G = VALUE FROM FLOW CURVE (Nearest Whole No.) (3 pt. method)

G = F X (CORR. FACTOR) (Nearest Whole No.) (1 pt. method)

Plasticity Index

$$S = G - R$$

Plastic Limit

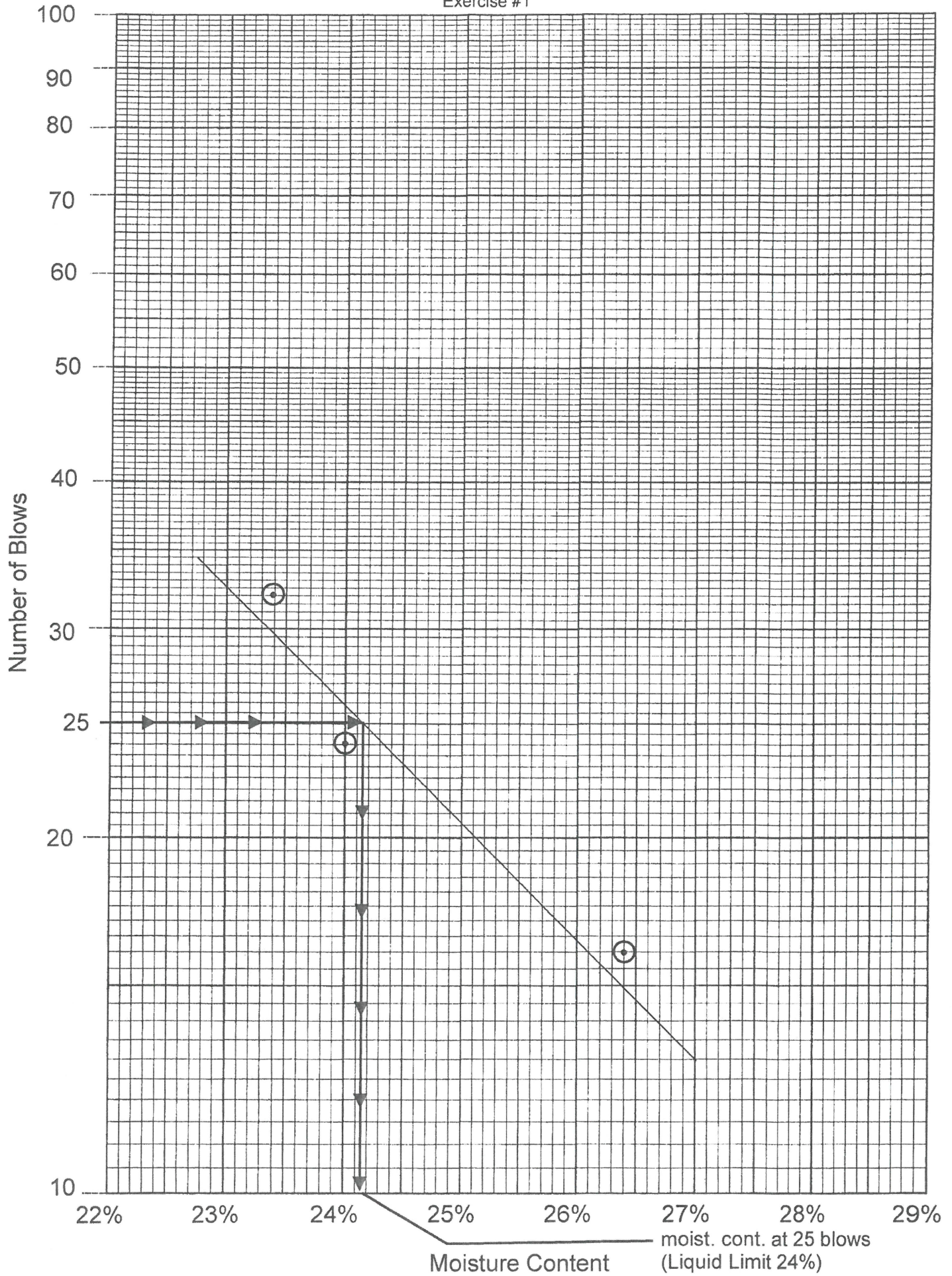
$$M = H - K$$

$$N = K - L$$

$$P = (M / N) \times 100$$

R = P (Nearest Whole No.)

Exercise #1



WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL SOILS & TESTING DIVISION

LIQUID / PLASTIC LIMIT AND PLASTICITY INDEX

Lab Number		Project and Contract				Date Sampled				Transmit Date	
Test Sequence	Material Code		C				Item Number	Plant Source Code		Aggregate Source Code	
	1st	2nd	3rd	4th	5th	6th		7th	8th	No. 200	
Sieves:	1st	2nd	3rd	4th	5th	6th	7th	8th	No. 200		
Design Number			Bitumen Content Target Actual		Unit Weight	Face %One	Fracture %Two	LL	PL	PI	
AASHTO Size	Smallest Sieve 100%		Target A-bar		Actual A-bar	FA A-bar	CA No. 200	FA No. 200	Total No. 200	P/F/N	

Technician **Exercise #2** Date _____ Field Sample # _____

Source _____

Report all masses to nearest 0.01 g.
Calculate % of Water to nearest 0.1%.

LIQUID LIMIT

		A	B	C	D	E	F	G
Dish No.	No. of Blows	Mass of Dish & Wet Soil	Mass of Dish & Dry Soil	Mass of Dish	Mass of Water	Mass of Dry Soil	% of Water	Liquid Limit
1	34	62.78	59.32	47.33	3.46	11.99	28.9	
2	26	65.94	61.74	47.92	4.20	13.82	30.4	31
3	18	63.27	59.41	48.22	3.86	11.19	34.5	

PLASTIC LIMIT AND PLASTICITY INDEX

	H	K	L	M	N	P	R	S
Dish No.	Mass of Dish & Wet Soil	Mass of Dish & Dry Soil	Mass of Dish	Mass of Water	Mass of Dry Soil	% of Water	Plastic Limit	Plasticity Index
4	29.31	27.51	20.37	1.80	7.14	25.2	25	6

Liquid Limit

$$D = A - B$$

$$E = B - C$$

$$F = (D / E) \times 100$$

G = VALUE FROM FLOW CURVE (Nearest Whole No.) (3 pt. method)

G = F X (CORR. FACTOR) (Nearest Whole No.) (1 pt. method)

Plasticity Index

$$S = G - R$$

Plastic Limit

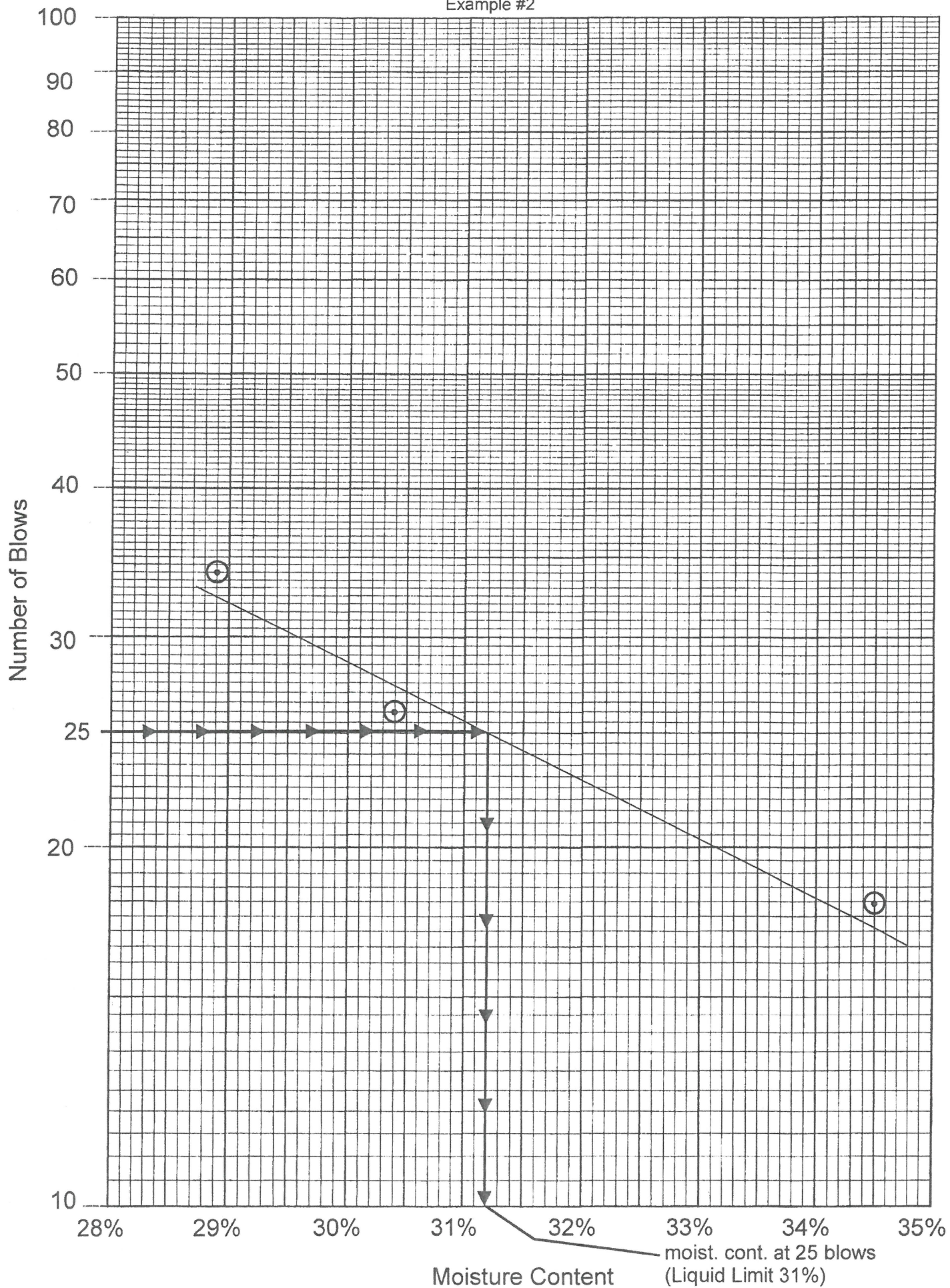
$$M = H - K$$

$$N = K - L$$

$$P = (M / N) \times 100$$

R = P (Nearest Whole No.)

Example #2



PLASTICITY INDEX

CHAPTER 7

FACE FRACTURE

T302E
Rev. 4-03

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL SOILS & TESTING DIVISION
FACE FRACTURE
MP 703.00.21

Lab Number		Project and Contract				Date Sampled				Transmit Date
Test Sequence	Material Code	C				Item Number	Plant Source Code	Aggregate Source Code		
		Quantity								
Sieves:	1st	2nd	3rd	4th	5th	6th	7th	8th	No. 200	
Design Number	Bitumen Content		Unit Weight		Face Fracture		LL	PL	PI	
		Target	Actual			%One	%Two			
AASHTO Size	Smallest Sieve 100%	Target A-bar	Actual A-bar	10 FA A-bar	75 CA No. 200	FA No. 200	Total No. 200	P/F/N		

Technician 1: Exercise #1 Technician 2: _____

Source _____ Date _____ Field Sample # _____

Technician 1. Initial Mass 2013

	Mass (Nearest 1g)	Percent of Sample (Nearest 0.1 %)
0 Face	<u>302</u>	<u>15.0</u>
1 Face	<u>226</u>	<u>11.2</u>
2 or More Face	<u>1485</u>	<u>73.8</u>
Final Mass	<u>2013</u>	
Total Crushed Particles	<u>1711</u>	<u>85.0</u>

Technician 2. Initial Mass 2013

	Mass (Nearest 1g)	Percent of Sample (Nearest 0.1 %)
0 Face	<u>305</u>	<u>15.2</u>
1 Face	<u>176</u>	<u>8.7</u>
2 or More Face	<u>1532</u>	<u>76.1</u>
Final Mass	<u>2013</u>	
Total Crushed Particles	<u>1708</u>	<u>84.8</u>

Final Results	Tech 1	Tech 2	Difference (Must be 2% or less)	Tech 1 & Tech 2 Average to Nearest 1 %
0 Face	<u>15.0</u>	<u>15.2</u>	<u>0</u>	<u>15</u>
1 Face	<u>11.2</u>	<u>8.7</u>	<u>3</u>	<u>10</u>
2 or More Face	<u>73.8</u>	<u>76.1</u>	<u>2</u>	<u>75</u>
Total Crushed Particles	<u>85.0</u>	<u>84.8</u>	<u>0</u>	<u>85</u>

T302E
Rev. 4-03

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL SOILS & TESTING DIVISION
FACE FRACTURE
MP 703.00.21

Lab Number		Project and Contract					Date Sampled			Transmit Date
Test Sequence	Material Code	C					Item Number	Plant Source Code	Aggregate Source Code	
		Quantity								
Sieves:	1st	2nd	3rd	4th	5th	6th	7th	8th	No. 200	
Design Number	Bitumen Content		Unit Weight		Face Fracture		LL	PL	PI	
		Target	Actual			%One	%Two			
AASHTO Size	Smallest Sieve 100%	Target A-bar	Actual A-bar			29 FA A-bar	54 CA No. 200	FA No. 200	Total No. 200	
									P/F/N	

Technician 1: Exercise #2 Technician 2: _____

Source _____ Date _____ Field Sample # _____

Technician 1.	Initial Mass	<u>519</u>	Mass (Nearest 1g)	Percent of Sample (Nearest 0.1 %)
	0 Face		<u>84</u>	<u>16.2</u>
	1 Face		<u>149</u>	<u>28.7</u>
	2 or More Face		<u>286</u>	<u>55.1</u>
	Final Mass		<u>519</u>	
	Total Crushed Particles		<u>435</u>	<u>83.8</u>

Technician 2.	Initial Mass	<u>519</u>	Mass (Nearest 1g)	Percent of Sample (Nearest 0.1 %)
	0 Face		<u>96</u>	<u>18.5</u>
	1 Face		<u>153</u>	<u>29.5</u>
	2 or More Face		<u>270</u>	<u>52.0</u>
	Final Mass		<u>519</u>	
	Total Crushed Particles		<u>423</u>	<u>81.5</u>

Final Results	Tech 1	Tech 2	Difference (Must be 2% or less)	Tech 1 & Tech 2 Average to Nearest 1 %
0 Face	<u>16.2</u>	<u>18.5</u>	<u>2</u>	<u>17</u>
1 Face	<u>28.7</u>	<u>29.5</u>	<u>1</u>	<u>29</u>
2 or More Face	<u>55.1</u>	<u>52.0</u>	<u>3</u>	<u>54</u>
Total Crushed Particles	<u>83.8</u>	<u>81.5</u>	<u>2</u>	<u>83</u>

*Rerun sample