

May 12, 2021



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
PHONE (719) 531-5599
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Winsome, LLC
1864 Woodmoor Drive, Suite 100
Monument, CO 80132

APPROVED
Engineering Department

05/19/2021 10:18:54 AM
dsdnijkamp

EPC Planning & Community
Development Department

Attn: Joe DesJardin

Re: Pavement Recommendations
Hodgen Road Widening
Winsome Subdivision, Phase 1
El Paso County, Colorado

PCD File No.
SF-21-003

Dear Mr. DesJardin:

If CTS is used, the design parameters will need to be submitted to the County prior to installation.

As requested, Entech Engineering, Inc. has obtained auger samples of the pavement subgrade soils for the widening of Hodgen Road for access to the above referenced subdivision. Laboratory testing to determine the pavement support characteristics of the soils was performed. This letter presents the results of the laboratory testing and pavement recommendations for these roadways.

Project Description

The project will consist of paving of the widening of Hodgen Road for access to the Winsome Subdivision, Filing No. 1. This report is for the new lane on the north side of Hodgen Road. One test boring was drilled, and four auger samples of the subgrade were sampled. Laboratory testing was performed to determine the pavement support characteristics of the soils. The layout and the locations of the test boring and auger samples are shown on the Site/Sample Location Map, Figure 1.

Subgrade Conditions

The test boring was drilled in the proposed roadway location to a depth of 5 feet. Due to the utility line placement, four hand-auger samples of the subgrade were obtained from the proposed roadway locations to determine the soil conditions. The Test Boring Log and Auger Sample Logs are presented in Appendix A. Sieve Analysis and Atterberg Limit testing were performed on soil samples obtained from the test boring and from the auger samples for the purpose of classification. Sieve analyses performed indicated the percent passing the No. 200 sieve for the Type 1 soils at subgrade depth ranged from approximately 10 to 30 percent. Atterberg Limit Tests performed on the Type 1 samples resulted in Liquid Limits ranging from 18 and no value with Plastic Indexes ranging from 2 and non-plastic. Soil Type 1 consisted of slightly silty to silty sand, which classified as A-2-4 soils based on the AASHTO classification system, which typically provide good support characteristics. One subgrade soil type was determined for pavement support from field investigation and laboratory testing (Soil Type 1). Groundwater was encountered in Test Boring No. 1 at a depth of 4 feet. The groundwater will not affect the design sections.

Swell testing was not required on the site soil samples based on the plastic indexes. The site soils do not require mitigation.

California Bearing Ratio (CBR) testing was performed on a representative sample of the subgrade soils to determine the support characteristic of the soils for the roadway section. The results of the CBR testing are presented in Appendix B and summarized as follows:

Soil Type 1 – Silty Sand

R @ 90% = 35.0
 R @ 95% = 60.0
 Use R = 50.0 for design

Classification Testing

Liquid Limit	NV
Plasticity Index	NP
Percent Passing 200	10.4
AASHTO Classification	A-2-4
Group Index	0
Unified Soils Classification	SM-SW

Pavement Design

The CBR testing was used to determine pavement sections for this site. The pavement sections were determined utilizing the El Paso County "Pavement Design Criteria and Report". The new lane classifies as a rural minor arterial, which used an 18K ESAL value of 689,850 to determine the pavement sections. Pavement sections for asphalt over aggregate base course or over recycled concrete base course sections are provided. Design parameters used in the pavement analysis are as follows:

Reliability	80%
Serviceability Index – Rural	2.5
Resilient Modulus	13,168 psi
"R" Value Subgrade	50
Structural Coefficients:	
Hot Bituminous Pavement	0.44
Aggregate Base Course	0.11
Recycled Concrete Base Course	0.11

Pavement calculations are attached in Appendix C. Pavement sections recommended for the site are summarized as follows:

Pavement Sections – Hodgen Road Widening

Minor Arterial
Soil Type 1, R = 50.0

<u>Alternatives</u>	<u>Asphalt (in)</u>	<u>Aggregate Base Course (in)</u>	<u>Recycled Conc. (in)</u>
1 – Asphalt Over Base Course	4.0*	8.0*	-
2 – Asphalt Over Recycled Concrete	4.0*	-	8.0*

* Minimum sections required in accordance with the El Paso County Paving Criteria.

Roadway Construction - Asphalt on Base Course or Recycled Concrete Alternatives

Prior to placement of the asphalt, the subgrade should be scarified, moisture-conditioned, compacted to a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557 at \pm 2% of optimum moisture content and proofrolled after properly compacted. Any loose or soft areas should be removed and replaced with suitable materials approved by Entech. Base course materials should be compacted to a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557 at \pm 2% of optimum moisture content. Special attention should be given to any areas adjacent to manholes, inlet structures and valves.

If significant grading is performed, the soils at subgrade may change. Modification to the pavement sections should be evaluated after site grading is completed.

In addition to the above guidance, the asphalt, recycled concrete, subgrade conditions, compaction of materials and roadway construction methods shall meet the El Paso County specifications.

We trust that this has provided you with the information you required. If you have any questions or need additional information, please do not hesitate to contact us.

Respectfully Submitted,

ENTECH ENGINEERING, INC.



Daniel P. Stegman

DPS/am

Encl.

Entech Job No. 210284

AAprojects/2021/210284 pr- widening



Reviewed by:


Mark H. Hauschild, P.E.
Senior Engineer

TABLE

TABLE 1**SUMMARY OF LABORATORY TEST RESULTS**

CLIENT WINSOME, LLC
PROJECT WINSOME AND HODGEN
JOB NO. 210284

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	AASHTO CLASS.	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1, CBR	1	0-3			10.4	NV	NP		A-2-4		SM-SW	SAND, SLIGHTLY SILTY
1	1	GRAB			24.4	NV	NP		A-2-4		SM	SAND, SILTY
1	2	GRAB			30.1	18	2		A-2-4		SM	SAND, SILTY
1	3	GRAB			24.2	NV	NP		A-2-4		SM	SAND, SILTY
1	4	GRAB			19.7	NV	NP		A-2-4		SM	SAND, SILTY

FIGURE

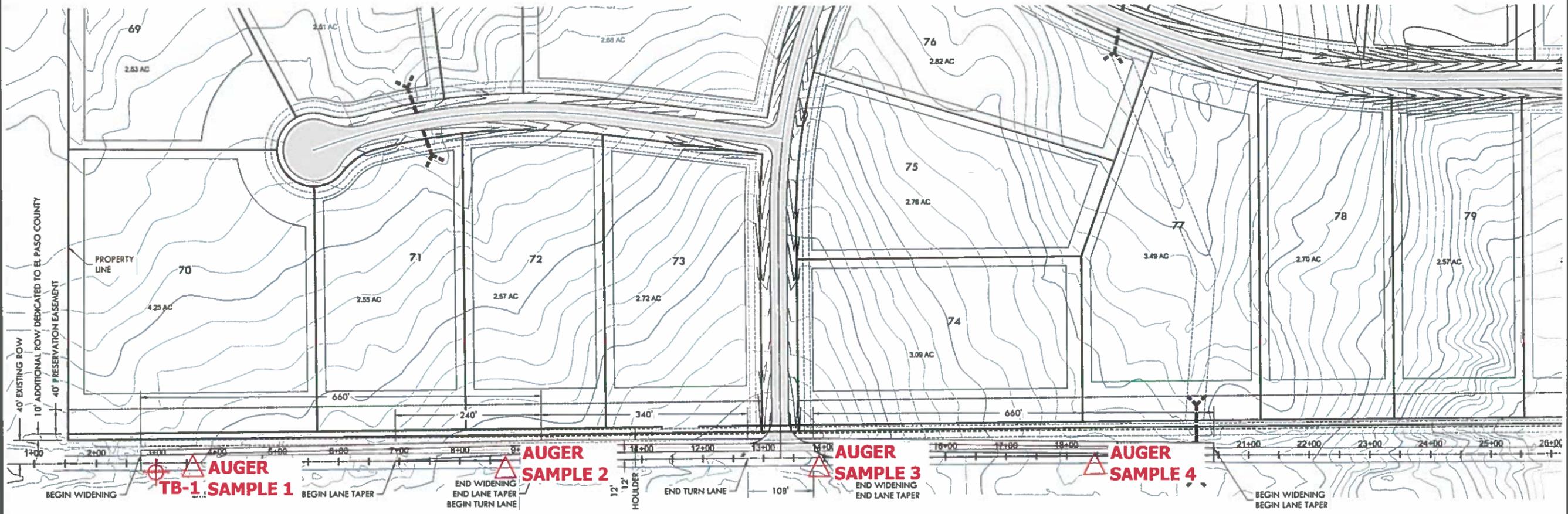
REVISION:	BY

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COLORADO SPRINGS, CO. 80907 (719) 531-5599



SITE/SAMPLE LOCATION MAP
HODGEN ROAD
COLORADO SPRINGS, CO
FOR: WINSOME, LLC

DRAWN	JAC
CHECKED	DPS
DATE	05/10/21
SCALE	AS SHOWN
JOB NO.	210284
FIGURE NO.	1



Hodgen Road

⊕ TB- APPROXIMATE TEST BORING LOCATIONS AND NUMBERS

△ 1 APPROXIMATE LOCATION OF AUGER SAMPLES AND NUMBERS

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
 DATE DRILLED 3/10/2021
 Job # 210284

TEST BORING NO.
 DATE DRILLED
 CLIENT WINSOME, LLC
 LOCATION WINSOME AND HODGEN

REMARKS

WATER @ 5', 3/10/21
 SAND, SILTY, FINE TO COARSE
 GRAINED, BROWN, MEDIUM
 DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
27			27	6.3	1
28			28	10.2	1
5					
10					
15					
20					



REMARKS

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5					
10					
15					
20					



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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		DS	5/12/21

JOB NO:
 210284

FIG NO:
 A- 1

AUGER NUMBER 1
 DATE DRILLED 4/30/2021
 Job # 210284

AUGER NUMBER 2
 DATE DRILLED 4/30/2021
 CLIENT WINSOME, LLC
 LOCATION WINSOME AND HODGEN

REMARKS

DRY TO 2', 4/30/21
 SAND, SILTY, FINE TO COARSE
 GRAINED, BROWN, MOIST

* - BULK SAMPLE TAKEN

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0-2			*	10.6	1
5					
10					
15					
20					

REMARKS

DRY TO 2', 4/30/21
 SAND, SILTY, FINE TO COARSE
 GRAINED, BROWN, MOIST

* - BULK SAMPLE TAKEN

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0-2			*	7.0	1
5					
10					
15					
20					



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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		DS	5/12/21

JOB NO:
 210284

FIG NO:
 A-2

AUGER NUMBER 3
 DATE DRILLED 4/30/2021
 Job # 210284

AUGER NUMBER 4
 DATE DRILLED 4/30/2021
 CLIENT WINSOME, LLC
 LOCATION WINSOME AND HODGEN

REMARKS

DRY TO 2', 4/30/21
 SAND, SILTY, FINE TO COARSE
 GRAINED, BROWN, MOIST

* - BULK SAMPLE TAKEN

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0-2			*	3.3	1
5					
10					
15					
20					

REMARKS

DRY TO 2', 4/30/21
 SAND, SILTY, FINE TO COARSE
 GRAINED, BROWN, MOIST

* - BULK SAMPLE TAKEN

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0-2			*	5.7	1
5					
10					
15					
20					



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TEST BORING LOG

DRAWN:

DATE:

CHECKED:

DATE:

DS

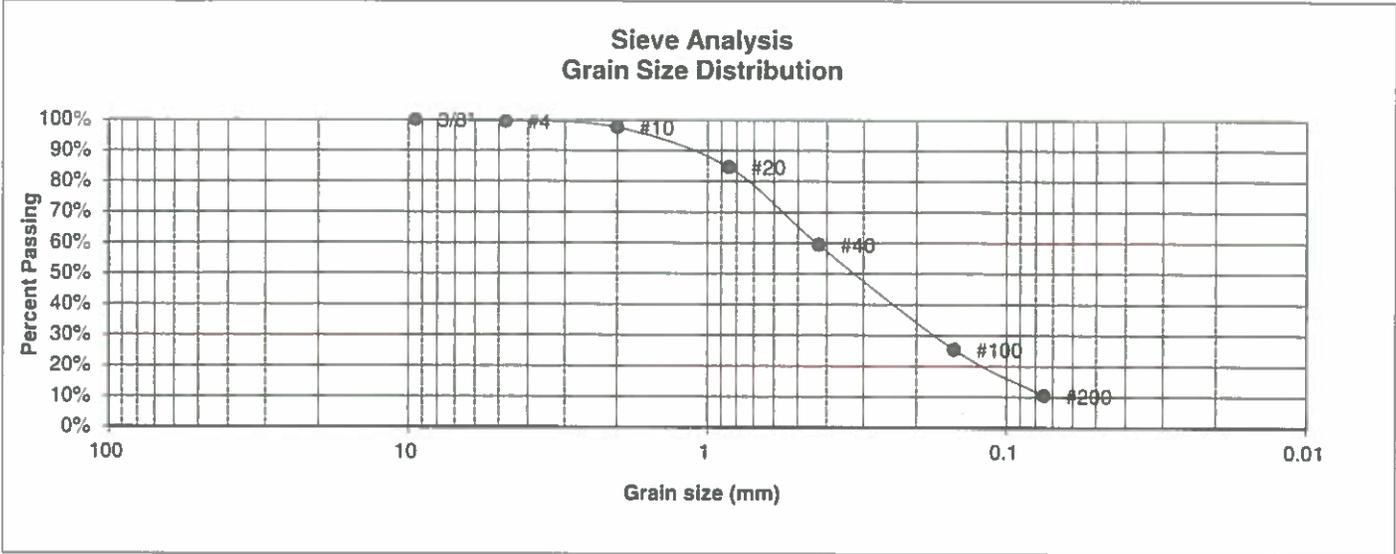
5/12/21

JOB NO:
 210284

FIG NO:
 A-3

APPENDIX B: Laboratory Test Results

<u>UNIFIED CLASSIFICATION</u>	SM-SW	<u>CLIENT</u>	WINSOME, LLC
<u>SOIL TYPE #</u>	1, CBR	<u>PROJECT</u>	WINSOME AND HODGEN
<u>TEST BORING #</u>	1	<u>JOB NO.</u>	210284
<u>DEPTH (FT)</u>	0-3	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-2-4	<u>GROUP INDEX</u>	0



<u>U.S. Sieve #</u>	<u>Percent Finer</u>
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.5%
10	97.5%
20	84.6%
40	59.4%
100	25.4%
200	10.4%

<u>Atterberg Limits</u>	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

<u>Swell</u>	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



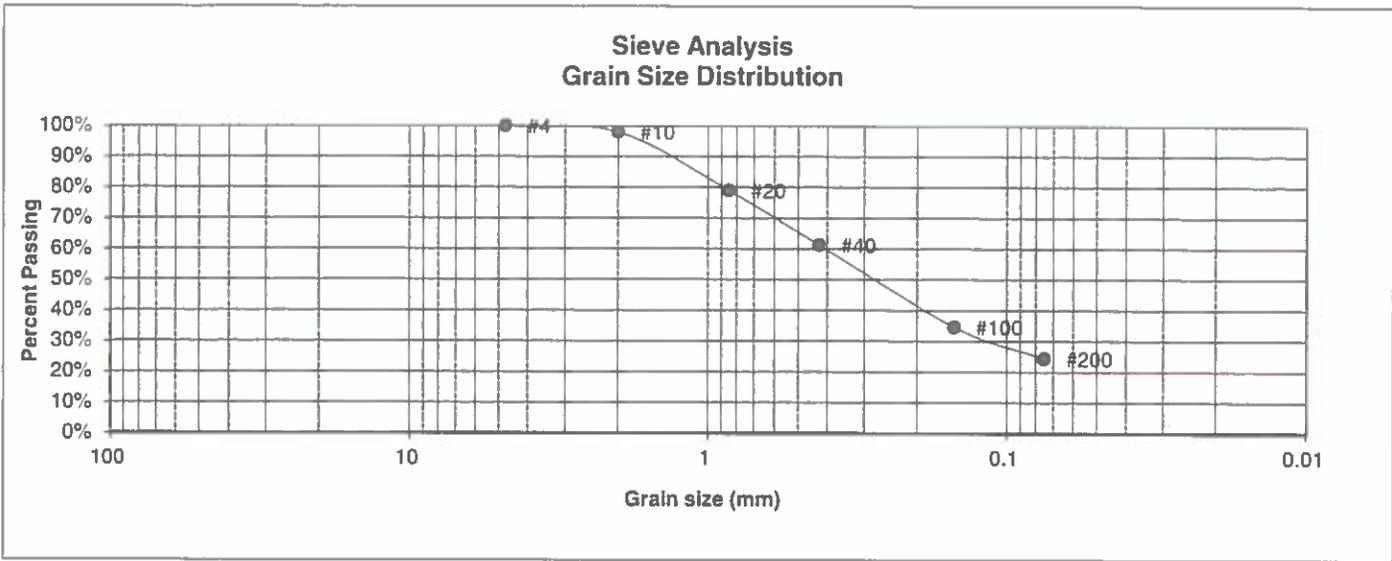
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**LABORATORY TEST
RESULTS**

<u>DRAWN:</u>	<u>DATE:</u>	<u>CHECKED:</u>	<u>DATE:</u>
		PS	5/12/21

JOB NO.:
210284
FIG NO.:
B-1

<u>UNIFIED CLASSIFICATION</u>	SM	<u>CLIENT</u>	WINSOME, LLC
<u>SOIL TYPE #</u>	1	<u>PROJECT</u>	WINSOME AND HODGEN
<u>TEST BORING #</u>	1	<u>JOB NO.</u>	210284
<u>DEPTH (FT)</u>	GRAB	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-2-4	<u>GROUP INDEX</u>	0



<u>U.S. Sieve #</u>	<u>Percent Finer</u>
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	98.0%
20	78.9%
40	61.2%
100	34.6%
200	24.4%

<u>Atterberg Limits</u>	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

<u>Swell</u>	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



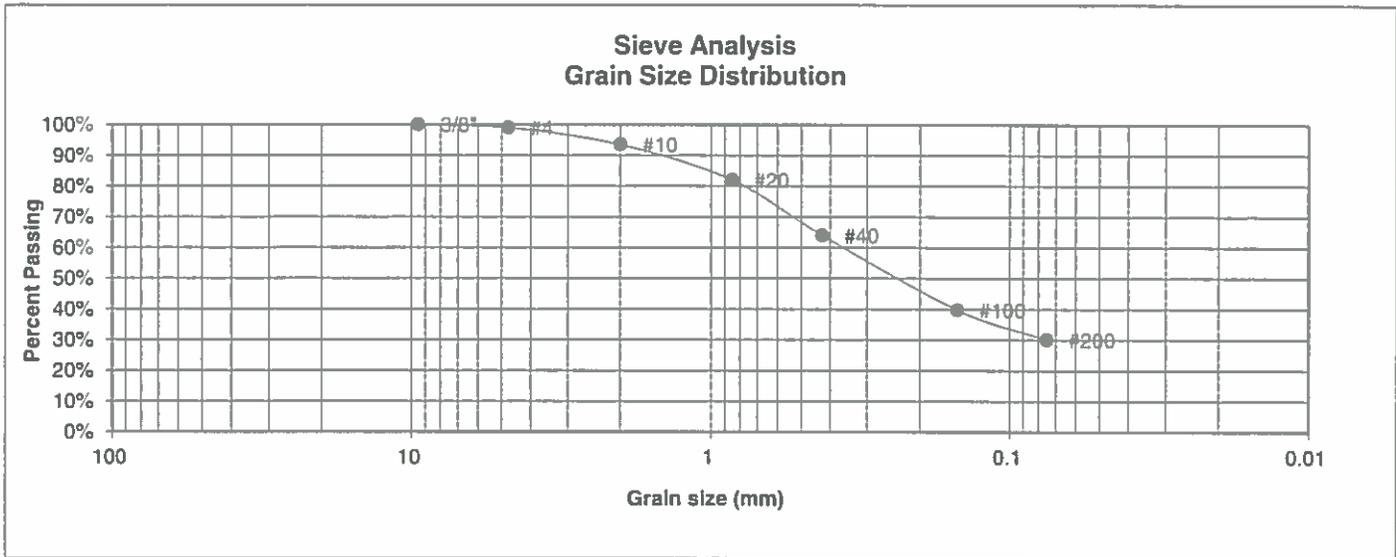
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**LABORATORY TEST
RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		BS	5/14/14

JOB NO.:
210284
FIG NO.:
B-2

UNIFIED CLASSIFICATION	SM	CLIENT	WINSOME, LLC
SOIL TYPE #	1	PROJECT	WINSOME AND HODGEN
TEST BORING #	2	JOB NO.	210284
DEPTH (FT)	GRAB	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.0%
10	93.5%
20	82.0%
40	64.0%
100	39.7%
200	30.1%

Atterberg Limits	
Plastic Limit	16
Liquid Limit	18
Plastic Index	2

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



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**LABORATORY TEST
RESULTS**

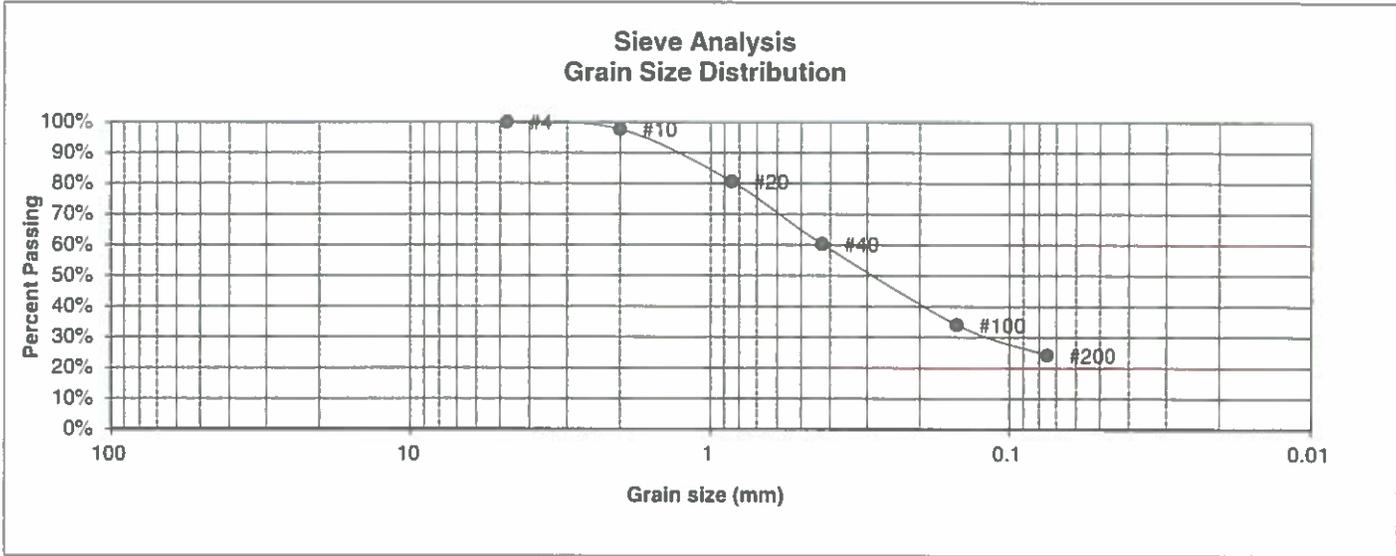
DRAWN:	DATE:	CHECKED: <i>DS</i>	DATE: <i>5/12/21</i>
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JOB NO:

210284
FIG NO:

B-3

<u>UNIFIED CLASSIFICATION</u>	SM	<u>CLIENT</u>	WINSOME, LLC
<u>SOIL TYPE #</u>	1	<u>PROJECT</u>	WINSOME AND HODGEN
<u>TEST BORING #</u>	3	<u>JOB NO.</u>	210284
<u>DEPTH (FT)</u>	GRAB	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-2-4	<u>GROUP INDEX</u>	0



<u>U.S. Sieve #</u>	<u>Percent Finer</u>
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	97.6%
20	80.6%
40	60.3%
100	34.0%
200	24.2%

<u>Atterberg Limits</u>	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

<u>Swell</u>	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



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**LABORATORY TEST
RESULTS**

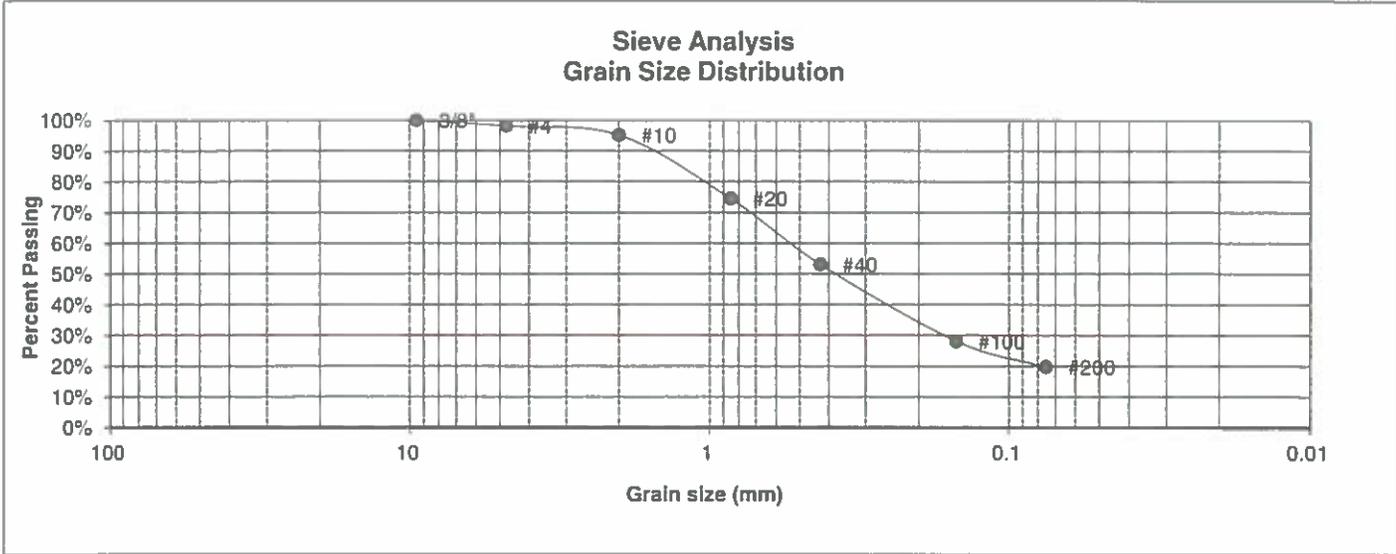
DRAWN:	DATE:	CHECKED:	DATE:
		DS	5/12/21

JOB NO.:

210284
FIG NO

B-4

UNIFIED CLASSIFICATION	SM	CLIENT	WINSOME, LLC
SOIL TYPE #	1	PROJECT	WINSOME AND HODGEN
TEST BORING #	4	JOB NO.	210284
DEPTH (FT)	GRAB	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.2%
10	95.2%
20	74.5%
40	53.0%
100	28.0%
200	19.7%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



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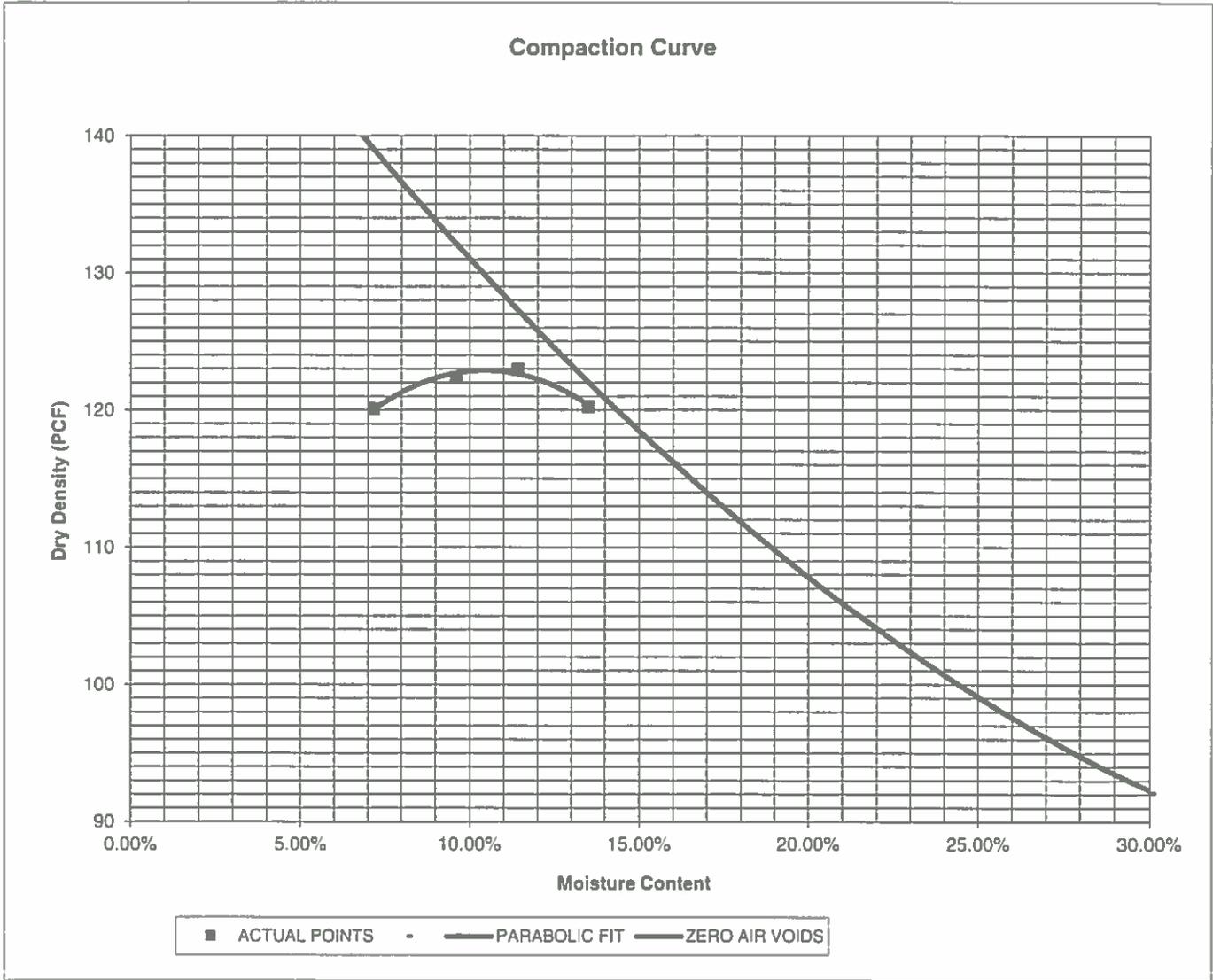
**LABORATORY TEST
RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		<i>DS</i>	<i>5/12/24</i>

JOB NO:
210284
FIG NO:
B-5

<u>PROJECT</u>	WINSOME AND HODGEN	<u>CLIENT</u>	WINSOME, LLC
<u>SAMPLE LOCATION</u>	TB-1 @ 0-3'	<u>JOB NO.</u>	210284
<u>SOIL DESCRIPTION</u>	SAND, SL. SILTY, TAN	<u>DATE</u>	04/13/21

<u>IDENTIFICATION</u>	SM-SW	<u>COMPACTION TEST #</u>	1
<u>TEST DESIGNATION / METHOD</u>	ASTM D-1557-A	<u>TEST BY</u>	SW
<u>MAXIMUM DRY DENSITY (PCF)</u>	123	<u>OPTIMUM MOISTURE</u>	10.5%

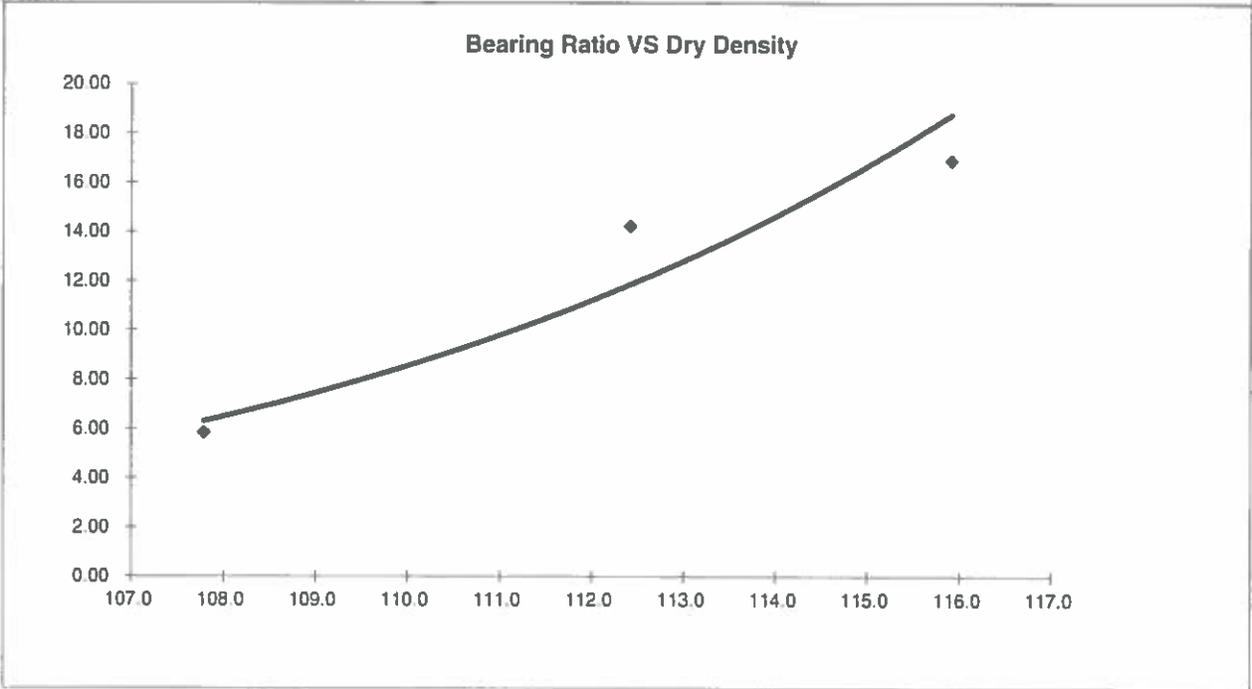
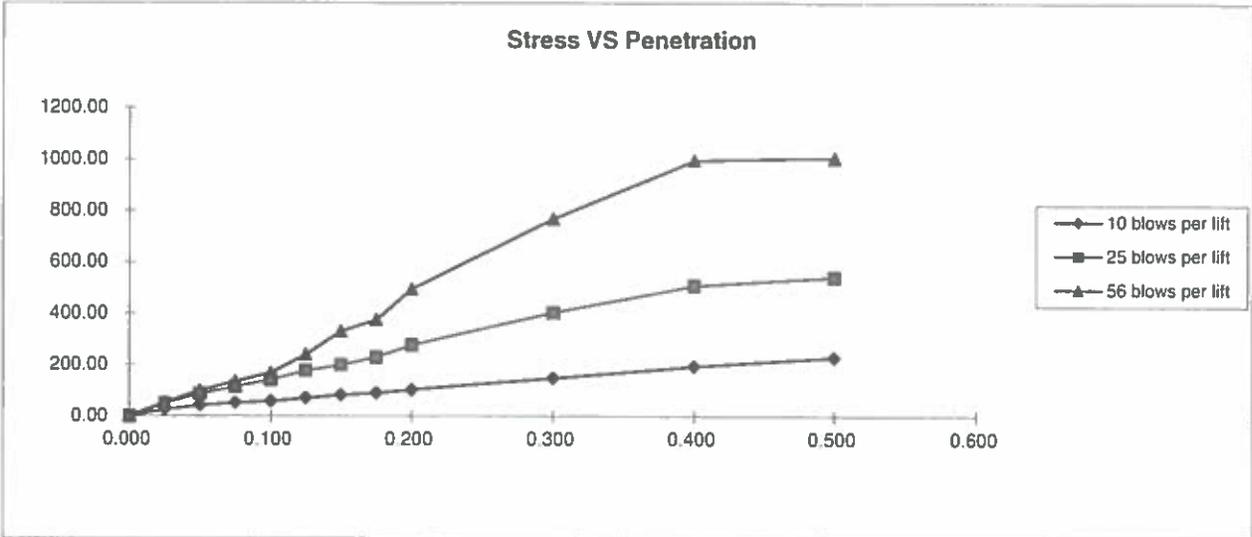



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MOISTURE DENSITY RELATION

DRAWN:	DATE:	CHECKED:	DATE:
		DS	5/12/21

JOB NO.:
210284
FIG NO.:
B-6



BEARING RATIO AT 90% OF MAX	11.12 ~ R VALUE	35.00
BEARING RATIO AT 95% OF MAX	17.64 ~ R VALUE	60.00

JOB NO: 210284
SOIL TYPE: 1



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CALIFORNIA BEARING RATIO

DRAWN:	DATE:	CHECKED:	DATE:
		<i>JS</i>	5/12/21

JOB NO: 210284
FIG NO: *B-8*

APPENDIX C: Pavement Design Calculations

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA

WINSOME SUBDIVISION - PHASE I
RURAL MINOR ARTERIAL

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	689,850
Hveem Stabilometer (R Value) Results:	R =	50
Standard Deviation	S_o =	0.44
Loss in Serviceability	$\Delta\psi$ =	2.5
Reliability	Reliability =	80
Reliability (z-statistic)	Z_R =	-0.84
Soil Resilient Modulus	M_R =	13168

Weighted Structural Number (WSN): ➔ WSN = 2.37

DESIGN TABLES AND EQUATIONS

$$S_1 = [(R - 5) / 11.29] + 3$$

$$M_R = 10^{[(S_1 + 18.72) / 6.24]}$$

$$k = M_R / 19.4$$

Where:

M_R = resilient modulus (psi)

S_1 = the soil support value

R = R-value obtained from the Hveem stabilometer

CBR = California Bearing Ratio

Reliability (%)	Z_R (z-statistic)
80	-0.84
85	-1.04
90	-1.28
93	-1.48
94	-1.56
95	-1.65
96	-1.75
97	-1.88
98	-2.05
99	-2.33
99.9	-3.09
99.99	-3.75

$$\log_{10} W_{18} = Z_R \cdot S_o + 9.36 \cdot \log_{10} (SN+1) - 0.20 + \frac{\log_{10} \left[\frac{\Delta \text{PSI}}{4.2 - 1.5} \right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 \cdot \log_{10} M_R - 8.07$$

Left	Right	Difference
5.84	5.84	0.0

Job No. 210284

Fig. No. C-1

DESIGN CALCULATIONS

DESIGN DATA

WINSOME SUBDIVISION - PHASE I

SOIL TYPE 1 - RURAL MINOR ARTERIAL

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL = 689,850
Hveem Stabilometer (R Value) Results:	R = 50
Weighted Structural Number (WSN):	WSN = 2.37

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

$C_1 = 0.44$ Strength Coefficient - Hot Bituminous Asphalt

$C_2 = 0.11$ Strength Coefficient - Aggregate Base Course

$D_1 =$ Depth of Asphalt (inches)

$D_2 =$ Depth of Base Course (inches)

FOR FULL DEPTH ASPHALT SECTION (CURRENTLY NOT ALLOWED)

$$D_1 = (WSN)/C_1 = 5.4 \text{ inches of Full Depth Asphalt}$$

Use N/A inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

$$\text{Asphalt Thickness (t)} = \boxed{4} \text{ inches}$$

$$D_2 = ((WSN) - (t)(C_1))/C_2 = 5.5 \text{ inches of Aggregate}$$

Base Course, use 8.0

RECOMMENDED ALTERNATIVES

1. 4.0 inches of Asphalt + 8.0 inches of Aggregate Base Course, or
2. N/A inches of Asphalt

Job No. 210284

Fig. No. C-2

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA

WINSOME SUBDIVISION - PHASE I
SOIL TYPE 1 - RURAL MINOR ARTERIAL

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	689,850
Hveem Stabilometer (R Value) Results:	R =	50
Standard Deviation	S_o =	0.44
Loss in Serviceability	$\Delta\psi$ =	2.5
Reliability	Reliability =	80
Reliability (z-statistic)	Z_R =	-0.84
Soil Resilient Modulus	M_R =	13168

Weighted Structural Number (WSN): ➔ WSN = 2.37

DESIGN TABLES AND EQUATIONS

$$S_1 = [(R - 5) / 11.29] + 3$$

$$M_R = 10^{[(S_1 - 18.72) / 6.24]}$$

$$k = M_R / 19.4$$

Where:

M_R = resilient modulus (psi)

S_1 = the soil support value

R = R-value obtained from the Hveem stabilometer

CBR = California Bearing Ratio

Reliability (%) Z_R (z-statistic)

80	-0.84
85	-1.04
90	-1.28
93	-1.48
94	-1.56
95	-1.65
96	-1.75
97	-1.88
98	-2.05
99	-2.33
99.9	-3.09
99.99	-3.75

$$\log_{10} W_{18} = Z_R \cdot S_o + 9.36 \cdot \log_{10} (SN+1) - 0.20 + \frac{\log_{10} \left[\frac{\Delta \text{PSI}}{4.2 - 1.5} \right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 \cdot \log_{10} M_R - 8.07$$

Left	Right	Difference
5.84	5.84	0.0

Job No. 210284
Fig. No. C-3

DESIGN CALCULATIONS

RECYCLED CONCRETE

DESIGN DATA

WINSOME SUBDIVISION - PHASE I

SOIL TYPE I - RURAL MINOR ARTERIAL

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL = 689,850
Hveem Stabilometer (R Value) Results:	R = 50
Weighted Structural Number (WSN):	WSN = 2.37

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

$C_1 = 0.44$ Strength Coefficient - Hot Bituminous Asphalt

$C_2 = 0.11$ Strength Coefficient - Recycled Concrete

$D_1 =$ Depth of Asphalt (inches)

$D_2 =$ Depth of Base Course (inches)

FOR FULL DEPTH ASPHALT SECTION (CURRENTLY NOT ALLOWED)

$$D_1 = (WSN)/C_1 = 5.4 \text{ inches of Full Depth Asphalt}$$

Use N/A inches Full Depth

FOR ASPHALT + RECYCLED CONCRETE BASE COURSE SECTION

Asphalt Thickness (t) = inches

$$D_2 = ((WSN) - (t)(C_1))/C_2 = 1.5 \text{ inches of Recycled Concrete}$$

Base Course, use 8.0 inches

RECOMMENDED ALTERNATIVES

1. 5.0 inches of Asphalt + 8.0 inches of Recycled Concrete Base Course, or
2. N/A inches of Asphalt

Job No. 210284

Fig. No. C-4